SPEECH, SEGMENTATION AND SPELLING SKILLS

~~PHONOLOGICAL DYSLEXIA~~ IN CHILDREN WITH DEVELOPMENTAL VERBAL DYSPRAXIA

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ABSTRACT

The thesis investigates the relationship between spoken and written language difficulties. Two children aged eleven and twelve years were studied. Both were of average intelligence but had a persisting speech difficulty of a dyspraxic nature. Normal control data was collected on each area tested so that the cases could be viewed from a developmental perspective.

First, a detailed analysis of speech errors was carried out. Compared to Articulation Age matched controls, the speech disordered children made multiple errors, had difficulty assembling the articulatory programme for unfamiliar words and relied on word specific knowledge. Second, on tests of auditory discrimination, lexical decision and segmentation skills, the speech disordered children performed less well than Reading Age matched controls. Their difficulties were most pronounced in the auditory modality and when nonword material was used. Third, their reading and spelling performance was compared to low Reading Age dyslexic children without obvious speech difficulties. The speech disordered children were more deficient in their use of phonological strategies and had not broken through to the alphabetic phase of literacy development.

The cases were followed up after three years. Although the children had improved their performance quantitatively, they still exhibited the same pattern of errors overall. They had become "trapped" in the logographic phase of literacy development and were adopting compensatory strategies when reading and spelling. Their pervasive phonological difficulties were compounded by their inconsistent and incoordinated speech.

These findings challenge the traditional view of Developmental Verbal Dyspraxia as a motor speech disorder. In addition to their articulatory difficulties, the children also had auditory processing and lexical problems. The findings allow further discussion of the role of articulatory and phonological skills in literacy development. A model of reading and spelling strategies is presented and the points where speech and language disordered children are most at risk are indicated. Finally, the clinical, educational and research implications are outlined.

CONTENTS

CONTENTS (Continued) Page

SECTION 2 - CASE STUDIES

CONTENTS (contd)

CONTENTS (Contd)

CONTENTS (contd)

Page

SECTION 3 - CONCLUSIONS AND IMPLICATIONS

CONTENTS (Contd)

APPENDIX (Contd) Page

LIST OF TABLES

TABLES (Contd)

TABLES (contd)

LIST OF FIGURES

SECTION 1 - THEORETICAL FRAMEWORK

CHAPTER 1

THE PHONOLOGICAL DEFICIT HYPOTHESIS

Surveys have shown a high prevalence of speech problems in preschool children (Davie, Butler and Goldstein 1972, Calnan and Richardson 1976, Morley 1965). Five percent of children are unintelligible when they enter school, whilst more severe and specific language problems arise in about one in every thousand children (Webster and McConnell 1987). These speech and language difficulties are usually accompanied by other learning difficulties which unfold as the child proceeds through school.

Typically, a child is referred first to a speech therapist because he is "not talking" even though he appears to be understanding spoken language and has no obvious hearing loss or physical abnormalities. There may be limited expressive vocabulary or delay in stringing words together. As the child's expressive language develops a speech problem becomes apparent. On starting school there may still be some articulatory difficulties but the child may be intelligible for most of the time. However, another problem emerges when reading. Familiar words may be recognised but a "sounding out strategy" to tackle new words eludes him. Spelling presents as an even bigger hurdle and may be "bizarre". Ideas in spoken and written language are often disorganised and grammatical errors are common. Some children also need help with the mechanics of handwriting. Overall the child's work may look "untidy" with an abundance of spelling mistakes and a paucity of punctuation. In contrast, accompanying drawings my be well constructed and detailed.

The following extract from a letter was written by Amanda aged nine years. It illustrates some of the above points. Note the grammatical simplifications and the particular difficulty when spelling longer words. This is like her speech. Amanda is very communicative but finds sentence construction and articulation of more complex words difficult. She attends a language unit and the letter was written following an assessment visit (a translation is provided underneath):-

Decesmdber 1st th

thak for Hare me I like to go a den
I like at den I like Chris and samd and at
Ket Cat and at Cake I like at lef with Mummy
Came I go to Bemaham and gen thak wennpms
Came I go No the telpe

December 1st

Thankyou for having me. I like to go again.
I like that dinner. I like crisps and sandwiches and that
Kitkat and that cake. I like that lift with Mummy.
Can I go to Birmingham again thankyou very much.
Can I go on the television.

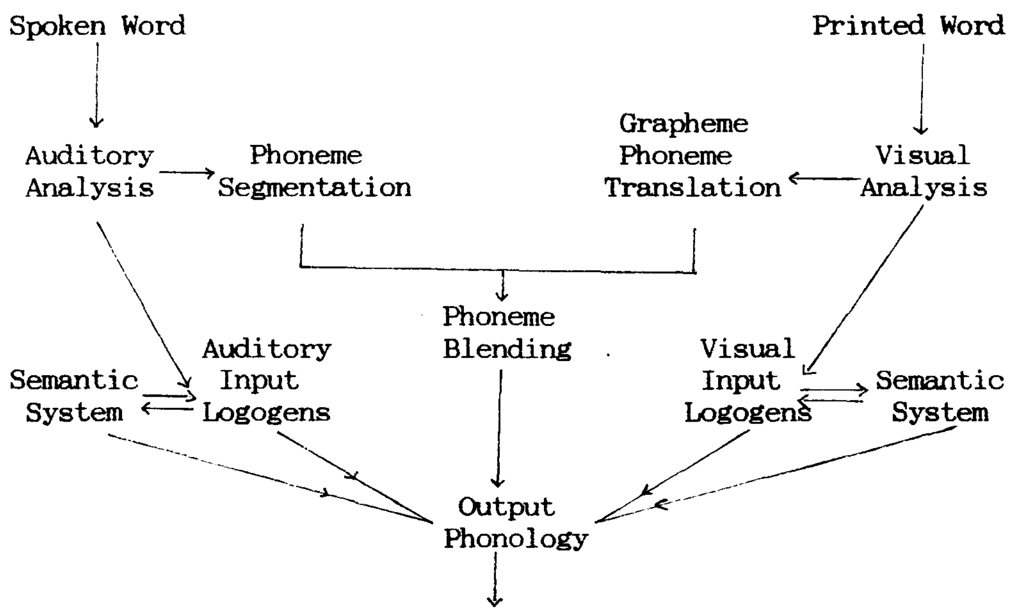
This chapter will discuss the relationship between spoken and written language development. It will focus on why developmental reading and spelling difficulties may be viewed as an extension of an underlying language difficulty by examining the reading and spelling process, by reviewing the phonological deficit hypothesis of dyslexia and by discussing investigations of reading and spelling skills in children with different types of speech and language disorders.

I. READING AND SPELLING DEVELOPMENT

A. The Reading and Spelling Process

Before learning to read and spell children have already established a psycholinguistic system to deal with verbal language. Single words are recognised via an auditory input lexicon, comprehended via the semantic system and produced via output phonology (Pring and Snowling 1986). In order to repeat unfamiliar words it is assumed that the child carries out phoneme segmentation and blending prior to assembling a new motor programme for output. When confronted by the printed word the child needs to integrate a visually based system for processing written material with the already existing auditory one (see Figure 1.1).

Figure 1.1 - Model showing interface between spoken and written language processing systems (Pring and Snowling 1986).



Familiar words are read through links between the visual input lexicon and semantic memory, and the output phonology system allows pronunciation from print. Unfamiliar words are decoded by grapheme-phoneme translation which requires successful sound segmentation skills (Coltheart 1980). Alternatively, they may be read by analogy with known words (Glushko 1979). Familiar words are spelt either by accessing automatic routines or by segmenting their components prior to phoneme-grapheme translation. When dealing with new or nonsense words only the latter strategy is possible. It is only later in the spelling process that teaching and experience have an effect. At this stage phoneme- grapheme translations are modified to fit spelling conventions, for example as in sigaret/cigarette (Frith 1980).

B. The Relationship Between Sound Segmentation Skills and Literacy Development

Segmentation refers to the child's ability to break up the speech stream into its components. This is a necessary skill when dealing with an alphabetic language such as English. The history of writing has seen a consistent trend towards alphabetic systems and away from logographic ones (Gleitman and Rozin 1977). Initially pictograms served as "written" communication. These pictures could be grouped to represent more abstract ideas, for example "share/speak" portrayed "gossip", while "bird/wood/ clothes" was used for "miscellaneous". Such logographic scripts which are still in use in China and Japan today, take years to learn because of the taxing memory load.

In contrast, an alphabetic script by nature of its grapheme-phoneme correspondences, allows the reader/speller to tackle words never seen before. In English for example, it is possible to combine a limited number of letters (twenty-six) into an infinite number of words and messages. To take advantage of this script however, the child must be able to segment the speech stream into its components and learn the grapheme-phoneme correspondences. Once he can do this, the child is not hampered by visual memory overload, he can read new words, and he can spell out messages even if these do not conform to English rules (Read 1975, Bissex 1980).

Some authors have argued that sound segmentation is a necessary prerequisite of learning to read (Liberman et al 1974, Gough and Hillinger 1980) and others have taken this further to suggest a predictive relationship between sound segmentation skill and later reading performance (Fox and Routh 1976, Hefgott 1976, Liberman and Mann 1980, Lundberg, Olofsson and Wall 1980). However, as Bryant (1985) emphasises, correlational results are relevant to a general group and of little consequence to individuals.

Following a longitudinal study of the effect of training segmentation skills on reading development, Bradley and Bryant (1983) were able to retrospectively match predicted "would have been" good/poor readers to "actual" good/poor readers. Less than one third of the "unusually good" sound categorisers went on to become unusually good readers and less than one third of the poor sound categorisers ended up as unusually weak readers. A similar relationship was found between initial segmentation performance and ultimate spelling level. Segmentation tasks can therefore not be used with certainty to predict later reading and spelling success in individuals. The first real empirical challenge to the prerequisite view was presented by Morais, Cary, Alegria and Bertelson in 1979. They addressed the issue of whether explicit knowledge of the phonetic structure of speech might be the outcome of normal cognitive growth through maturation or whether it requires specific training. To circumvent the ethical problem of depriving a group of children of literacy training, they moved their study to a poor agricultural area of Portugal where an adult literacy scheme had been introduced. This allowed for the testing of two groups; illiterate adults of normal intelligence and adults who had been taught to read after the age of fifteen years. The subjects were asked to subtract sounds from words, for example "What would "purso" sound like without the p?" ("urso" means bear in Portugese), and to add sounds to words, for example "What would "allacho" sound like with a /p/ at the beginning?" ("pallacho" means clown). The illiterates made significantly more errors (79%) than the literates (28%) on these tasks. When nonwords were presented the illiterate group were unable to delete or add a single phoneme, while the literate group could do so fairly readily.

These results suggest that sound segmentation is induced by literacy training. It can therefore not be an essential prerequisite to learning to read although Morais et al acknowledge that training prior to a "critical period" of maturation or cognitive growth may be ineffectual.

Morais and his colleagues have recently reported a follow up to this study (Morais, Bertelson, Cary and Alegria 1986). They administered a wider range of segmentation tasks to new groups of illiterate and ex-illiterate adults. The illiterates were again unable to deal with phonetic segment manipulation. They were however better at syllable and rhyme tasks although still performed less well than the literate group. The authors conclude that rhyme and syllable segmentation can be developed up to a certain point in nonreaders but that the analysis of phonetic segments requires literacy experience.

Studies of young children also indicate that reading experience aids segmentation performance. Barton, Miller and Macken (1980) taught preliterate preschoolers to segment initial consonants in words (m/ouse, b/ear). They then examined how the children analysed words with initial consonant clusters (tr/ee). Children with some reading ability were able to segment the clusters into phonemes but nonreaders regarded the clusters as single units.

Ehri and Wilce (1980) presented twenty-four children (aged nine years and six months) with words to segment by matching a counter to each phoneme. They were then asked to spell them. Half of the words contained "hidden" letters (pitch/rich, comb/home). The results indicated that children used their orthographic knowledge in the segmentation task - those who could spell the words marked the "hidden" letters with a counter.

In a second experiment, Ehri and Wilce (1980) invented nonsense words for pictures of animals. Each of the five nonsense words used had two spellings. One of the spellings included an extra letter that corresponded to a potential sound in a word (tadge, banyu). The control set had no such hidden letters (taj, banu). Twenty-four subjects were matched on the basis of word reading scores and one member of each pair was taught the experimental set of names spelled with the extra letter while the other member of the pair learned the control set. The children segmented and then spelled the words. The subjects who had been taught the experimental set of words marked the extra letter when segmenting the word indicating that reading experience shapes the learner's conceptualisations of the phoneme segments.

Perin (1983) extended this work by examining whether segmentation skill was more closely related to reading or spelling development in a group of adolescents. These were divided into the groups; good readers and spellers (group A), good readers and poor spellers (group B), and poor readers and spellers (group C). The hypothesis was that if spelling performance is more important than reading performance then poor spellers should perform less well on segmentation tasks irrespective of reading ability. In Perin's first experiment she asked subjects to "spoonerise" current pop singers' names (Bob Dylan -> Dob Bylan). Good readers/good spellers (group A) were significantly better than the other two groups, but interestingly there was no significant difference between children who were good readers/poor spellers (group B) and children who were poor at both reading and spelling (group C). These results suggest that spelling and not reading is the primary influence on success rate on this task. A qualitative analysis of the spoonerism responses showed that subjects in Groups B and C made more serious errors than those in Group A. In addition, subjects in both groups B and C made a predominance of nonphonetic spelling errors. Perin considered two possibilities to explain these results. First, grapheme-phoneme conversion may be hindered by poor segmentation resulting in poor spelling or conversely segmentation attempts in the spoonerism task may have been hindered by poor spelling knowledge. The latter view was supported by subject reports. A group B subject stated that he used spelling knowledge to perform the task. As his spelling was poor this may have accounted for his poor performance on spoonerisms.

Perin went on to present the same three groups of subjects with a segment judgement task in which words containing more letters than phonemes were presented, for example "ache, vague, ocean" (Type 1), together with words containing equal numbers of letters and phonemes, for example "mud, atom" (Type 2). In addition a set of Type 2 nonwords, for example "kig, cadim" were included. It was predicted that if spelling knowledge influences segmentation ability then there should be a clear difference between Type 1 and 2 words in Group A but not in Groups B or C, while performance on Type 2 real and nonwords should be similar. The results supported this prediction. Given the findings that orthographic experience influences the child's segmentation skill, a recent line of enquiry has been to examine the **nature** of this literacy experience. Is specific alphabetic experience important? Studies of children receiving different types of reading instruction suggest that it is. Children who have been taught phonically are more aware of phonemes than those who have learned reading via a "look and say" method (Alegria, Pignot and Morais 1982). This is also true of adults.

Chinese adults, literate only in Chinese characters, performed poorly on phoneme segmentation tasks compared to Chinese adults literate in alphabetic spelling as well as characters (Read, Yun-Fei, Hong-Yin and Bao-Qing, 1986). The two groups were matched on education and experience but the first group were older and had not been taught alphabetic skills - a comparatively recent addition in schools. Interestingly, adults who could only read Chinese characters at the time of testing but who had once been exposed to alphabetic skills, either early on or through their own children, were able to manipulate phonemes.

Read et al's results suggest that specific phoneme segmentation skills do not develop merely as the result of cognitive maturation, or through any kind of literacy experience, or even when the child is exposed to other metalinguistic experiences such as rhyme. Rather, it develops as a result of learning to read and write alphabetically.

Mann (1986) contradicted these findings in her cross cultural study of Japanese and American children's awareness of syllables and phonemes. She agreed that beginner readers are influenced by the script that they are learning. Thus, young American children were aware of both syllables and phonemes whereas Japanese children who first learn a syllabic script were poorer at detecting phonemes but could count and manipulate syllables. However, when these same tasks were administered to older Japanese children, they were able to complete phoneme segmentation tasks whether or not they had received alphabetic instruction. The author concluded that the development of phonological awareness is a "multi-faceted process"; the ability to manipulate phonemes may be a natural concomitant of primary language development, which in turn is exploited by secondary language activities such as reading, versification and word games. This suggests that phoneme segmentation skills become more precise throughout reading development rather than being a direct consequence of having learned to read.

Debate over segmentation skill as a prerequisite or as a consequence of learning to read will not help our understanding without reference to a developmental perspective. Clearly sound segmentation is not a necessary prerequisite of learning to read for beginner readers rely on a visual strategy (Bryant and Bradley 1980) and read logographically (Frith 1985). Only later do they use an alphabetic code. However, also unlikely is the possibility that **all** phonological awareness is the consequence of orthographic experience for tacit sound awareness abilities have been demonstrated in young children. So, the development of phonological awareness must be viewed on a developmental continuum which will be influenced at some stages by orthographic experience.

In order to account for both Read et al's (1986) finding that only experience of an alphabetic script promoted sound segmentation skills and Mann's (1986) finding that older Japanese children could segment at the sound level without alphabetic experience, the role of articulatory feedback in segmentation development needs to be acknowledged. Let us reconsider the findings of single sound segmentation versus cluster segmentation. Why should the preliterate children in Barton et al's study (1980) have been able to segment sounds but not clusters? Why are young children unable to detect the nasal in nasal clusters such as in "tent" (Marcel 1980, Snowling 1982)? Why do young nonreaders produce salient consonants but not clusters or vowels in their spontaneous spelling (Read 1975, Bissex 1980)? A possible answer to these questions is that children use articulatory feedback to segment single sounds but this is not sufficient when words contain more subtle articulations which are acoustically more complex. For example, beginner spellers only mark the element of the cluster that has articulatory salience - hence the deletion of nasals (mn) and glide approximants (wrly). Similarly, vowels are often omitted since unlike consonants they have no firm articulatory contacts - compare the pressure of plosives (p t k) with the vague tongue positions for vowels (ah oh ee). Mann's results support this hypothesis since the older children who successfully performed the sound segmentation tasks were already proficient in segmenting at the syllable level and could draw on their articulatory plus acoustic feedback to segment at the simple sound level. Furthermore, a critical feature of Japanese is that it contains no clusters; therefore the children's segmentation skills were not taxed at the level at which alphabetic experience was necessary.

Thus, it is proposed that although orthographic experience is necessary for the child to tackle more complex sound segmentation tasks such as those involving clusters, simple sound segmentation can be accomplished by prereaders with normal auditory input and articulatory development and sufficient general metalinguistic awareness to tap such cues.

C. The Relationship Between Reading and Spelling Development

The development of spelling has received less attention than the development of reading (Kirk 1983). It has been assumed that both reading and spelling comprise the same skills - spelling being the reading process in reverse. However, the finding that some children can spell before they can read challenges this view. Read's (1971) analysis of invented spellings from a group of four and five year old nonreaders indicates that spelling reflects a tacit mastery of a language based rule system. The children used their limited alphabetic knowledge in conjunction with their articulatory skills to symbolise sounds. Letter names were used for sounds and syllables (CAKE/CAK, ART/RT, LITTLE/LETL, BOTTOM/BOTM). When an appropriate letter name could not be found, the children chose an articulatorily close symbol (BUT/BIT, SIT/SET). The close relationship between their speech production and spelling was evident in words triggering speech errors (DRAGON/JRAGN). Their spelling performance was independent of reading development and was determined by the knowledge and experience they brought to the situation at the time.

Further support for the dissociation view comes from Bradley and Bryant (1979). They experimentally demonstrated that beginner readers may be able to read irregular words that they cannot spell (school) and spell regular words that they cannot read (bun). However, when the regular words were later embedded in nonword lists (dun, bik) the children were able to read them. This suggests that although children prefer to read by the visual route and to spell by the phonological one, they can change their strategy if the situation dictates. The rigid use of strategies is normally found in the early stages of development and prevents children from successfully completing tasks that they have the ability to accomplish. Increasing flexibility of strategy use is a sign of normal reading and spelling development (Bryant and Bradley 1980). The corollary of this is that persisting dissociation of reading and spelling skills is a sign of problematic development.

Frith and Frith (1980) tested three groups of twelve year old children: good reader/spellers, good readers/poor spellers, and poor reader/spellers. All children were asked to spell nonwords. The children who were good readers but poor spellers performed in a qualitatively similar way to Bradley and Bryant's (1979) six and a half year olds; they read visually but spelled phonologically. In contrast, the children who were poor at both reading and spelling were not proficient in either visual or phonological strategies. The authors concluded that reading is a recognition process reliant on visual skills, while spelling is a retrieval process reliant on phonological skills.

In contrast, Ehri (1985) argued that reading and spelling are not separate. Rather when reading, phonological skills draw attention to the visual form of the word and promote orthographic storage. Similarly spelling cannot be purely a retrieval process since recognition is required to check spelling-sound rules and detect errors. This view is not necessarily incompatible with that of Bryant and Bradley who accept that the dissociation between reading and spelling may only be present for a short period early in development. As the child matures the development of reading will influence his spelling. This influence however may be detrimental to spelling performance. As children become more reliant on context for reading comprehension their global scanning of the text detracts from the specific attention to spelling detail and spelling may suffer (Ehri and Roberts 1979, Ehri and Wilce 1980, and Maul 1983).

D. Models Of Reading and Spelling Development

Current models of reading development argue strongly for a process that unfolds in a sequence of stages or phases. Models must be able to account for the changing relationship between reading and spelling skills and also for individual differences in the strategies children use (Baron and Strawson 1976). A strategy has been defined as an "active change in processing modes to accommodate task demands" (Marsh and Desberg 1983). A model based on such strategy change has been forwarded by Marsh, Friedman, Welch and Desberg (1980).

In this reading development comprises four stages:-

1) rote learning plus linguistic guessing.
2) visual letter plus linguistic context cued guessing.
3) sequential decoding - letter by letter and phoneme by phoneme.
4) hierarchical decoding where phoneme decoding is dependent on the letter context. Analogy strategy.

and spelling development three stages:-

1) simple sequential phoneme encoding.
2) hierarchical encoding involving rules dependent on the word/letter context.

3)spelling by analogy to spelling already known.

Frith (1985) has elaborated this approach to produce an interactive framework for literacy development. The model comprises three phases. The first, the **logographic** occurs when a child recognises words on the basis of minimal visual features in a nonanalytical fashion. Unfamiliar words cannot yet be read. To move into the next phase, the **alphabetic**, a child must learn the relationship between letter and sounds and they can begin to spell "by ear". Once grapheme-phoneme rules are learned new words can be tackled. Finally, in the **orthographic** phase a child's reading is independent of sound and there is automatic analysis of words into orthographic units. This is therefore a morphemic rather than phonemic stage.

The stages suggested are similar to Marsh et al's but the attraction and strength of Frith's model is that it attempts to account for the developmental relationship between reading and spelling (see Figure 1.2).

Figure 1.2 - Frith's (1985) 6-step model of reading and spelling development.

Step	Reading		Spelling
1	Logographic	└──→	Logographic
2	Alphabetic	←──┘	Alphabetic
3	Orthographic	└──→	Orthographic

According to this model, reading and spelling develop out of phase with each other. It is possible for the beginner reader to be in one phase when reading and in another when spelling. While logographic skills develop first for reading, it is spelling that acts as the pacemaker for the development of alphabetic skills. Thus, normal children first learn to use letter/sound correspondences when writing and only later transfer this knowledge to the reading situation. This "out of phase" development accounts for the dissociation in reading and spelling found by Read (1971), Bradley and Bryant (1979), and Frith and Frith (1980).

According to Frith, breakthrough from one phase to another occurs as the result of the **merging** of old and new strategies. For example, the orthographic phase arises from the merging of the previously learned holistic and analytical skills. Movement through these phases is not necessarily one way. Although each subsequent phase is built on the previous one a skilled reader can "fall back" on an earlier phase of development if the task demands it. For example, a phase three reader can adopt an alphabetic strategy to tackle new or nonwords.

Closer examination of these phases reveals why speech and language skills are important for satisfactory literacy development.

E. Phases of Reading and Spelling Development

1. Preliterate

Before embarking on reading and spelling specific words, the young child develops an awareness of the purpose of written language. Reading readiness may be indicated by the child picking up a book or newspaper and "reading" a familiar story or rhyme to an adult, pet or toy. Similarly, many adults have been the recipients of "letters" from young children. These comprise a series of squiggles and shapes, often with a drawing, conveying the idea of communication (see Bissex 1980). If letter forms are used at all during this stage they bear no relationship to sounds and the "message" is unreadable (Gentry 1982). Children's early scribblings do however suggest that they know how print should look (Gibson and Levin 1975, Harste, Burke and Woodward 1982). This stage is necessary for logographic reading and spelling to begin. Children who have such metalinguistic awareness when starting school have accelerated development of reading and spelling strategies.

2. Logographic

On entering the logographic phase, children first recognise highly familiar words such as store labels on bags, breakfast cereal or favourite chocolate bars. They are not able to read these words in different contexts or if written in a different script (Harris and Coltheart 1986). This is essentially a whole word recognition phase. Very soon minimal visual cues are used, for example, length or overall shape of the word, the number of dotted i's, or the number of similar letters (Seymour and Elder 1986). Reading skill is reliant on visual memory and visual errors are increasingly common.

Frith suggests that the automatic reading and spelling of familiar and irregular words begins in the logographic phase since some words are so highly familiar that they are recognised as "wholes" from very early on in development. Ehri (1985) disagrees with this. She argues that because word storage is sound based, automatic reading and spelling will only occur in the later alphabetic phase.

These disparate views can be reconciled. It makes sense that automatic reading and spelling will emerge from the logographic phase but that it will also need the support of alphabetic skills to enhance visual memory. Without the phonological strategy for word storage the system will quickly become overloaded and uneconomical. In addition both visual and phonological strategies are necessary for checking responses (Schallert 1982, Ehri 1985, Content, Kolinsky, Morais and Bertelson 1986).

A similar controversy surrounds the development of reading and spelling by analogy with familiar words. Marsh et al (1980) and Frith (1985) cite this late in development - at the orthographic phase. Recently however, Goswami (1986) has demonstrated reading by analogy in much younger children. Given that children are recognising word patterns in the logographic phase, it is unlikely that they will wait until the orthographic phase before utilising such an economic way of reading and spelling. Indeed, early spelling attempts may instigate the analogy strategy by drawing attention to orthographic and phonological commonalities through motor practice. The use of this strategy is however dependent on the development of orthographic neighbourhoods (Glushko 1979) and may therefore not be used **proficiently** until the orthographic phase. Therefore although the analogy strategy may begin in the logographic stage it is restricted in its use at this point by the child's limited visual lexicon.

Spelling development also begins with the logographic phase. Very often the child first learns to write his name, often as a complete motor pattern. Frith argues that this draws attention to the elements of a word which acts as a pacemaker for the alphabetic skills characteristic of the next phase of development.

3. Alphabetic

In the alphabetic phase, the relationship between letters and sounds is learned, and spelling "by ear" is possible (Frith 1979). Unfamiliar words can be tackled via phoneme-grapheme translation rules. According to Frith the child breaks through to the alphabetic phase via spelling rather than reading.

Development of letter knowledge is an important prerequisite to the development of reading (Ehri 1983, Mason 1980). It is considered to be a better predictor of reading achievement than intelligence (Chall 1967, Johnson 1969). Ehri and Wilce (1979) found that children learned letter-sound associations easily once they knew the letter names. In contrast it took children a long time to learn arbitrary associations between meaningless stimuli and responses. Children starting school with alphabetic experience learn to read earlier than those without (Francis 1982). The ability to use the phonetic features of letters rather than relying on visual features, proves to be a more robust reading strategy. Mason (1980) found that children who relied on visual cues recalled fewer words after a fifteen minute delay than those able to use a sound strategy.

It is through the focussed attention of learning letter names that children learn to discriminate and remember shapes. Furthermore, children associate the shape with a name that often incorporates the letter sound (Durrell 1980, Ehri 1983). This letter sound learning may explain the close relationship between letter naming and literacy development. What is often viewed as a visual recognition task - learning letters - is an important grapheme-phoneme skill. The ability to make this association enables breakthrough into the alphabetic phase. Once children are able to utilise this phonological rather than visual strategy they are in a position to invent spellings (see Read 1971, Bissex 1980).

Ehri (1985) distinguishes between phonetic and semiphonetic spelling errors in the alphabetic phase of development. Semiphonetic errors are partial word spellings usually found in pre or beginner readers and include: a letter name to represent a sound (ARM/RM), boundary sounds only (BACK/BK), vowels ignored or misrepresented unless their name can be used (BOAT/BOT), reduced clusters (CRAB/KB), and representation of syllables by graphemes (ELEPHANT/LFT). Voicing confusions are also common and follow logical acoustic cues - voiced in initial position (PET/BT), and devoiced in final position (BED/BT). Cook (1981) called this "preconventional" stage as although logical it lacks English spelling conventions. It is however different to the logographic phase since syllable and sound segmentation are involved.

The second phonetic phase reflects increased orthographic experience. It is characterised by the one to one mapping of letters and sounds (CIGARETTE/sigaret, CATALOGUE/catalog). Sound blending is now as important as sound segmentation. Without it sound segmentation will not be helpful when decoding text as meanings cannot be accessed from a string of unrelated sounds. When spelling, it is not uncommon for overexaggerated phonems to be represented as a result of emphasis or elongation of the word or sounds during the segmentation process (FRIEND/ferend, CUP/cuphe). Unlike semiphonetic spelling, phonetic spellings are readable and include vowels. There is a much closer relationship between reading and spelling performance (as noted by Ehri 1985, and Boder and Jarrico 1982).

4. Orthographic.

Unfortunately for the young child, spelling development cannot stop at the alphabetic phase since the English orthographic system is riddled with irregularities - within spellings, between spellings and sounds, and between spellings and lexical meanings (Henderson 1982). In order to cope with these irregularities the child must transcend the phonetic principle of one sound per letter which dominates the alphabetic phase and move into the orthographic phase. This phase marks the child's ability to spell by larger units - morphemes. Eight year old children who are successful readers and good spellers progress beyond the stage of relying on a phonetic approach and have adopted visual orthographic strategies (Roberts 1983). The ability to recognise root words plus affixes is a more economical reading and spelling strategy. Phonetic spelling is not abandoned entirely but can supplement morphemic spelling when the task demands, for example when spelling new or nonwords. Nonphonetic spelling may also reoccur. Previously readable words (KITCHEN/kichin) may be compromised by an attempt to spell morphologically (KITCHEN/kittion). Thus, a peak in spelling performance in the alphabetic phase may be followed by a drop on entering the orthographic phase.

In this phase of spelling development, the child links his reading experience with his morphological development. Reading experience is critical to learning how to represent these morphemes since they often bear little resemblance to sound, for example the "tion" in ADDITION. Skilled spellers within this phase not only abstract orthographic regularities at a phonetic level but also penetrate below the surface structure to the underlying morphophonological representations allowing them to change the surface forms accordingly (compare: CONFER/CONFERRING/CONFERENCE). The child recognises regularities across words and learns the orthographic patterns to represent the morphophonemic rules. Rapid, automatic decoding skills are acquired (LaBerge and Samuels 1974) which can be used to conduct checks of word spellings which in turn facilitates storage and maintenance of spellings. This increase of word storage via orthographic neighbourhoods results in the analogy strategy being used more effectively than in the earlier stages.

Breakthrough to the orthographic phase does not mark the end of spelling development. In a study of spelling proficiency and sensitivity to word structure in an undergraduate student population, Fischer, Shankweiler and Liberman (1985) showed that spelling is by no means a simple skill acquired during elementary education. Many of the students tested had persisting spelling problems even though they may have been good readers. Reading experience alone is therefore not sufficient for the successful functioning of this stage. Abstraction of rules is also required though not necessarily at a conscious level. When asked, the students were unable to verbalise their rationale for changes in surface form (have/having) indicating a tacit level of metalinguistic awareness in young adults.

An intact facility for speech and language is therefore necessary for satisfactory reading and spelling development. The child must first be aware of the communicative purpose of written language. Second, he uses his phonetic and phonological knowledge to breakthrough into the alphabetic phase of reading and spelling and finally the orthographic phase builds on his morphological development.

Evidence that children with delayed or problematic speech and language development show subsequent reading and spelling difficulties has been collected from a variety of sources. Ingram, Mason and Blackburn (1970) followed up a large group of children who had had speech therapy in Edinburgh to find that the majority of these were having reading difficulties. Similarly, Aram and Nation (1980) studied 63 preschool children with language delay over a five year period. Forty percent of these children were found to have reading problems, 24 percent had spelling difficulties and 28 percent performed below average in maths. Epidemiological studies have also demonstrated a relationship between language and learning problems (Silva 1987).

For example, Rutter, Tizard, Yule, Graham and Whitmore (1976) found that in the nine year old population on the Isle of Wight, those children who had reading problems were characterised by earlier linguistic difficulties. Furthermore, within the reading disabled group generally backward readers could be differentiated from children with specific reading retardation. As in verbal language disorders (Morley 1965) these specific difficulties were more common in boys and often ran in the family. Indeed the association between reading disability and spoken language disorders is so strong that it has been difficult to differentiate groups of children labelled as reading impaired or language impaired on tests of phonological processing (Kamhi and Catts 1986). It is therefore not surprising that specific reading and spelling difficulties (dyslexia) are currently viewed as a special case of language disorder (Snowling 1985).

II. THE VERBAL DEFICIT HYPOTHESIS OF DYSLEXIA

The work of Vellutino (1979) in particular has shifted attention from visual to verbal processing deficits in children with specific reading difficulties. Vellutino, Harding, Phillips, and Steger (1975) demonstrated that dyslexic and normal children in grades 4-6 could visually match and select abstract shapes equally well. However, the dyslexic children were poorer at associating abstract shapes with a verbal response and had difficulty transferring their learning of verbal codes to new tasks. More recently, Ellis (1981) asked a group of dyslexics to make same/different judgements on letter pairs. The dyslexics were no different to normal controls when the letters presented were visually identical, as in the "AA" condition, but responded significantly more slowly in the visually distinct condition - "Aa".

These studies suggest that it is the visual-verbal relationship that is problematic rather than visual perception per se. Dyslexic children do not seem to have such easy access to verbal codes. This hypothesis has been investigated through experiments examining a variety of tasks as follows:-

A. **Naming**

Dyslexics are slower at naming a variety of stimuli: common objects, colours, and digits (Spring and Capps 1974). Denckla and Rudel (1976) have taken this further. They compared three groups of children in the age range of eight to eleven years on response latencies to picture naming. The first group were dyslexic, the second had learning problems but were adequate readers, and the third were normal controls. The dyslexics made more naming errors than the other two groups and had the greatest difficulty on low frequency words. The errors were also qualitatively different. The dyslexics made more circomlocutions, while the learning disabled children made more "wrong name" errors. Both these groups had longer response latencies than the normal controls. Denckla and Rudel concluded that dyslexic children are "subtly dysphasic" and believe that the deficient verbal retrieval results from a problem making visual-verbal associations. This is compatible with word finding difficulties reported by teachers and clinicians. Katz (1986) reports similar findings when he compared reading disabled eight year olds with average and good readers of the same age on an object naming task. The finding that the dyslexic children could define words more accurately than they could produce them suggests that their difficulty is in accessing the phonological name form rather than in the semantic representation itself. However, Snowling (1987) noted that these results are somewhat tentative given that reading groups in this study differed in receptive vocabulary age and that a reading age matched control group was not included. In order to rectify this, Snowling, van Wagtendonk and Stafford (in press) attempted to replicate Katz's findings in a group of dyslexic children by comparing their performance on a naming test not only with children of a similar age who were normal readers, but also with younger children whose reading age was similar to that of the dyslexics. Two experiments were carried out. The first required speed naming and the other allowed subjects to respond in their own time. It was found that dyslexics did worse on object naming tasks than would be predicted by their age and intelligence. However, this naming deficit cannot be accounted for by general low levels of vocabulary knowledge. Dyslexic children do not have a problem with the semantic representation of words but rather with the lexical-phonological representations of spoken words they know. Snowling et al conclude that dyslexics do not have an access problem when attempting to retrieve the phonological forms of words but they possess a faulty or impoverished representation of these words as illustrated by the following response for the target "aquarium": ack, ac, aquarine, fishtank.

B. Verbal Memory

The existence of verbal coding difficulties should be demonstrable in other tasks. Children with reading problems often perform poorly on digit span tests (Miles 1982). More importantly, not only do they recall fewer items, they recall fewer of the earlier items presented. Thus, the normal primacy effect is not present (Spring and Capps 1974, Bauer and Emhert 1984). In contrast, poor readers have shown no deficit in memory for nonverbal stimuli (Perfetti and Goldman 1976).

The lack of primacy effect raises the issue of rehearsal strategies. Torgeson and Goldman (1977) found that dyslexics verbalised less during a fifteen second interval on a visual memory task and were worse at recalling the correct number and order of items. They concluded that the dyslexics failed to spontaneously use the appropriate rehearsal strategy. It may however not be the rehearsal strategy itself that is the root problem but rather an inadequate access to name codes (Rack and Snowling 1985).

An alternative approach has been to examine the type of coding which dyslexic and normal children use in memory. Conrad (1964) found that normal subjects made more errors when the stimuli to be remembered rhymed as in the letter string "B-D-G-P-T", and made less errors on non-rhyming stimuli as in "A-L-K-U-Z". Dyslexic children however did not experience this phonological interference and performed equally well on rhyming and nonrhyming material (Liberman, Shankweiler, Liberman, Fowler and Fischer 1977, Mark, Shankweiler, Liberman and Fowler 1977). This suggests that the dyslexic children are not using a phonologically based code. Further evidence for this comes from Byrne and Shea (1979) who noted an encoding difference in dyslexic children who made more false alarm responses to words which were semantically related to targets presented earlier (table/chair). In contrast, normal readers' false alarms were more likely to sound like the targets (fair/chair). The dyslexics were therefore using a semantic rather than a phonological code for storage of items.

The possibility that dyslexic children's difficulties in using a phonological code might force the utilisation of an alternative code has been investigated by Rack (1986). Pairs of words were presented for a rhyme judgement task under four conditions: rhyme and orthographically similar (farm/harm), rhyme and orthographically dissimilar (head/said), no rhyme but orthographically similar (low/how), no rhyme and orthographically dissimilar (stood/car). Following this rhyme judgement task the subjects were unexpectedly asked to recall the item previously paired with a given target (farm/?, low/?). Normal readers were most successful in recalling rhyming paired items while dyslexics recalled orthographically similar pairs best. The dyslexics were therefore using a visually rather than phonologically based code. This was found on both auditory and visual presentation.

These findings suggest that dyslexics do not have a generalised learning difficulty. Their memory deficits are only obvious when the circumstances require a phonological code to be used. This is most apparent when sound segmentation skills are required.

C. Segmentation Skills

A relationship between segmentation skills and reading development has long been noted (Durrel and Murphy 1953). During informal observations of inner city children, Savin (1972) found that children who were having difficulty learning to read could segment at the syllable level but were unable to carry out more complex sound segmentation tasks. Formal studies have also found a positive correlation between performance on segmentation tasks and reading ability (Fox and Routh 1975, Calfee, Lindamood, and Lindamood 1973, Jorm 1978, Rosner and Simon 1971, Rozin, Bressman and Taft 1974, and Liberman, Shankweiler, Fischer and Carter 1974). Bradley and Bryant (1978,1985) in particular, have highlighted the importance of the ability to organise and categorise speech sounds when learning to read and spell. Children's performance in the preschool years on odd-one-out phoneme tasks (sun gun RUB fun, lot cot pot HAT, bud RUG bus bun) was found to be indicative of their reading and spelling performance at eight years of age. They have also shown a strong relationship between sound categorisation training and learning to read and spell. In their training study (1983) sixty-five children who were nonreaders and below average on sound categorisation when starting school were divided into four groups. The first and second groups received sound categorisation tasks such as listening for shared letters in paired words (hen/hat, hen/man), but in addition the second group were shown by plastic letters how each sound was represented in the alphabet. Groups three and four were controls. Group three was taught semantic categorisation (hen/pig - farm animals, hen/bat -

animals), while group four received no training at all. Training occurred during forty individual sessions over two years. At the end of this time the first two groups were ahead of the third in their literacy development but the greatest success with reading and spelling development was in the second group indicating the need for explicit alphabetic teaching.

Although the relationship between sound segmentation skills and literacy development is not clear, the consensus is that children with both verbal and written language disorders also exhibit difficulties with sound segmentation (Stackhouse and Snowling 1983, Magnusson, Naucler and Soderpalm 1984, Kamhi, Lee and Nelson 1985).

D. Speech Perception

The finding that syllable rather than phoneme segmentation has proved more accessible to younger children makes acoustic sense (Liberman et al 1974). The syllable contains a vocalic nucleus which provides a clearly audible cue by its distinctive peak of energy. Units smaller than the syllable are not so clearly marked. Phonemes are contaminated by coarticulations whereby their physical characteristics are modified by the phonetic context. An example of this is when initial phonemes show different spectrographic patterns depending on the following vowel.

Humans perceive speech signals in a different manner to nonspeech signals (Lieberman 1972). Traditionally, the motor theory of speech perception recognises special auditory receptors that are tuned-in to the acoustic patterns of human speech, such that humans have a built-in pitch extractor to decode intonation. Lieberman suggests that when analysing a speech signal the listener refers to how that signal may be produced by the vocal apparatus which in itself is species specific. This is how the listener can perceive /d/ at the beginning of "da, di, do", even though the syllables have different formant transitions as a result of the vowel. This reference to articulatory feedback is therefore an important aid to sound segmentation.

Tallal (1980) investigated the possibility that children's reading difficulties are due to a basic auditory perceptual problem. Her hypothesis was that any deficit in auditory temporal analysis should affect the acquisition of phonic skills. Twenty reading disabled children ranging in age from eight to twelve years were given a battery of nonverbal auditory perceptual tasks such as distinguishing between tones presented with different inter-stimulus intervals. No significant difference emerged between the reading disabled and normal control groups when the stimuli were presented at slow rates. As the rate of presentation increased however, the reading disabled group made more errors regardless of whether temporal order perception was required. Normal children could perform as well as adults on the tasks by the age of eight and a half years.

The correlation between performance on a nonword reading test and the psychoacoustic tests was highly significant and positive. There was however, considerable variation within the reading disabled group on these tests. Twelve out of the twenty reading disabled children were within normal limits on the auditory perceptual tasks and yet had significant reading delays. Similarly, accuracy on the reading test ranged from thirty to ninety-five per cent. This excludes any clear causal interpretation of the results. It is possible that the slow processing may be the effect of another disability such as a reduced memory capacity.

Brandt and Rosen (1980) presented twelve dyslexic children ranging in age from eight to twelve years, with synthetic speech syllables varying in either voice onset time or direction of formant transitions (signalling place of articulation). This time the dyslexics did not differ significantly from the normal controls, although the authors hint that the dyslexics appeared to be at an earlier developmental level. This possibility was also recognised by Tallal.

Godfrey, Syrdal, Lasky, Millay and Knox (1981) found these nonsignificant results difficult to accept. They accounted for them in two ways. First, there was too low a pass criterion on preliminary tests, and second, the statistical analysis was too narrow. Godfrey et al therefore asked seventeen dyslexic children aged ten years, to identify and discriminate synthesized voiced stop consonants differing in place of articulation. Prior to testing the dyslexic children had been classified as either having phonological or visual deficits on the Diagnostic Screening Procedure (Boder 1973). Overall the dyslexics were significantly different to normal controls on tests of categorical perception but contrary to expectation there was no difference between the two dyslexic subgroups.

Tallal (1980) and Godfrey et al (1981) explain their results in different ways. Tallal believes that a basic perceptual mechanism breakdown underlies difficulties in learning to read since rapidly changing auditory information play a crucial role in analysing the speech code. Godfrey et al however, believe that children with reading difficulties have a phonetic rather than a more basic auditory deficit. Dyslexics are inconsistent in their phonetic classification of auditory cues. This will affect long term phonetic representations which will have repercussions on grapheme-phoneme conversions. It is of course possible for both of these views to be acceptable. Some children may have a basic perceptual problem which disrupts higher level processing, while others may only experience difficulties at the higher level of processing. Tallal's own variable results would support this notion. Regardless of this dispute, it is noted that the dyslexic groups studied performed similarly but better than children with known verbal language difficulties (Tallal and Piercy 1973, Stark and Tallal 1981, Tallal, Stark and Mellits, 1985). This again suggests the existence of a continuum of subtle language disorder in children with reading difficulties.

Katz (1983) also acknowledged the possibility of a basic perceptual deficit in sound segmentation problems. He envisaged a phonemic zone responsible for analysis, synthesis and memory for phonemic information. Problems in this area would affect the imprinting of "engrams". These faulty engrams may persist even after the original cause has disappeared. Children with these faulty engrams will require more time than normal children to process incoming stimuli. This is compatible with Tallal's results.

The question of what might cause this phonemic zone dysfunction is raised. Genetic factors feature strongly, (Lieberman, Meskill, Chatillon, and Schupack 1985). Trauma, infection, or allergy are also strong etiological contenders. Whatever the cause, the effect is inconsistent stimulation during optimum periods of central nervous system plasticity or activity. Hearing impairments are obviously critical here. Although it is doubtful that upper respiratory infections alone can account for persisting speech and language difficulties (Bishop and Edmundson 1986), the contributory effects of even a mild fluctuating hearing loss over critical periods of development should not be underestimated (Bamford and Saunders 1985).

In keeping with Katz's (1983) faulty engram hypothesis, Brady, Shankweiler and Mann (1983) found that a group of eight year old poor readers made significantly more errors than chronologically matched good readers when repeating words presented in noise. The authors concluded that the poor readers required a better quality speech signal in order to perform the task and that this indicated a difficulty in speech perception.

There is however, an alternative explanation. The process of reading itself may allow the child to redefine and refine his phonetic representations. Poor performance on speech perception tasks could therefore be a consequence rather than a cause of reading difficulties since the good readers may be able to draw on a greater lexical or orthographic store. With this in mind, Snowling, Goulandris, Bowlby, and Howell (1986) extended Brady's study by including reading age matched controls in addition to a chronological match and by adding a third noise condition (low, high, and no noise) to avoid ceiling effects. This time there was no differential effect of noise on the performance of the three groups. There was however, an important group by word type interaction. All groups were at ceiling when repeating high frequency words. The dyslexic group made significantly more errors than their chronological matched group on repeating low frequency words but performed similarly to their reading age matched group. When asked to repeat nonsense words, the dyslexic group were significantly worse than both of the control groups.

It was concluded that the difficulties encountered by the dyslexic group could not have been due to problems with input phonology since their performance was no more affected by the noise conditions than that of the control groups. Neither could their problems be in output phonology since they could repeat some of the words. Rather, their deficit was specific to processing nonwords which suggested a problem in the nonlexical route to phonology.

This study shifted the focus of the deficit from one at the level of speech production to a more central phonological problem. First, it suggested that dyslexics have a specific difficulty in processing nonlexical items and second that there may be an effect on the development of the spoken language lexicon. Thus, dyslexic children may have access to fewer lexical representations than matched chronological aged normal readers. This study fits comfortably with the literature on sound segmentation, since processing of nonsense words requires segmentation of the sound stream prior to assembly for speech output (Snowling 1981).

E. Lexical Development

The relationship between segmentation skills and lexical development makes sense considering that the lexicon is phonologically organised. Brown and McNeill (1966) experimentally induced tip-of-the-tongue phenomena by asking subjects to name rare words after hearing a definition. Subjects produced a surprising amount of information about the word structure even though they could not produce the target. Fay and Cutler (1977) reported similar findings in their study of spontaneous speech errors, for example "magician" instead of "musician". They concluded that words of similar length, sound and stress pattern are close to each other in the lexicon.

The question arises as to whether this is also true in the developing lexicon. Elbers (1985) has given an account of tip-of-the-tongue experience in her two year old son. This suggests that some independent storage of form and meaning is also present very early on. However, analysis of her son's malapropisms suggests that when searching for an as yet weakly represented form, similar forms which are not tied strongly to semantic representations will often present. For example, when searching for the word "microscope", the child adopted a word from a nursery rhyme which had the same final syllable stress as the target. This suggests that a child's lexicon may contain forms searching for meaning and vice versa.

Further evidence that the developing lexicon may differ from the adult's comes from Aitcheson and Straf (1982). A multivariate analysis of malapropisms taken from 472 adults and 208 children revealed that although both groups searched for clusters of salient features when they retrieved words, children and adults differed in which features were to the fore. Adults gave priority to initial consonants while children paid more attention to the number of syllables and the stressed vowel. Children therefore attended to the more primitive perceptually salient aspects and were influenced by the rhythm of the word. They may attend more to word endings because of the memorability of rhyme while adults needed to focus on the beginning of words since these are more efficient in distinguishing between words in a larger vocabulary. Adults have also had more print and dictionary experience.

Support for the importance of rhythm saliency in a child's lexical development is given by Chiat (1983). In her study of a five year old boy with delayed phonological development she reported that velar stops /k g/ were fronted /t d/. The substitution process was dependent on word stress and boundaries, but independent of input since the child could discriminate sounds perfectly well. He fronted velars at word initial position and medially before a stressed vowel, however he produced them correctly in word final position and word medially before an unstressed vowel. This led Chiat to conclude that the error occurs in the lexical representations and that these representations consist of prosodic structures on which articulatory segments are specified. Again, this makes acoustic sense and mirrors the developmental pattern noted in the segmentation studies above.

Waterson (1981) has a similar premise for the starting point of her model of phonological representation. To begin with, the child distinguishes between speech and nonspeech noise - an innate ability according to Lieberman's theory discussed above. The child then proceeds to analyse familiar language material by abstracting the perceptually salient features. These features are synthesised into possible phonetic patterns of the language and stored, without meaning, in the "Underlying Representation 1" (UR1). According to this model the child differentiates legal vs illegal sound combinations quite early. "Underlying Representation 2" (UR2) stores lexical phonological patterns with meaning. The child therefore needs to match patterns and words between UR1 and UR2. This may account for Elbers claim of free floating forms (in UR1) and meanings (in UR2). Waterson stresses that it is only the salient auditory cues that are necessary to develop these systems. Unstressed bits are fitted in to the rhythmic pattern of the utterance with the help of higher level segmentation skills and print experience. Segmentation of the speech stream is therefore necessary for satisfactory lexical development. It is aided by the child's knowledge of the subject matter and context which help to constrain the probabilities. It would therefore not be surprising to find that dyslexic children with delayed or troublesome segmentation development also exhibited lexical difficulties.

F. Articulatory Skills

Clinicians have often commented on the fact that dyslexic children have difficulty in articulating multisyllabic words (Miles 1982). Investigating the relationship between reading and speech difficulties, Snowling (1981) compared dyslexic and normal readers matched for reading age when reading one and two syllable nonwords. The dyslexics had more difficulty on reading the two syllable nonwords particularly when these incorporated consonant clusters. They also performed more poorly as syllable length was increased on a nonword repetition task.

Articulatory problems of an even more subtle nature have been observed by Montgomery (1981). She examined eight year old dyslexics' ability to access articulatory postures by asking them to indicate on oral structure diagrams the position of their tongue and lips for given phonemes. Unlike their reading age matched controls, they experienced great difficulty with this.

In a recent study, Kamhi and Catts (1986) compared twelve poor readers with no history of speech/language impairment and twelve who had a developmental language impairment with twelve children having normal reading and language abilities. The age range studied was six to nine years and a variety of phonological tests were administered. Although it was initially thought that the language impaired group would perform more poorly than the reading impaired group on all of the tests, they only actually did so on three measures - all of these involved word and sentence repetition. No difference was found between the two groups on tests of bisyllable word division, monosyllable word division, segmentation, elision, sentence division into words and morpheme judgements. Overall, the two clinical groups performed more poorly than the normal controls. The authors concluded that although traditionally these language and reading impaired groups have been separated it may be worth viewing language and reading impaired children on a continuum or as sub-groups of the learning disabled group.

Articulatory skills may be important here. The authors found that the word repetition task seemed to provide the most direct measure of a child's ability to generate accurate representations of phonological information. The language impaired group may have a more severe form of phonological deficit. It is necessary to clarify the status of articulatory difficulties since they can reflect different levels of breakdown - input, representation, programming, motor, or structural.

III. THE PHONOLOGICAL DEFICIT HYPOTHESIS

In reviewing the evidence for the verbal deficit hypothesis of dyslexia, a range of problems have been discussed - memory strategies, word retrieval, lexical development, sound segmentation, auditory and articulatory skills. The child's ability to analyse and synthesise the speech stream is a central issue in these areas. For example, it has been argued that dyslexic children are slow to acquire precise phonological representations for words which are semantically represented because of difficulties with phoneme segmentation and phonetic coding (Snowling, van Wagtendonk and Stafford 1988).

Shankweiler and Crain (1986) have suggested that a common difficulty at the level of phonology underlies all the problems encountered by dyslexic children. They argue that phonological processing is critical for the working memory system to support the analysis of both auditory and visual information. Furthermore, as language is hierarchically organised, the development of semantics and syntax is dependent on satisfactory phonological skills. With reference to Figure 1.1, a basic phonological deficit will impede the development of the system for processing verbal language which in turn will provide a shaky foundation for the integration of a system for processing written language. How this phonological deficit manifests will depend on the level or levels of breakdown in the system. It is possible to have a phonological deficit at an input, representational or output stage (Snowling, Stackhouse and Rack 1986).

IV. PHONOLOGICAL DYSLEXIA

Although it is difficult to comment upon the distribution of different types of dyslexia, the available evidence suggests that the characteristics of "developmental phonological dyslexia" are the most common in children with specific reading and spelling difficulties. Boder (1973) studied the behaviour of a large group of dylexic children when asked to read and spell a corpus of words. She found over sixty percent of her sample to be "dysphonetic" in that they relied on a visual strategy for reading, had difficulties tackling unfamiliar words and could only spell words that they knew. Only ten per cent of the children showed visual deficits. These she called "dyseidetics". The remainder exhibited mixed difficulties and were the most seriously affected. Unfortunately, this study has limitations since it failed to take account of the subjects' range of reading abilities when discussing individual differences. It is possible that the dyseidetics were simply better readers than the dysphonetics and that the mixed group were at a very early stage of development and not using visual or phonological strategies successfully. Further, different stimuli were presented to subjects so that the likelihood of producing dysphonetic and dyseidetic errors was not equally distributed (Snowling 1987).

Temple and Marshall (1983) were the first to apply the label "phonological dyslexia" to children with phonological deficits when reading and spelling. Prior to this, subgrouping of dyslexic types was specific to adults with acquired neuropsychological disorders (Coltheart 1980). It is usually the case that phonological dyslexics also have a "phonological dysgraphia" although some children may only manifest difficulties when spelling. Phonological dyslexia is characterised by an inability to read nonsense words, an absence of the word regularity effect, auditory processing problems (notably a limited short term auditory memory), sound segmentation difficulties, bizarre spelling and articulatory breakdown but no obvious semantic difficulties (Snowling, Stackhouse and Rack 1986, Seymour and MacGregor, 1984).

This profile contrasts with that of other named dyslexias. Surface dyslexics for example, are able to read regular and nonsense words. In fact they are likely to regularise irregular words ("broad" read as"brode"). Their spelling is phonetically correct (CATALOGUE/catalog) and they are able to spell nonwords.

This shows functioning phonological skills. Homophones are often confused (route/root) and orthographic errors when reading have been noted (omitting, altering, adding or transposing letters). These are supposedly characteristic of deficits in visual skills (Temple 1986, Coltheart, Masterson, Byng, Prior and Riddoch 1983).

Cases of deep dyslexia where the child makes semantic associations when reading and spelling (chair/table) have also been reported in the literature (Johnston 1983, Siegal 1985). The existence of this analogue of the acquired dyslexias has proved more controversial than the two discussed above (Snowling 1987).

Within Frith's (1985) framework "classic" developmental dyslexia is thought to occur when a child fails to break through to the alphabetic phase. Although the cause of this failure is not clear it is unlikely to be due to a single factor. Arrest in the logographic phase would yield symptoms of phonological dyslexia. Such an arrest, however would not necessarily preclude the child progressing through later phases albeit more slowly or with obvious difficulties. Compensatory strategies are possible and need to be identified. Failure to achieve orthographic reading would be revealed by a reliance on alphabetic and logographic skills. An arrest in the second phase would be more likely to affect spelling than reading although it is possible that surface dyslexia could be cited here. The problems of the good reader/poor speller would be located at a later substage. These "type B" spellers (Frith 1982) appear to be in the orthographic stage for reading but not for spelling.

Frith's model is important because it allows a differentiation of developmental and acquired disorders. A developmental disorder is the result of an arrest in a particular phase. Following that point, development can continue but may do so in a quantitatively and qualitatively different way. In contrast, a strategy may be lost as the result of an acquired disorder but strategies developed later than the one affected may still function. Thus, there are likely to be more discrete deficits in the acquired dyslexias than in the developmental disorders. Studies that ignore a developmental framework may yield spurious results. H.M. a seventeen year old girl with a reading age of ten years, was the first case of developmental phonological dyslexia to be presented (Temple and Marshall 1983). Her reading and spelling performance reflected problems with phonological skills. Sound segmentation was weak, reading of nonwords was impaired and she made nonphonetic spelling errors, that is "bizarre" spellings that do not resemble the target (CHLORINE/colrean, MOPE/momb). H.M. was tested on tasks originally devised to investigate patients with acquired dyslexia and no developmental control children were included. Recently, Bryant and Impey (1986) have reported control data on these tasks. They found that their group of sixteen normal readers, all reading at the ten year level, presented with similar characteristics to both the phonological dyslexic H.M .(Temple and Marshall 1983) and to the surface dyslexic C.D. presented by Coltheart, Masterson, Prior and Byng 1983. Bryant and Impey emphasise a number of issues. First, "dyslexic characteristics" are not unique to dyslexia. Second, it challenges the notion of subgroups within developmental dyslexia. An alternative view is that C.D. who was also reading around the ten year level was at a later stage of development than HM. Third, it highlights the need for appropriate controls when studying children with developmental disorders and fourth, it demonstrates variability within a group of normally developing children which needs to be accounted for when selecting control groups.

The need for a developmental perspective however is not supported by all. Temple (1986) believes that one model can suffice for the study of normal and abnormal reading and spelling processes in both children and adults. Two ten-year-old children, R.B. and A.H., with developmental dysgraphia were compared. An important finding was that although at the same quantitative level of spelling, the two children were qualitatively different from each other in their strategy use. R.B. presented as a "surface dysgraphic" and A.H. as a "phonological dysgraphic". However, an alternative interpretation of the data is that A.H.'s development is arrested in the alphabetic stage while R.B. has broken through to this stage but is still having difficulties at the orthographic level. This is supported by the finding that R.B. did not perform differently to younger spelling age matched children and could perform rhyming tasks satisfactorily. In contrast A.H. was qualitatively different to the normal children and had difficulty with the phonological tasks.

A broader range of tasks were administered to R.E. a dyslexic young woman aged twenty-one who had achieved a high level of literacy skill despite phonological deficits (Campbell and Butterworth 1985). Like H.M. she had problems in nonword reading and made nonphonetic spelling errors. Campbell and Butterworth claimed that her difficulties were due to a reduced short term memory capacity which was unable to support phoneme parsing. This study challenged the hierarchical nature of reading and spelling development since R.E. seemed to have bypassed an earlier alphabetic stage and yet could function at the later orthographic one. Her deficits only became apparent when asked to spell complex nonwords. R.E. may not be a typical developmental dyslexic but the notion of compensatory strategies needs further investigation in more seriously affected or younger children.

The case studies of Seymour and his colleagues were perhaps the first to take a developmental perspective. Seymour and MacGregor (1984) presented four cases ranging in age from twelve to twenty-one years and discussed their results with reference to Frith's model of reading and spelling development. An attempt was made to pinpoint the location and nature of the primary source of disturbance and to speculate on what the effects of these might be.

A more recent study (Seymour 1987) has examined the individual variation in performance in both normal children and children meeting the diagnostic criteria for phonological dyslexia. Heterogeneity within the groups arose as a result of the interplay between a child's strengths and weaknesses. Unfortunately however, only a limited range of tasks was given and there was no attempt made to examine associated cognitive and linguistic strengths.

To investigate how phonological difficulties may affect reading and spelling strategies, Snowling, Stackhouse and Rack (1986) examined seven cases of developmental phonological dyslexia. Three of the children were of low reading age (seven years) and the remainder, which included an adult, were of high reading ages above ten years. Tests of reading, spelling and auditory processing revealed a range of phonological deficits when compared to Reading Age control children. However, there were clear individual differences within the dyslexic group. In the low reading age group T.W. had difficulty with input phonology, A.S. had sound segmentation and memory problems and J.M. had problems with output phonology. These individual differences affected the children's spelling strategies in subtle ways. T.W. was the only child who had difficulties representing word initial phonemes. She spelled LIP as peryse, SACK as canpe, and TRAP as mupter. In contrast, A.S. and J.M. were able to transcribe initial phonemes but not subsequent sounds. A.S. spelled SACK as sed, BUMP as bunt and TRUMPET as tumput. J.M.'s spelling errors reflected his articulatory difficulties. He spelled SACK as sag, PACKET as pagit, POLISH as bols and TRAFFIC as tafit. Thus, these findings suggest that a child's reading and spelling difficulties are dependent upon the level at which the phonological system breaks down. Furthermore, compensatory strategies adopted by the children were dependent on the strengths and experience they brought to the learning situation. Thus, a developmental perspective enabled a clearer picture of the nature of reading and spelling difficulties.

Up until recently we have known little about how individual children with reading difficulties progress. However, Temple (in press) discussed the progress of a child whom she described as a "deep dyslexic". In her reading she made semantic errors and she was unable to read nonwords. Within Frith's (1985) framework it could be argued that this girl was functioning at an early logographic phase of development (Morton 1987). At follow-up semantic errors were no longer apparent but the girl was still unable to use phonological reading strategies. She had not made the transition to the alphabetic phase. Similarly the progress of J.M. (mentioned above) has been discussed by Snowling and Hulme (in prep). Despite four years of intensive remedial assistance with phonic skills, J.M. remained deficient in the use of phonological reading and spelling strategies. Arguably, his reading and spelling had improved by the compensatory use of visual strategies.

In view of the failure of these two children to achieve alphabetic competence, the outcome for children with more serious phonological disorders, for example children with persisting speech disorders, seems pessimistic.

V. READING AND SPELLING DEVELOPMENT IN SPEECH DISORDERED POPULATIONS

A group of children with obvious input phonology problems is the deaf. Children with serious hearing impairments do have reading difficulties (Furth 1966, Conrad 1979) and delayed linguistic competence (Iveymey and Lachterman 1980). They often "plateau" at a reading age of around thirteen years (Quigley and

Kretschmer 1982) although this result needs careful interpretation since the children may have been at ceiling on the tests used. Studies of memory strategies (Conrad 1964) and rhyme judgement (Dodd and Hermelin 1977) reveal that a deaf population is capable of using a phonological code adequately. By administering a memory test to a group of eight year old deaf children divided into good and poor readers, Hanson, Liberman, and Shankweiler (1984) showed that the good readers were able to use both speech and finger spelling to remember printed letters. In contrast, the poor readers could not utilise either. They concluded that reading problems in the deaf population are more related to the individual child's linguistic ability than to the presence or even severity of the deafness.

Examination of their spelling errors also supported this conclusion (Dodd 1980). A group of deaf children compared favourably with a group of speech disordered children on spelling tests (Dodd and Cockerill 1985). The children were asked to spell regular words (went, limp), complex rule governed words (liquid, deck), and rare words that needed to be remembered orthographically (laugh, pint). Unlike the speech disordered children, the deaf children did not have specific difficulties deriving and using phonological rules. There were, however limitations to this study. First, the stimuli were not clearly differentiated since the "rule governed" words were merely more complex regular words - a regular/irregular comparison may have been more revealing. Second, the deaf group studied were older (age range thirteen to sixteen years) than the speech disordered group (age range seven to fourteen years) and they were also at a slightly higher level of reading performance (mean of eight years seven months compared to seven years eleven months). Third, it is not clear what criteria was used to select and label the speech disordered group as "phonologically disordered". Nonetheless, a general trend is worth discussing; the deaf child does not appear to be as at risk for specific segmentation and reading/spelling problems as the normally hearing but speech and language impaired child.

Although it is encouraging that deaf children can use a phonological code, it still remains that they normally do not develop literacy skills commensurate with their chronological age. Conrad (1970) addressed this issue and suggested that hearing impaired children may use internal speech "less incisively" than normally hearing children. This has been elaborated by Pattison (1983) who suggested that the quality of the code suffers as a result of it being assembled from a variety of modalities, for example the visual and kinaesthetic, rather than from the one most appropriate,that is the auditory. The deaf child may also take longer to process information phonologically which may in turn affect storage and retrieval of that information. The deaf child is therefore at risk for delayed or limited phonological processing but can develop phonological skills in reading and spelling to a satisfactory level.

This is not necessarily so for a hearing child with a speech disorder. Few studies have examined the reading and spelling performance of children with different forms of speech handicap, although many authors refer to speech disordered children's general learning difficulties (Durrell and Murphy 1953, de Montford Supple 1980). More recently however, reading and spelling strategies in different types of speech disorders have been investigated. In order to evaluate the role of articulatory coding when converting phonemes to graphemes, Bishop (1985) tested seven physically handicapped dysarthric teenagers on homonym judgement and real and nonword spelling. Her hypothesis was that if articulatory coding is critical for spelling, then the dysarthrics would perform poorly on the spelling tests as their motor speech impairment rendered their articulation indistinct. This would not affect their silent homonym judgement performance. There was no difference between the dysarthric children and a matched group of physically handicapped children who had normal speech. Neither was there any hint of phonological difficulty as would have been the case had the dysarthric children spelled in a bizarre way. The indications were that higher level phonological processing which is required for reading and spelling development is not based on articulatory skill. The corollary of this is that children with lower level articulatory disorders are not necessarily at risk of specific reading and spelling difficulties.

These results can be contrasted with spelling errors taken from eleven children with obvious phonological output difficulties in the absence of structural and neurological abnormality reported by Robinson, Beresford, and Dodd (1981). These phonologically disordered children made significantly more errors than a control group of normally speaking children matched on age, sex and reading ability. They did not find the spelling of regular words any easier than irregular words whereas the control group demonstrated a "regularity" effect. They made as many spelling errors on words they pronounced correctly as they did on words they mispronounced. Furthermore, a qualitative difference between the two groups emerged. Unlike the errors from the control group, the spelling errors from the phonologically disordered group defied analysis - CASTLE/calkael, HEDGEHOG/acox, TORTOISE/tasinaclejath. Such nonphonetic spelling is considered to be indicative of a more pervasive language problem (Schwartz 1983, Thomson 1981, Sweeney and Rourke 1978). The speech disordered children therefore performed as "phonological dysgraphics" and it was concluded that they had a specific difficulty in generating phoneme-grapheme correspondences.

It is important in such studies to identify the nature and severity of the speech problems involved. It is quite possible that some of the children in the above study also had dyspraxic characteristics (Dodd personal communication 1983). The dyspraxic child is thought to have difficulties in planning the motor programme for speech and to have an incoordinated vocal tract resulting in variable and inconsistent speech production. Dyspraxia has been classified as one of the motor speech disorders along with dysarthria (Darley, Aronson and Brown 1975) and is a serious and persisting speech disorder in both children and adults.

To investigate the possibility that children with certain types of speech disorders may be more vulnerable to reading and spelling difficulties than others, Stackhouse (1982) tested a group of children with developmental verbal dyspraxia, and a group of children with structural abnormalities (cleft lip and palate) ranging in age from seven to eleven years, on tests of reading, spelling and silent phonology. Results were compared with an age matched control group of normally speaking children. The dyspraxic group was quantitatively poorer than the other two groups on standardised tests of reading and spelling. The cleft lip/palate group were not significantly different from the normal controls. There was also a qualitative difference in the errors of the dyspraxic group compared to those of the other two groups. When reading, the dyspraxic children seemed to be guessing the target on the basis of individual letter cues. For example, CANARY was read as "competition" and DREAM as "under". The errors of the cleft lip/palate and normally speaking children suggested an attempt to use a sound building strategy - SABRE was read as "saybree", and CEILING as "kelling". When spelling, the dyspraxic children made bizarre errors similar to those quoted in the Robinson et al (1981) study above (YEAR/andere, HEALTH/heens, SLIPPERY/greid). In contrast, the cleft lip/palate and normally speaking children showed evidence of phonetic spelling (SOONER/soona, MIGHT/mit, BOAT/bot). To confirm that the dyspraxic children had a breakdown in phonological processing at a level higher than motor control a silent test of phonology was administered (after Coltheart 1980). The children were asked to sort cards into same and different piles. Each card showed two nonwords which either sounded the same (fid/phid) or different (fid/prid) when read silently. The performance of the cleft lip/palate and normally speaking children on this task correlated with reading age. The performance of the dyspraxic children did not. Their reading age increased without a corresponding increase of accuracy on the silent test of phonology. In this respect they performed in a similar way to a group of dyslexic children studied by Snowling (1980) who found that the use of grapheme-phoneme correspondences increased with reading age in normal readers but not in dyslexics. It would seem that both dyspraxic and dyslexic children increase their reading age by relying on the visual strategy to develop a sight vocabulary.

Following these two studies Snowling and Stackhouse (1983) examined a small group of dyspraxic children, ranging in age from eight to ten years, in more detail. These children were matched on reading age with younger normally speaking children from the same school. Each child was asked to imitate, read, spell and copy a series of consonant vowel consonant (CVC) syllables that varied in their degree of articulatory place change. For example, 0 place change - mop, 1 place change - bat, 2 place change - peg. Normal children were at ceiling on these tasks. The dyspraxic children performed within the same range as the controls on reading and copying but did significantly less well than the controls on imitation and spelling. A qualitative analysis of the imitation and spelling results was carried out to investigate the possible link between speech and spelling performance. Errors were categorised according to whether they differed from the correct form in voicing (dad/dat), placement (dog/dod) or manner (can/cal) of articulation. The results of the analysis were in line with Robinson at al's (1982) findings:

accuracy of pronunciation did not necessarily result in accuracy of spelling. Overall there were more spelling than imitation errors, but there was no obvious one to one relationship between the imitation and spelling errors.

During this study it became apparent that the dyspraxic children had great difficulty in segmenting the target prior to spelling it. For example, PAM was repeated correctly, segmented as "pe-te" and spelled "potm", NICK was also repeated correctly, segmented as "ke-ke-ne-i-te", and spelled "cat". This type of error is characteristic of a breakdown at an earlier stage in the spelling process than that suggested by Robinson et al (1982), and Dodd and Cockerill (1984). It is more likely that the problem arises at a sound segmentation level prior to phoneme-grapheme translation.

The consensus in the studies of speech disordered children suggests that those with an underlying phonological disability are more at risk of reading and spelling difficulties than those with a more pure articulatory difficulty. It is recognised however, that children who have articulatory difficulties at a lower level may also be vulnerable but for different reasons. They may well show delayed development of written language skills because of poor health, hospitalisation, and absenteeism from school. Nontheless, the incidence of difficulties specific to written language should be lower in this group.

VI. SUMMARY

It has been argued that an underlying phonological deficit can account for speech, segmentation, reading and spelling difficulties. The aim of the present study is to investigate the relationship between verbal and written language disorders. It will adopt a developmental framework and track the progress of two children with a serious speech disorder known as Developmental Verbal Dyspraxia. This disorder is a particular challenge for further study because of its controversial nature and associated literacy problems.

CHAPTER 2

DEVELOPMENTAL VERBAL DYSPRAXIA

The speech disorder designated as "Developmental Verbal Dyspraxia" has proved to be one of the most controversial of the developmental speech disorders. Arguments surround not only the nature of the problem but indeed its very existence (Guyette and Diedrich 1981). Historically the term was used with reference to the population of adults who had acquired a problem in programming motor speech output (Broca 1865). From this point there has been heated debate as to whether acquired dyspraxia of speech is a pure motor difficulty (Darley, Aronson and Brown 1975) or one of linguistic processing (Martin 1974).

The label was not applied to children with developmental speech disorders until the 1950s when Muriel Morley identified a "dyspraxic" group of twelve children ranging in age from four to ten years. She defined the condition as follows (Morley 1965),

> "A defect of articulation which occurs when movements of the muscles used for speech .... appear normal for involuntary and spontaneous movements .... or even for voluntary imitation of movements .... , but are inadequate for the complex and rapid movements used for articulation and reproduction of sequences of sounds used in speech."

This articulatory standpoint, based on diagnostic criteria for the acquired condition in adults, has proved unhelpful when dealing with children with developmental speech disorders.

Three major areas would seem to account for the current confusion over differential diagnosis of developmental verbal dyspraxia:-

1. the sequence of the scientific method (Deputy 1984),
2. methodological problems within individual studies,
3. lack of a developmental perspective.

The scientific method begins with OBSERVATION which leads to DESCRIPTION then to EXPLANATION and finally to PREDICTION. There is a missing link in the chain of studies of developmental verbal dyspraxia - a thorough DESCRIPTION of the behaviour. When children's articulatory struggle behaviour was observed and labelled dyspraxic it was automatically explained as a motor programming difficulty. It was not long before predictions were made about etiology. Rosenbek and Wertz (1972) discuss the location of "lesions" and praxic centres in the brain, Ferry, Hall and Hicks (1975) talk about a "neurological disorder" and yet hard evidence of this is not apparent (Gubbay 1978).

The second issue is a methodological one. A major criticism of the studies of children with developmental verbal dyspraxia surrounds the subject selection process. First, subjects have been included who also have dysarthria, nondescript language problems, and mental handicap (Rosenbek and Wertz 1972, Ferry et al 1975). Second, wide age ranges have been incorporated in the same clinical group. Rosenbek and Wertz (1972) tested preschool children to teenagers, while Morley (1965) and Ferry et al (1975) extended the range to adults - from four to twenty years, and from four to thirty years respectively. Third, subjects have been allocated to experimental groups on shaky premises. These include: (a) preconceived but not proven diagnostic criteria - slow diadochokinetic rates, inconsistency and groping for articulatory positions (Ferry et al 1975), (b) severity ratings - multiple articulation errors (Crary 1984), failure to make progress in conventional therapy (Ferry et al 1975), (c) previous diagnosis by clinicians ranging from different professions and thereby increasing the likelihood of differing diagnostic criteria (Prichard, Tekieli, and Kozup 1979, Parsons, 1984), and (d) tests used for the selection procedure have been incorporated in the experimental procedure (Aram and Horwitz 1983, Milloy 1986). A circular argument has therefore evolved. Thus, criteria for allocation to the dyspraxic group have become the recognised symptoms of developmental verbal dyspraxia. Furthermore, the mixed populations studied invalidate the results.

The last and perhaps most serious barrier to developing our knowledge of developmental verbal dyspraxia, is the lack of a developmental perspective. The unfolding nature of the problem in children has been ignored. To illustrate this a typical dyspraxic case will be described.

Kevin was eight years old when first seen in 1977. He presented as a cheerful, communicative and alert boy whose speech was often unintelligible. In infancy, head circumference was recorded as two standard deviations above the normal and still appeared large for his body. A general mild clumsiness was noted and there was a history of delayed lateralisation, but no hard neurological signs were found. Facial expression was limited and there was specific vocal tract incoordination. This affected breathing control for speech and coordination of the velo-pharyngeal sphincter, lips and tongue. An oral (non-verbal) dyspraxia was evident.

Verbal comprehension was never significantly delayed and he performed above chronological age at five years five months on the Reynell Developmental Language Scales (1969). In contrast, expressive language was compromised. At two years eight months, performance was at the nine-month level. Syntactic difficulties were still evident in the teenage years.

Speech development was initially characterised by a restricted vowel system and consonant omissions. By eight years of age, Kevin was able to imitate all sounds in isolation but would omit or substitute sounds in continuous speech, particularly when a word required an articulatory place change. Non-English sounds occurred, often the result of a distorted attempt at an English target. As vocabulary and sound awareness increased, so did groping for articulations. The sequencing and production of multisyllabic words is a continuing difficulty. The following responses were taken from a verbal repetition task at fourteen years of age: CHRYSANTHEMUM/[krɪs ˌæn ˈkrɪs ˈskrɪstæn ˌθəm] PRELIMINARY/[pəˈlɪm əm pəˈlɪm: pəˈlɪm pəˈlɪməgə pələməˈlɪ]. To avoid such words he has learned to circumlocute in conversations. The following transcription from a taped interview at chronological age fourteen illustrates his perception of his difficulties,

> "From the age of two, from er eighteen months, I had er this problem called dyspraxia and since then I had problem of speaking and pronouncing letters ....and um from a age of two I did not speak for two years, til about four....when I tried to speak....my tongue wouldn't cooperate with what I wanted to do and my brain would tell my tongue to do it properly...."

Throughout his school years, Kevin has been a popular and active pupil. Learning to read was difficult for him and he needed extra help with his handwriting. He performed as a classic "phonological dyslexic" having reduced auditory memory and segmentation difficulties. At the age of 17 years 1 month he had a Reading Age of 12 years 4 months but he enjoyed reading and was coping well with a day release college course. Spelling however, was still a worrying problem for him.

Kevin demonstrates the complexity of the condition known as developmental verbal dyspraxia. His articulatory difficulties pervade other levels of speech and language development resulting in both spoken and written language problems. Moreover, the manifestations of the condition changed over time. As different demands were made on him, the extent of his learning difficulties became apparent.

Although the developmental perspective is lacking in the studies of developmental verbal dyspraxia other perspectives have been taken: clinical, articulatory, linguistic and cognitive. Table 2.1. summarises the characteristics pertaining to each.

I. THE CLINICAL PERSPECTIVE

Acquired verbal dyspraxia is normally accompanied by a right hemiparesis/paralysis with lesions in Broca's Area and the sensorimotor cortex. In contrast hard clinical evidence of a neurological etiology has been difficult to find in its developmental counterpart (Gubbay 1978). In a review of cases of developmental dyspraxia, ranging in age from two to fourteen years, Rosenbek and Wertz (1972) found that 61% of the children presented as "essentially normal" on neurological examination.

Table 2.1 - Perspectives on Developmental Verbal Dyspraxia

A. THE SPEECH PERSPECTIVE

1. **General Characteristics**
   - (a) History of delayed speech development
   - (b) Resistant to Therapy
   - (c) Unintelligible

2. **Articulation**
   - (a) Inconsistent vs Rigid Pattern
   - (b) Phonetic experimentation
   - (c) Non-English articulation
   - (d) Errors increase as word length and complexity increase
   - (e) Breakdown in continuous speech
   - (f) Perseveration
   - (g) Metathesis
   - (h) Intrusive schwa
   - (i) Sound omissions - particularly in syllable final position
   - (j) Voice, Place and Manner errors
   - (k) Vowel distortion
   - (l) May also show dysarthric features

3. **Prosody**
   - (a) Inappropriate stress and intonation
   - (b) Variable speed - may have rushes of speech
   - (c) Monotonous

4. **Resonance**
   - (a) Fluctuating nasality as a result of incoordination of the palatopharyngeal sphincter

5. **Incoordinationof the Vocal Tract**

   This will result in:-
   - (a) dysphonia
   - (b) dysprosody
   - (c) disorder of resonance
   - (d) inconsistent articulatory pattern

B. THE CLINICAL PERSPECTIVE

1. **Genetic**

   Speech and/or learning problems often occur in other members of the family.

2. **Neurological**
   - (a) Soft signs, eg. Clumsiness
   - (b) Delayed lateralisation of cerebral function
   - (c) Predominance in males
   - (d) Feeding problems - chewing and sucking
   - (e) Drooling

3. **Oral Examination**
   - (a) Oral Apraxia
   - (b) Poor lip posture
   - (c) Poor tongue tip control
   - (d) Slow or inability to perform diadochokinetic rates
   - (e) Problems with oral sensory-motor feedback

C. THE LINGUISTIC PERSPECTIVE

- (a) History of delayed language development
- (b) Verbal comprehension often significantly ahead of expressive language development
- (c) Phonological disability
- (d) Restricted use of syntax
- (e) Disordered verbal language development
- (f) Non-verbal communication may be well developed and compensatory

D. THE COGNITIVE PERSPECTIVE

- (a) Often a significant discrepancy between verbal and performance tasks
- (b) Problems with reading, spelling, writing and drawing
- (c) Poor auditory memory
- (d) Sequencing difficulties
- (e) Cross-modality difficulties
- (f) Selective attention problems

The incidence of neurological soft signs in developmental dyspraxics is reported more widely in the literature (Yoss and Darley 1974, Rosenbek and Wertz 1972, Ferry et al 1975, Gubbay 1978, Crary 1984). These include: drooling, early feeding difficulties, and clumsiness on gross and fine motor tasks such as bead threading, tying shoelaces, and dressing. In Crary's (1984) review of twenty-five dyspraxic children, 52% had motor coordination difficulties and 92% of these had a significant medical history such as convulsions, high fever or pneumonia. The incident usually occurred before the age of two years and was serious enough to lead to hospitalisation.

It is debatable whether a diagnosis of verbal dyspraxia can be made in the absence of oral dyspraxia. All twenty-five of Crary's (1984) cases had some degree of oral motor incoordination even though no obvious motor weakness was apparent. Eisenson (1972) argued that, unlike in the acquired condition, developmental verbal dyspraxia will always be accompanied by oral dyspraxia. Nonverbal skills however, often respond well to oral training so that it is possible for a child to be left with a verbal dyspraxia alone. A longitudinal clinical perspective is needed to investigate this further.

It is also doubtful whether developmental verbal dyspraxia can be differentiated from other developmental disorders on the basis of nonverbal skills. The features of clumsiness, lack of facial expression, poor oral sensory motor feedback and slow diadochokinetic rates could equally be true of children with specific language disorders, phonological disability and dyslexia.

As with other language related conditions there is a predominance of males compared to females in groups of dyspraxic children investigated. There was between sixty-seven and ninety percent of boys in the studies quoted above. Along with this is the strong family incidence of language/learning problems. Sixty-seven per cent of familes in Morley's (1965) study demonstrated this. Similarly, Crary (1984) reports that a high percentage of the subjects' fathers or paternal family members had a history of delayed speech development, articulation problems, stuttering, or dyslexic difficulties.

The overlap of symptoms with other disorders raises the issue of developmental verbal dyspraxia as a discrete clinical entity. If the label is to have any credence at all it should refer to children who have incoordination of the vocal tract for nonverbal and/or verbal movements in the absence of obvious neurological and structural abnormalities. It is likely that the child will exhibit soft neurological signs at some stage in his development and that there will be a family history of similar or associated difficulties. Without these accompanying signs to the speech disorder, it would be difficult to justify the use of the dyspraxic label. After all, the term "praxis" refers to movement and "dyspraxia" refers to clumsiness of gross and/or fine motor movements (Cermak 1985).

II. THE SPEECH PERSPECTIVE

Three speech characteristics are repeatedly cited in the literature as pertaining to developmental verbal dyspraxia: (a) history of delayed speech development, (b) unintelligibility and (c) resistance to remediation (Macaluso-Haynes 1978). Although all are true of the condition they are not differentially diagnostic. These general characteristics could be present in any moderate to severe speech disorder. It is therefore necessary to look for characteristics specific to developmental verbal dyspraxia.

The articulatory characteristics have received the most attention and the speech perspective is perhaps the one most influenced by the adult model. Thus, such diagnostic criteria as "breakdown in multisyllabic words, extreme variability in production, and groping for sounds" are meaningless in a young child who has not yet developed multisyllabic words or a sound system with which to be variable. Other signs may be relevant to the developmental disorder, for example non-English articulations, sound omissions, voice, place and manner errors, metathesis and vowel distortion. Even so, these could equally characterise what others might call a "Phonological Disability" and differentiation between these two has proved difficult (Parsons 1984). Speech characteristics alone are unlikely to lead to diagnosis.

Edwards (1984) has shifted attention from the segmental to the suprasegmental level of speech production. The view that dyspraxia is **primarily** a prosodic disorder is in opposition to Darley et al (1975) who believe that any arhythmia in dyspraxic speech is the result of struggling for articulatory postures. Laver's (1970) model of skilled speech production cites two possible types of rhythmic disorder. The first is at a phonological level of linguistic programming and the second at a phonetic level of vocal tract incoordination resulting from neuromuscular dysfunction. Although Edwards has referred to this possibility it has not been addressed in the developmental literature on verbal dyspraxia where it has been assumed that one level of breakdown - motor programming - is the cause of the articulatory difficulties.

Critical to the understanding of the developmental disorder are the repercussions that may occur from breakdown within the speech chain. If the child with verbal dyspraxia does have a primary prosodic disturbance what effect might this have on the developing lexicon and phonological representation? The work of Waterson (1981) and Chiat (1983) discussed in Chapter 1 indicates that a disturbance at this level will have far reaching effects; another reason why studies of children with developmental verbal dyspraxia need to break away from the rigid criteria set for studying the acquired condition in adults.

A further barrier to speech production occurs when the vocal tract is incoordinated. In order to produce sounds contrastively, the child needs to control laryngeal vibration (pin/bin), the velo-pharyngeal sphincter (bee/me), and articulatory place change (pea/tea/key). The accurate timing of such movements is another possible explanation of the speech characteristics of developmental verbal dyspraxia. The literature however, is sparse on normal developmental speech data. Given that the physical immaturity and motor control of the vocal tract in normal children is more influential in early speech output than perceptual factors (Macneilage 1980), and that persisting articulatory immaturity may be an explanation of developmental phonological disability (Hewlett 1985), data on normal motor speech development is needed to clarify if developmental verbal dyspraxia is qualitatively or quantitatively different from normal development. If distinct, the condition should be differentiated from the normally developing population as well as other developmental speech disorders by a persisting mistiming and ordering of vocal tract sequences. The result would be inconsistent respiration, voicing, prosody, resonance and articulation.

In summary, the speech difficulties characteristic of developmental verbal dyspraxia could be the result of a single deficit or a combination of three levels of breakdown: phonological misrepresentations in the lexicon, inability to programme the speech output, and/or vocal tract incoordination.

In the adult with an acquired disorder these levels may breakdown more discretely but it is not clear what affect a malfunction at any of these levels may have on the child's developing phonology for speech, reading and spelling. The assumption that the child with developmental verbal dyspraxia will behave in a similar fashion to the adult with acquired dyspraxia has resulted in confused criteria for the identification and differentiation of the developmental condition particularly within the preschool population.

III. THE LINGUISTIC PERSPECTIVE

Recent studies of children with developmental verbal dyspraxia have examined the phonological system. Crary, Landess, and Towne (1984) made a phonological analysis of the continuous speech samples of ten dyspraxic children in the age range of 3 years 9 months to 13 years 11 months. Twelve phonological processes were identified. Six reflected syntagmatic errors which were sequential reductions dependent on the position within the word. For example, prevocalic voicing will occur in prevocalic position regardless of whether the phoneme is /p/, /t/ or /k/. Five processes were paradigmatic. These relate to the phoneme itself regardless of its position in the word, for example /p/ for /f/ or /t/ for /s/. The remaining process identified was vowel neutralisation. The syntagmatic errors were the most prevalent. Sequential simplification by omission was the most common of these, for example deletion of final and intervocalic consonants, and cluster reduction. The results indicated a deficit in phonological sequencing abilities and/or motor speech timing. The authors dismissed the possibility of lower level articulatory constraints since none of the children had physical abnormalities. Instead they suggested that the children had "programming limitations". However, these results are interpreted cautiously because of the wide age range tested. It is feasible that the performance of the three to seven year olds at least would be clouded by normal articulatory immaturity while that of the older children may have been characteristic of a specific speech disorder.

The predominance of omission errors is reminiscent of an earlier study by Frisch and Handler (1974). A group of speech disordered children were differentiated on the basis of their substitution and omission errors. The "omission" group were compared to adults with left cerebral dysfunction. They differed from the other group on motor output tasks even though there were no obvious gross motor difficulties. The persistence of omission errors over the age of three years was interpreted as indicative of cerebral dysfunction and this group was viewed as qualitatively distinct from other developmental speech disorders.

Although this comparison with the adult must be treated with caution, the phonological approach can be illuminating if the children are examined longitudinally. The "qualitative" distinction suggested by Frisch and Handler may disintegrate as the children mature. In short, the distinction may reflect different phases of the developmental process rather than qualitatively distinct groups.

The lack of a developmental perspective renders much of the evidence on developmental verbal dyspraxia difficult to interpret. Parsons (1984) for example, criticised Crary et al's study for its lack of control group. He therefore selected seven phonologically impaired children ranging in age from 4 years 6 months to 6 years 8 months, and matched them on number of articulation errors to seven children with developmental verbal dyspraxia ranging in age from 3 years 11 months to 7 years 9 months. Data was collected from both groups when naming pictures and from continuous speech. Twenty-four phonological processes were identified in the speech sample but there was no significant difference in the distribution of these processes between the two groups. The author concluded that children with developmental verbal dyspraxia are no different from children with multiple errors found in phonological disability.

Parson's study raises a number of points. First, selection of subjects. Criteria for selection to the dyspraxic group was based on poor diadochokinetic rates, history of incoordination or clumsiness, oral/articulatory struggle when speaking. Children were assigned to the phonologically impaired group if they had multiple articulation errors in the absence of articulatory incoordination or struggle behaviour. The diagnostic limitations of these characteristics have been discussed in the clinical perspective section above. The findings suggest that they bear no relationship to the speech pattern. Children already labelled as dyspraxic by their clinicians were also included. This is worrying since diagnostic criteria, particularly in the younger children, have never been clarified. The no difference result could therefore be an effect of the selection procedure.

Second, although the two speech disordered groups were equivalent on the number of sounds in error, the dyspraxic group made more multiple errors as a result of the simultaneous use of simplifying processes. Parsons suggested that this is why authors have noted inconsistencies in dyspraxic speech (Rosenbek and Wertz 1972, Ferry et al 1975, Murdoch, Porter, Younger and Ozzane 1984). It is a pity that Parsons then dismissed this evidence since it could be argued that multiple simultaneous errors may indicate a different or additional level of breakdown in the articulatory process. As no normal control group was included in Parson's study, it is not possible to say if these multiple errors are unique to the dyspraxic population or merely an earlier stage of normal development.

Third, Parson's finding of more paradigmatic processes within the dyspraxic group is a direct contradiction of Crary et al (1984) who found a greater incidence of syntagmatic simplification. The conflicting results can be explained by the different age ranges studied (Parsons: 3:11 - 7:09, Crary et al: 3:09 - 13:11). If paradigmatic processes result mainly from articulatory immaturity and syntagmatic processes from higher level programming skills, then it would follow that the younger the child the more likely that both error types will occur. As the child with developmental verbal dyspraxia matures, the paradigmatic processes will decline since by definition they should not have any neuromuscular weakness, leaving the more specific syntagmatic difficulties. The two studies are therefore not in conflict but are tapping different developmental stages. This view is compatible with Milloy's (1986) notion of children with immature articulatory praxis as distinct from the more severe and persisting dyspraxic condition. However, a more detailed investigation of normally developing children is necessary in order to test this hypothesis. Appropriately matched younger normal controls have not yet featured in any of the studies of developmental verbal dyspraxia.

Syntax development has been another area of linguistic interest. Many papers have referred to "delayed language development" in dyspraxic children (Morley 1965, Rosenbek and

Wertz 1972, Ferry at al 1975) but only recently has there been a systematic study of the syntactic structure of dyspraxic children's utterances. Ekelman and Aram (1983) collected fifty spontaneous utterances from each of eight children previously diagnosed as dyspraxic and ranging in age from 4 years 4 months to 11 years 11 months. Although all of the children had appropriate developmental mean length of utterance this did not predict their use of grammatical markers as would normally be expected (Brown 1973). Several of the children omitted grammatical markers associated with earlier stages of development. In addition to the omission errors, pronoun confusion and auxiliary substitutions occurred. The children maintained their mean length of utterance by stringing together simple sentences. They were able to use conjunctions but not necessarily embedded clauses.

The use of more advanced structures in the absence of simpler ones led the authors to conclude that the children were not simply delayed in their syntax development. Furthermore, the results cannot be explained by an articulatory difficulty alone. The children were able to produce /s/ in the final position of a word to mark plurality but did not do so on another occasion to mark third person ending. As the data was not supplied in this study the results are questionable since the phonetic context of the responses cannot be controlled in childen's spontaneous utterances. However, this study indicates that children with developmental verbal dyspraxia can sometimes present with a specific syntactic disability.

The addition of the linguistic perspective to the clinical and speech perspectives has led Crary (1984) to redefine dyspraxia as a "motor-linguistic disorder". The child's incoordination difficulties are no longer only located at the level of the vocal tract. Crary and Towne (1984) suggest that there is also "asynergy" between the linguistic levels of phonology, morphology and syntax.

IV. THE COGNITIVE PERSPECTIVE

It is not uncommon for a dyspraxic child to show a discrepancy between verbal and performance scores on standardised intelligence tests. Although it is normally the verbal scores that are lower, some dyspraxic children also have difficulties on performance tests. This is particularly the case when forms other than verbal dyspraxia exist, for example dressing or limb apraxia. Clinicians have reported difficulties when teaching sign language to dyspraxics and many of the children have difficulties in sequencing nonspeech motor acts (Walton, Ellis, and Court 1962, Morley 1965, Yoss and Darley 1974, McLaughlin and Kriegsmann 1980, Gordon and McKinlay 1980). Surprisingly however, there have been very few systematic studies of nonverbal processing in dyspraxic children.

Aram and Horwitz (1983) addressed two questions: The first was whether dyspraxic children's sequential difficulties were generalised or whether they were only related to verbal tasks, and the second was whether their praxic difficulties were evident only in speech or also in nonverbal tasks. Again unfortunately a wide age range was studied: 4 years 4 months to 13 years 2 months. Ten children were selected based on the criteria of having a moderate to severe speech disorder even though there was a "full range of lip and tongue movements". In addition, the children had normal nonverbal intelligence and verbal comprehension. Standardised tests of verbal and nonverbal sequencing (Kirk, McCarthy and Kirk's Illinois Test of Psycholinguistic Abilities 1968, Aten's Denver Auditory Phoneme Sequencing Test 1979, and the Wechsler Intelligence Scale for Children 1974) as well as nonstandardised tests of single and sequenced volitional oral movements were administered. The children's sequencing difficulties were found to be specific to verbal tasks. It could not be concluded however, that a verbal sequencing difficulty is unique to verbal dyspraxia. Yoss and Darley (1974) found that the Denver test did not differentiate their two speech disordered groups of functional articulatory problems and articulatory dyspraxia. Furthermore, verbal sequential difficulties are noted in a variety of disorders - developmental dysphasia (Wyke 1980), hearing impairment (Furth 1966) and dyslexia (Miles 1982).

A general point of interest is raised from this study - individual variation within the group on the praxic tasks. Four of the children exhibited signs of a more generalised praxic disorder. It is a pity that the nonverbal sequencing skills of these children were not reported separately. Given that there are different types of dyspraxia (Roy 1978) it is possible that verbal sequencing deficits only occur with verbal dyspraxia, while nonverbal sequencing deficits accompany nonverbal dyspraxias. This would not preclude both verbal and nonverbal deficits presenting within the same child. The individual variation is another reminder of the importance of subject selection criteria and the lack of homogeneity in many groups of dyspraxic children studied.

Recently, a better controlled study of dyspraxic children's auditory discrimination skills has been carried out (Bridgeman and Snowling 1988). Twelve children with developmental verbal dyspraxia ranging in age from 7 years 2 months to 11 years were tested on an auditory discrimination test and their performance was compared to reading age matched children. The task was designed to test sequential auditory discrimination in real and nonwords. Discrimination of fifteen familar and fifteen nonsense monosyllabic word pairs comprising cluster reversals (lost/lots, vost/vots) were compared to fifteen word and nonword pairs without clusters (loss/lot, vos/vot). There was no difference between the speech disordered children and normal controls on the no cluster condition and all of the children were at ceiling on this task. However, the speech disordered children performed less well on the cluster reversal condition particularly on nonword items. This supports the hypothesis that children with developmental verbal dyspraxia are at risk on tasks of more complex auditory discrimination involving sequencing. Their performance cannot be explained by auditory perception alone since they were at ceiling on the simple word condition. Neither can it be explained by orthographic experience since these children were matched on reading age. The dyspraxic children therefore had a specific difficulty in detecting the sequence of phonemes within words.

Finally, the recent work on reading and spelling performance of children diagnosed as having developmental verbal dyspraxia reported in Chapter 1 (Stackhouse 1982, Snowling and Stackhouse 1983) suggests that the condition is more pervasive than a lower level articulatory disorder. A breakdown in phonological processing is indicated and requires further investigation.

V. DIFFERENTIAL DIAGNOSIS

The reliable identification of a dyspraxic subgroup in developmental speech disorders has seriously been questioned. In 1981 Williams, Ingham, and Rosenthal failed to replicate Yoss and Darley's (1974) study which purported to distinguish between children with dyspraxia and functional articulation disorders. Williams et al administered the same tests as Yoss and Darley to a group of thirty moderately to severely speech disordered children whose articulatory difficulties could not be explained by low intelligence, poor hearing, slow language development or an organic etiology. Unlike Yoss and Darley these authors found that neither tests of isolated nor sequenced volitional oral movements distinguished a dyspraxic subgroup in these speech disordered children. Nor were there any significant neurological findings. Williams et al suggested that their failure to replicate the earlier study may have been due to a difference in the severity of the speech disorders chosen, or even the referral source. Until such variables are controlled, it remains that no dyspraxic subgroup has been empirically identified in the population with developmental speech disorders. This has led

Guyette and Diedrich (1981) to conclude that,

> "developmental apraxia of speech is a label in search of a population".

It is salutary that despite this, there is a strong consensus among clinicians as to what constitutes developmental verbal dyspraxia. Williams, Packman, Ingham, and Rosenthal (1980) reported the results of a questionnaire study administered to thirty-one clinicians who had had between three and twenty years experience. The clinicians were asked to classify eighteen behaviours as being "always", "sometimes", or "never" associated with the three types of articulatory behaviour: functional, dyspraxic or organic. The following four behaviours were "always" associated with developmental verbal dyspraxia:-

1. Deviant rather than immature articulatory behaviour.

2. Searching behaviour when trying to produce phonemes.

3. Inability to produce individual or sequences of phonemes volitionally.

4. Inconsistent pattern of errors.

This study implies that developmental verbal dyspraxia exists as a clinical entity and can be identified by measurable behaviours. However, there are some problems in the way the questionnaire was designed. First, the clinicians were presented with a three pronged classification of speech disorders - functional, dyspraxic and organic - ironically the first two of which the same authors had been unable to differentiate in the study discussed above (Williams et al 1981). Second, it forced clinicians to differentiate the speech disorders by drawing on the traditional and accepted definitions. Deputy (1984) refers to this phenomena as the "Authority Effect". This occurs when "tentative conclusions and findings gain status through citation".

It is clear that few of the characteristics listed in Table 2.1. are unique to developmental verbal dyspraxia. Furthermore, there are no guidelines as to which, if not all, need to be identified before a diagnosis of dyspraxia can be made. In the absence of these guidelines, it is perhaps not surprising that diagnosis is often made by exclusion.

In summary, the term "dyspraxia" was originally used to describe an articulatory difficulty in adults with acquired disorders. The terminology and diagnostic criteria have been applied to the developmental speech disordered population without modification. Consequently, it has become an umbrella term for children with persisting and serious speech difficulties.

Methodological problems are partly to blame for this situation. First, the wide age ranges studied within one group seriously jeopardise the understanding of an unfolding speech disorder: to include older subjects alongside preschoolers as though they will behave in the same way is plainly indefensible.

Second, the majority of studies fail to acknowledge the importance of normal-speaking control subjects. Although rapid speech development occurs in the normal child between the ages of two and four years, articulatory skills do not stabilise until around seven years of age. Up until this time the child is having to use a changing anatomical and physiological system (Baken

1983) and studies have shown that, compared to adults, three year olds are three times as variable in their vowel quality and voice onset time (Eguchi and Hirsh 1969). It is likely therefore, that normal children will not perform perfectly on articulatory tests and the possibility of finding developmental immaturities should be acknowledged in the diagnostic criteria. These issues will be addressed in Chapter 5.

CHAPTER 3

RATIONALE AND STRUCTURE OF THE STUDY

I. COMMON THEMES IN DEVELOPMENTAL DYSLEXIA AND DYSPRAXIA

A number of recurring themes have emerged from Chapters 1 and 2.

A. Heterogeneity

Neither developmental dyslexia nor developmental verbal dyspraxia are unitary disorders. Yet in both cases assumptions have been made about the homogeneity of the groups tested. With reference to studies of dyslexic children, Seymour (1987) stated that to assume all cases under one heading of "poor readers" or even to divide into subgroups is a serious oversimplification and distortion. Similarly, in studies of speech disordered children, the lack of description of the precise nature of the children's difficulties has inevitably resulted in heterogeneous groups.

The question of subtypes has also been raised by Ellis (1985). Until indicators of the various subtypes in dyslexia can be specified, categorisation of cases cannot be resolved. Similarly, in the case of developmental verbal dyspraxia, controversy surrounds whether such a condition can be differentiated from other speech disorders (Williams et al 1981, Parsons 1984). Furthermore, there is also overlap in the features said to be characteristic of developmental dyslexia and developmental verbal dyspraxia themselves.

B. Lack of a Developmental Perspective

Both developmental dyslexia and developmental verbal dyspraxia must be viewed within an appropriate developmental framework. It is no longer feasible to work from models of skilled performance when dealing with developmental disorders (Ellis 1985). Snowling (1983) has noted that to do so will limit understanding of both etiology and prognosis of developmental dyslexia. She argued that comparisons between acquired and developmental disorders of reading can never be comfortably executed since (a) there are difficulties in deciding upon the developmental level to be tested, (b) there are difficulties in assessing the appropriateness of experimental materials, and (c) there is a tendency for all children to switch processing strategies according to task demands.

Similarly, Ehri (1985) has attacked the application of the two route model of skilled reading to developmental disorders. She has three major criticisms. First, it is wrong to assume that there are only two ways to read words (visually and phonologically). Second, the two routes themselves are not necessarily independent of each other since phonological processing focusses attention on visual forms and enhances storage in memory. Third, the dual access theory has trouble explaining how readers know which letter/sound rules to apply when reading ambiguous orthographic combinations (compare "th" in HOTHEAD vs BOTHER). Clearly, the rigid models appropriate for skilled readers cannot account for the dynamic nature of reading and spelling development and consequently have not been able to explain the difficulties encountered by developmental dyslexics.

Frith (1985) examined the requirements of a developmental model of reading and spelling development. These include (a) the identification and explanation of how the various stages of reading and spelling are mastered, (b) an account of developmental spurts, dips and plateaus, (c) the interaction between reading and spelling development, (d) the role of other cognitive skills, and (e) the identification of levels of breakdown in the reading and spelling processes. A developmental perspective also needs to be cognisant of the influence of maturational processes and the effect of environmental, social, cultural and educational factors.

A developmental model must therefore be able to account for levels of change and breakdown. This dynamic model is unlikely to be how Horn (1969) perceived it - a steady improvement over time. The process is more likely to be one of "dips and drops" in keeping with other aspects of cognitive and language development. This uneven rate and pattern of development mirrors how children learn through sudden insight - breaking through to the next phase and using new strategies which may not always be successful at first.

In the same way that the work on acquired dyslexia and its subgroups is a shaky premise from which to study developmental reading disabilities, the controversies never resolved in acquired verbal dyspraxia have been carried over to the developmental condition. An obvious but frequently overlooked point is that an adult whose language breaks down has previously possessed an intact speech, language and literacy system - the child has not. The unfolding nature of developmental disorders and the effect of teaching and therapy should not be underestimated.

C. Subject Allocation

Allocation of subjects to clinical groups has been somewhat haphazard. Such general terms as dyslexia, functional articulation disorder, phonological disability or dyspraxia can cover a multitude of disabilities. This has led to conflicting results and may account for the variability in performance within groups. A possible solution to the problem of heterogeneity within groups is the application of systematic single case studies. Such a move has recently been seen in the literature on developmental dyslexia (Temple and Marshall 1983, Campbell and Butterworth 1985, Snowling, Stackhouse and Rack 1986, Seymour 1987) but as yet no single case studies of children who have been designated as having developmental verbal dyspraxia have been reported. However, in instituting such case studies, great care must be taken over controls.

D. Controls

Lack of appropriate controls has rendered some results meaningless. For example, dyslexics have sometimes been matched to normal children on the basis of chronological age. Bradley and Bryant (1985) point out that such a procedure means that the two groups will have very different reading and spelling experience. What is more, the dyslexic children may have experienced failure on tasks often used in experimental procedures. Controls for intelligence, and reading and spelling ages need to be considered

(Snowling 1983). Similarly, when testing speech disordered children, their difficulties must be evaluated with reference to the normal child's articulatory maturity (Backen 1983). This has not been accounted for in the studies discussed.

E. Lack of a Longitudinal Perspective

Lastly, there are no comprehensive studies of children accounting for their speech, reading and spelling problems which have taken a longitudinal perspective. The majority of studies have tested groups of children on specific tasks such as segmentation, memory or articulation. This piecemeal approach does not help our understanding of the complex interaction of spoken and written language.

II. CRITIQUE OF SEGMENTATION SKILLS STUDIES

An area central to the study of developmental dyslexia and verbal dyspraxia is segmentation. Unfortunately, this is also riddled with methodological problems. As a result of these, controversy surrounds whether segmentation skills are an essential prerequisite or consequence of learning to read. Furthermore, the age at which segmentation skills emerge has varied across studies from four to seven years (Read 1975, Calfee, Chapman and Venezky 1972, Liberman, Shankweiler, Fischer and Carter 1974, and Bruce 1964). The following appear to be the main causes of the confusion:-

A. Control Groups

Bradley and Bryant (1985) stress the importance of appropriately controlled studies. When investigating segmentaion skills in ten year old children with reading ages of around seven years, they included both mental and reading age matched children (Bradley and Bryant 1978). As the backward readers performed more poorly on odd one out sound categorisation tasks compared to the control group, it is safe to conclude that there is a genuine difference between these two groups on categorising words by sounds. This cannot be said for studies with only chronological age match controls, since children of varying abilities will mask the results.

When comparing the performance of good and poor readers on segmentation tasks, reading age controls are essential. Without these it is not known if the poor readers are performing less well merely because of lack of reading/sound experience. Bryant (1985) states,

> "Without any doubt the experience of reading will have its effects on children. Reading introduces children to new kinds of information presented in a new kind of way."

However, this control can be difficult to achieve. Older children of the same reading age as younger normal readers are not necessarily matched on reading experience as compared to skill (Henderson 1982). There is also the possibility of "negative" reading experience in the poor reader group.

Recent work on segmentation skills and spelling development raises the issue of spelling age matched controls. Snowling and Perin (1983) found that although performance on an elision task was closely tied to reading skill, segment judgement was related to spelling performance. Few studies to date have acknowledged the relationship between segmentation and spelling development or have incorporated the appropriate controls.

B. Range of Tasks and Instructions

Investigations of children's abilities to segment words into syllables and phonemes have incorporated a variety of tasks which differ in the knowledge and experience a child needs in order to complete them successfully. Little attention has been given to comparing the demands of these tasks on the children or to evaluating which tasks may be most related to the reading process. Lewkowicz (1980) noted that at least ten different types of tasks have been presented. These include:-

a) Sound to word matching - "Does fish start with f?" (Calfee, Chapman and Venezky 1972, Wallach and Wallach 1976)

b) Word to word matching - "Does fish start with the same sound as feather?" (Calfee et al 1972).

c) Recognition of rhyme (Calfee et al 1972, Bradley and Bryant 1978).

d) Isolation of a beginning, medial or final sound - "What is the last sound in dog?" (Skjelfjord 1976, Wallach and Wallach 1976, Zhurova 1963-4).

e) Phonemic segmentation - "What are the three sounds in fish?" (Elkonin 1973, Fox and Routh 1975, Lewkowicz and Low 1979).

f) Counting the syllables or phonemes in a word - "How many beats in potato?". "How many sounds in cat?" (Liberman et al 1974). A variation on this task has been to present counters or blocks or thread beads for each unit rather than to count verbally (Ehri and Wilce 1980, Kamhi, Lee and Nelson 1985).

g) Blending - "What does c-a-t say?" (Fox and Routh 1976, Goldstein 1976, Williams 1980).

h) Deletion of a phoneme - "Say fish without f" or "Say fish without the first sound" (Calfee et al 1972), or "If I take away t from stand, what will be left?" (Bruce 1964).

i) Specifying which phoneme has been deleted - "Say meat, now say eat - what sound was left out of the second word?" (Zhurova 1963-4).

j) Phoneme substitution - "Say meat - now say it with f instead of m." Vowel substitution has also been involved (Elkonin 1973), and coloured blocks have been used to denote at what position within the word the substitution has taken place (Lindamood and Lindamood 1969).

This is by no means an exhaustive list. Studies have also combined tasks. For example, Savin's (1972) "Pig Latin" task required the child to detach the initial phoneme or cluster and move it to the end of the word after which an agreed syllable - often "ay" - was added (RUN/unray, SHOOT/ootshay).

This range of tasks have been classified into three levels of difficulty (Golinkoff 1978):-

a) Recognising the presence or absence of a unit.
b) Performing a deletion and recombining the remaining elements.
c) Performing a deletion and replacing the deleted element with another element.

Other variables to consider when designing segmentation tasks for children are: word length, phoneme position within the word, and the segmentation boundary within the word. For instance, Treiman (1985) has shown that it is easier for a child to divide a syllable into its onset (initial consonant or cluster) and rime (vowel and following consonants) as in "c/at" than it is to segment within the rime as in "ca/t". This was also true on a lexical decision task (Treiman and Chafetz 1987). Stimuli with slashes after the initial consonants as in CR/ISP yielded faster response times than stimuli with slashes after the vowel as in CRI/SP. This hierarchical structure of the syllable has not always been taken into account when studying developing segmentation skills.

One study in particular illustrates the problems that arise from using a variety of stimulus demands. Whitworth and Zubrick (1983) asked children to find small words hidden in longer ones. Some stimuli presented required the child to cross a syllable boundary ("cough" from "coffee") while in others the child had to segment within a syllable ("car" from "calf") or use morphological knowledge ("paint" from "painter"). Furthermore, orthographic knowledge of the target could either help ("out" from "shout") or hinder ("car" from "calf"). The range of stimuli used may explain why Whitworth and Zubrick's findings contradicts other studies (for example Liberman, Shankweiler, Fischer and Carter 1974) on the development of word and sound awareness.

Children's performance on segmentation tasks may also vary as a result of the different instructions which have been given. Calfee et al (1972), for example, asked "Do these words sound the same at the end?". This question would almost certainly have been too difficult for the preschool children in the study. Indeed, the finding was that rhyme skills emerge at school age. This is in contrast to Read's (1975) ingeneous use of implicit instructions via puppets. The children were taught to select words that rhymed with the puppet's name. For example, they were asked "Would Ed like bed or bead?" In this study four year olds could successfully complete the task.

Many segmentation tasks require the child to have a concept of "beginning" and "end" of words. This puts the young child at a disadvantage. Furthermore, the assumption that the child will share the tester's understanding of "word" and "sound" may be false. This is particularly the case if the child is also language or learning disordered (Kamhi, Lee and Nelson 1985).

Thus, poor performance on sound segmentation tasks may be due to lack of knowledge or experience in other language related areas rather than to a specific segmentation deficit. Snowling and Perin (1983) argued that tasks make different "cognitive demands" on children. They divided their tasks into those requiring implicit and explicit knowledge. Implicit tasks comprised auditory discrimination and imitation of paired words. Explicit tasks required the child to make segmentation judgements - he had to detect sounds "inside the words" and perform elisions which were presented through a puppet who "could not say his words properly". The children therefore had to correct the puppet's speech errors, for example, if he said "net" for "nest", the child, had to tell him to add "s". This added the load of manipulation as well as keeping track and was therefore the most difficult cognitively. The tests were given to twenty-four girls aged four to six years. All of the children performed at ceiling on the auditory discrimination and imitation tasks, but the four year olds had difficulty with the judgement task and found elision impossible. Improvement was noted in the five and six year olds but performance was not significantly different between these two ages. The authors concluded that segmentation skill depends on the extent to which explicit phoneme awareness is required.

C. **Tacit versus Explicit Sound Awareness**

The studies of segmentation skills have tended to focus on the child's "explicit" knowledge that speech consists of smaller units. An earlier "tacit" level of phonological knowledge has often been missed. A child who is unable to consciously manipulate phonemes is not necessarily unaware of sounds. Zhurova (1963) reports that when the young child - Igor - was asked if his name was "Gor", he confidently replied that it was not but he was unable to supply the omitted phoneme. Instead, he elongated the initial sound without segmenting it from the remainder of the word - "Eeeegor".

Furthermore, as children have shown "sudden insight" into the task presented, it has been assumed that skills like rhyming are all or nothing phenomena without regard for the possibility of a **readiness to breakthrough** stage. Bimodal results reported by Calfee et al (1972) and Stanovich, Cunningham and Cramer (1984) may merely reflect the right/wrong scoring procedure adopted. Such studies are not designed to tap children's **developing** sound awareness. The qualitative analyses of responses needed for this have not been reported. Neither have speed of responses. This is particularly important when dealing with older learning disabled children who may be successfully completing the task albeit more slowly. Only recently has it been acknowledged that children may pass through a series of stages in order to achieve segmentation skill (Content, Kolinsky, Morais and Bertelson 1986, Snowling and Perin 1983).

III. STRUCTURE OF THE THESIS

The present study investigated the relationship between verbal and written language development in speech disordered children. The approach taken was to collect data from groups of normally developing children and to use these data to establish a framework against which to compare two children with specific speech, reading and spelling problems. Because of the importance of collecting appropriate control data for case studies, Chapter Four of the thesis focusses on the normal development of rhyming and spelling skills. Attention will be given to qualitative analysis of the data and emerging phases of development. Section Two takes up the clinical issues. Two detailed case studies investigating the spoken and written language processes of adolescents with persisting speech problems of a dyspraxic nature are presented. Both children have severe reading and spelling difficulties and attend a language unit attached to a normal secondary school. They were first tested during 1982-84. Their articulatory performance is compared to younger normally developing children in Chapter Five. Investigations of their lexical, auditory discrimination, segmentation and sound blending skills are reported in Chapter Six, and Chapter Seven presents a study of their reading and spelling strategies. Their progress was reviewed in 1986 and is reported in Chapter Eight. At each stage their performance is compared to appropriately matched controls to highlight the specific difficulties encountered by the speech disordered children.

The final section summarises and discusses the results with reference to developmental models of speech, segmentation and literacy. It examines the clinical implications of the findings and suggests directions for future research.

CHAPTER 4

NORMAL DEVELOPMENT OF RHYME AND SPELLING SKILLS

In order to study clinical cases within a developmental framework, two investigations have been carried out of normally developing children. The first was of a special case of segmentation skill - rhyming development, and the second was an investigation of children's spelling errors. The aim of these investigations was to identify the phases of development which normal children pass through when acquiring rhyming and spelling skills in order to compare clinical cases later. The emphasis was therefore on the qualitative nature of their responses rather than on quantitative measures.

INVESTIGATION 1 - YOUNG CHILDREN'S RHYMING SKILLS

Anyone familiar with the play of young children will be aware of the popularity of rhyme. Long before school age, children enjoy nursery rhymes and gleefully produce rhyming strings. The occurrence of such games is so common that Chukovsky (1963) stated that,

> "Rhyme making during the second year of life is an inescapable stage of our linguistic development. Children who do not perform such linguistic exercises are abnormal or ill."

Such sound play may have an important function in developing language by providing a means for exploring structural possibilities and for practising new sounds and sequences (Ferguson and Macken 1980). Rhyming is a "natural" skill observed in very young children. Slobin (1978) reports that his daughter engaged in rhyme play from the age of three years one month. Chukovsky (1963) presents rhyming poems from three and four year old children. Yet empirical studies conclude that rhyming develops around the age of five or six years of age (Savin 1972, Calfee et al 1972, and Liberman et al 1977).

These discrepant findings can once again be explained by the lack of suitable control groups, variability of tasks and difficult task instructions (see Chapter 3). A criticism specific to the studies on rhyme development is the failure to distinguish between rhyme detection and rhyme production. Reports of preschool children's rhyming skill normally refer to spontaneous production of rhyming words in play. This reflects a tacit level of sound development since the children are not necessarily "aware" of what they have done. In contrast, reports of emerging rhyming skill at school age normally refer to rhyme detection. In general, studies have not been designed to tap children's developing rhyme detection and production skills simultaneously.

Although some studies have tried to examine children's rhyme development at different ages (Lenel and Cantor 1981), no study has identified how rhyme emerges. For example, it is feasible to suppose that a child goes through a rhyming readiness period where he is tuned in to sound but as yet cannot make or detect rhyme response. The identification of early rhyme skills in normal children is important if we are to establish the nature of the sound awareness problems experienced by language disordered children (Kamhi, Friemoth and Lee 1985).

The first investigation (1A) was therefore designed to test children's early rhyme detection skills. The stimuli incorporated semantic distractors as well as sound distractors in the form of alliterations. If young children are not tuned in to sound associations, their errors should comprise semantic rather than alliterative distractors. If, on the other hand, children developing sound awareness do not fully understand the concept of rhyme but relate it to sound similarity with the target, their errors should be alliterative rather than semantic responses. The task was presented pictorially and auditorily to investigate possible modality differences.

The second investigation (1B) examined qualitatively young children's rhyme production responses. If rhyming skill develops gradually, children's rhyming responses should allow the identification of developmental phases.

INVESTIGATION 1A: RHYME DETECTION

Design and Materials

The rhyme detection task comprised twenty-four pairs of rhyming words (including four practice items) selected on the basis of three criteria: (1) the vocabulary was appropriate for the age range four to six years, (2) a clear pictorial representation was possible and (3) semantic and alliterative distractors could be found that would also meet criteria (1) and (2).

Each rhyming pair was presented once with a semantic distractor (CAT: mat **fish**) and once with an alliterative distractor (CAT: mat **kite**). Therefore there were forty test items. These were divided into two sets (see Appendix 4-1) so that each rhyming pair occurred once in each set. Half of the items per set comprised semantic distractors and the other half alliterative distractors. The first word on each item was the target and the other two the response choice. The position of the rhyming and distractor choice was randomised. For the visual presentation the words were presented pictorially on individual cards (three cards per item).

A one between and two within mixed design was adopted. The between subjects variable was Reading Age (Prereaders - RA <4 years, Beginner Readers - Mean RA 5 years 10 months, Readers - Mean RA 7 years 9 months) and the within subjects variables were Modality (visual or auditory) and Distractor Type (semantic or alliterative). The mode of presentation was randomised so that half of the subjects received the auditory presentation first and half received the pictorial stimuli.

Subjects

Twenty-four children from a north London primary school participated in the study. Their chronological ages ranged from 4 years 3 months to 6 years 9 months. Equal numbers of boys and girls were tested. All the children spoke English as a first language and had no history of speech, language or learning problems. They were selected on the basis of their general age appropriate performance within the classroom situation as evaluated by their teacher's progress reports.

The children were assigned according to reading age (measured by the Carver Word Recognition Test 1970) into one of three groups. The first comprised 11 prereaders. Seven of these were nonreaders while four had a reading age level of four years.

The second group of seven children were beginner readers whose reading performance was at the five/six year level. The third group comprised six children who were reading at the seven/eight year level. Table 4.1 shows the chronological and performance ages for each group.

Table 4.1 - Investigation 1A: Details of Subjects.

Group	Number in Group	Chronological Age	Reading Age	Vocabulary Age
Prereaders	11			
Mean		4:09	<4:0	5:06
Range		4:01-5:08	<4:0-4:0	4:05-7:02
S.d.		0.58	-	1.1
Beginners	7			
Mean		6:01	5:10	6:10
Range		5:08-6:06	5:03-6:06	4:05-9:08
S.d.		0.43	0.57	1.6
Readers	6			
Mean		6:04	7:09	7:07
Range		5:07-6:09	7:03-8:06	5:09-8:11
S.d.		0.41	0.56	1.1

Procedure

Each child was seen individually on two occasions to administer the British Picture Vocabulary Scales (Dunn, Dunn, Whetton and Pintilie 1982) and the rhyme detection test. The children were seen in small groups to complete the Carver Word Recognition Test (1970).

The vocabulary test was administered at the first visit. Following this the concept of rhyme was introduced by reciting nursery rhymes leaving gaps for the child to complete. The child was then asked if words rhymed with his own name. The four practice items were administered. If visual presentation was first, the child was shown the three pictures in any order to check he recognised the picture and knew the vocabulary. If he did not, the tester supplied the word for him. The target was presented on its own and then the two response cards were placed face down below it (see Figure 4.1). This allowed the child to focus on the target and was particularly important for the younger children. The child was told that one of the hidden pictures rhymed with the first and he was to find it.

Figure 4.1 - Method of presentation of the pictorial test items.

```
-----------------------------------------------
                    ---------
                     picture
                     showing
                    ---------

          ---------             ---------
           picture               picture
          face down             face down
          ---------             ---------
-----------------------------------------------
```

Any errors were corrected and further examples given until the child was ready to proceed with the test items. No help was given with the test items. The child's first choice was recorded unless he spontaneously corrected himself in which case this was taken as the response.

Auditory presentation proceeded in a similar way. The child was asked to listen and to remember the target word. He was then to say which of the following two words rhymed with the target. Only ten test items were presented from each modality at one visit.

The children's responses were recorded onto the test sheets and the number of correct, semantic, and alliterative responses were calculated.

Results and Discussion

Even the prereaders were able to complete the task and the readers were at ceiling. The results are therefore interpreted cautiously. The beginner readers performed equally well on the two different modes of presentation (see Table 4.2). The number of semantic and alliterative responses recorded within each group is presented in Table 4.3.

Table 4.2 - Number of correct responses made by children from each group in visual and auditory modalities (maximum=20).

Group		Visual	Auditory
Prereaders			
	Mean	15.64	17.18
	S.d.	3.75	2.23
Beginners			
	Mean	18.57	18.43
	S.d.	0.98	1.81
Readers			
	Mean	19.33	19.50
	S.d.	0.82	0.84

Table 4.3 - Number of semantic and alliterative errors made by children from each group in visual and auditory modalities (Maximum=10).

Group		Visual		Auditory	
		Sem	Allit	Sem	Allit
Prereaders					
	Mean	1.82	2.55	1.27	1.55
	S.d.	1.94	2.11	1.49	1.37
Beginners					
	Mean	0.14	1.29	0.14	1.43
	S.d.	0.38	0.95	0.38	1.90
Readers					
	Mean	0	0.67	0.17	0.33
	S.d.	0	0.82	0.41	0.82

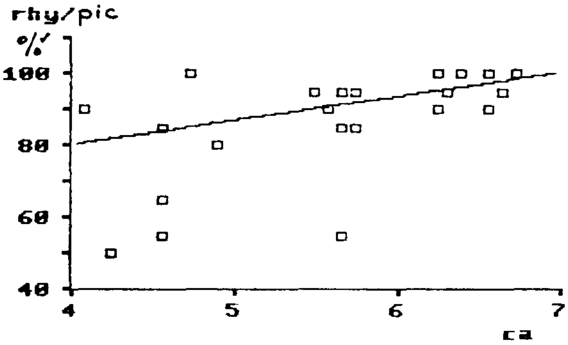
To examine the relationship between Reading Age and rhyme detection more fully, a mixed design analysis of variance for unequal numbers was carried out on these data (See Appendix 4-2). There was a significant effect of Reading Age, $F(2,21)=5.22$, $p < 0.01$, and of Error Type, $F(1,21)=8.464$, $p < 0.01$, but not of Modality, $F(1,21)=0.815$, $p < 0.38$. There was no significant interaction between the variables, $F(2,21)=0.25$, $p < 0.78$.

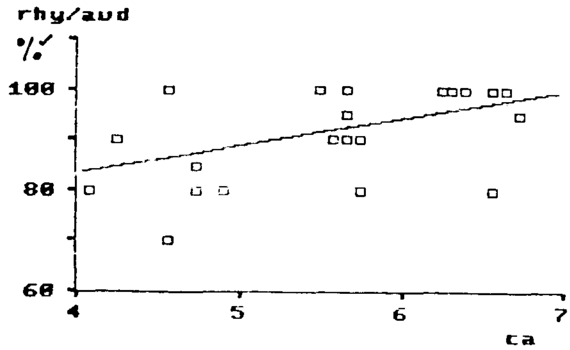
Spearman's Rank Correlation Coefficient tests were also carried out on the data. There was a significant positive correlation between rhyme detection performance and chronological age ($r_s(23) = 0.67$, $p < 0.005$), reading age ($r_s(23) = 0.63$, $p < 0.005$), and vocabulary age ($r_s(23) = 0.55$, $p < 0.005$). Figure 4.2 shows the correlations on the different modes of presentation.

Figure 4.2 - Spearman's rho correlations between performance on pictorial and auditory rhyme detection tasks and a) chronological, b) reading and c) vocabulary ages.

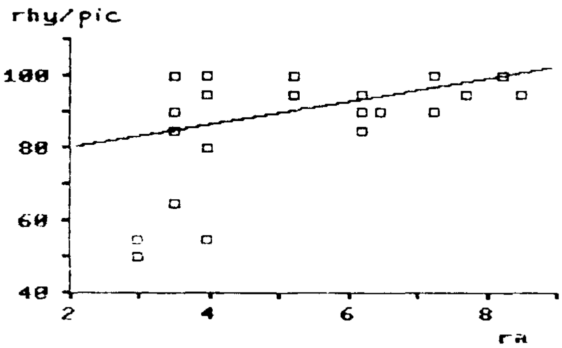
Picture Presentation | Auditory Presentation

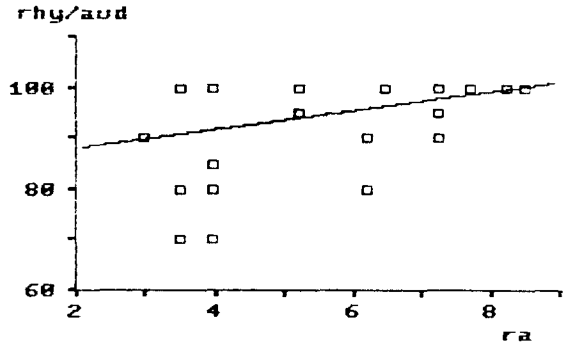
a) Chronological Age



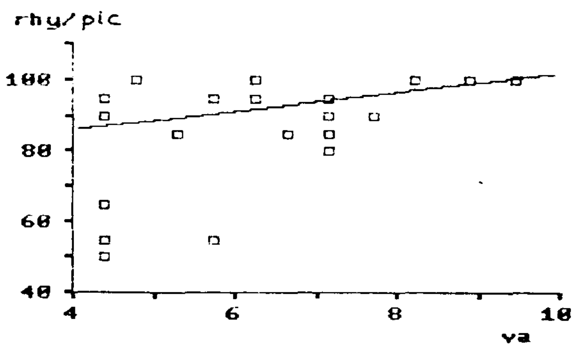


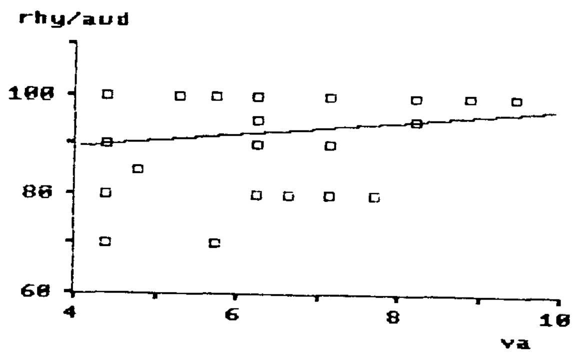
b) Reading Age





c) Vocabulary Age





As predicted, the prereaders selected more semantic distractors than alliterative ones compared to the other two groups. This suggests that they have more shaky sound awareness. However, alliterative errors were predominant in all three groups. Therefore the prereaders were tuned-in to sound prior to learning to read, indicating that rhyme detection can occur in the absence of orthographic knowledge. This is compatible with the findings of Morais et al (1986) discussed above. Not all cases of sound segmentation skill are the consequence of learning to read.

Although not significant it is noted that there was the greatest difference between the number of semantic and alliterative errors in the beginner readers. Testing of a larger sample of children would clarify this. An increase in alliterative responses while learning to read would make sense given the alphabetic methods used to teach reading in schools and would support Mann's (1986) view that sound segmentation skills are heightened by the process of learning to read rather than as a consequence of reading itself. Indeed, there was a significant correlation between rhyme detection and Reading Age. Given that the children tested were developing normally, it is not surprising that chronological and vocabulary age also correlated with rhyming performance. These results are recorded however for later comparison with children who have specific difficulties with segmentation skills.

INVESTIGATION 1B: RHYME PRODUCTION

Design and Materials

Children were asked to produce as many rhyming words as they could to a target word spoken by the tester. Requesting one response only may allow the child to give a learned response, for example from a familiar rhyme or story. The rhyming string allows clearer identification of developing rhyming strategies. The emphasis of the study was therefore on the qualitative analysis of children's rhyming errors.

Twenty words suitable in vocabulary and phonetic complexity for young children were chosen for the elicitation of verbal rhyming responses. These were all single syllable words: hat, key, comb, bin, shell, drawer, map, log, bear, sew, sun, wool, eye, bed, four, ring, fish, can, heart, iron. Two practice items were included: pig, plate.

Subjects

Twelve children, four girls and eight boys, in the age range of 4 years 8 months to 6 years 9 months participated in the study. The children attended a Birmingham primary school and none of them had a history of speech, language or learning problems. All spoke English as a first language. Eleven of the children attended the infants class while one of the four-year-olds attended a play group attached to the school. For the purpose of qualitative analyses the children were divided into three groups on the basis of chronological age (See Table 4.4).

Table 4.4 - Investigation 1B: Details of Subjects.

Chronological Age Group	Number in Group	Chronological Age Mean	Chronological Age Range
4 years	2	4:09	4:08-4:11 S.d. 0.18
5 years	5	5:06	5:01-5:11 S.d. 0.42
6 years	5	6:05	6:01-6:09 S.d. 0.27

Procedure

Each child was seen individually on one or two occasions depending on age and attention span. Vocabulary, reading and spelling performance had been tested previously.

As in the rhyme detection task, the children were first introduced to the concept of rhyme through popular nursery rhymes and playing with rhyme by producing rhyming strings to the child's and tester's name. Real and nonsense words were used. Two practice items were administered and the child given corrective feedback if necessary. No help was given with the test items.

The child was asked to give as many rhyming words as he could to the target. He was encouraged to respond until he said that he did not know any more. Each response was recorded on the test sheet (see Appendix 4-3 for data corpus).

Results and Discussion

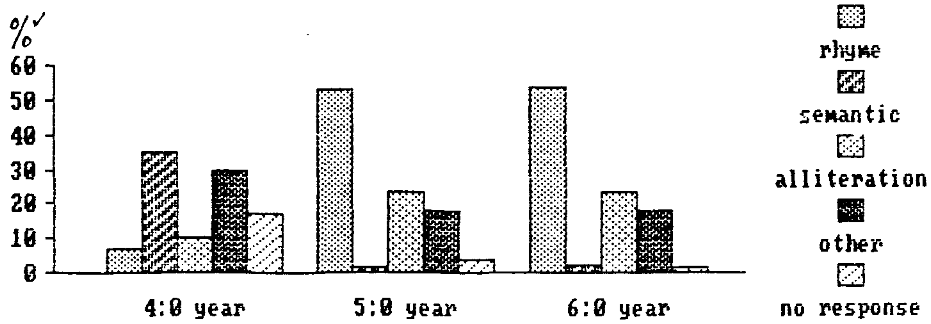
Two scores were obtained: (1) the accuracy of the first response to each target and (2) the number of correct responses to each target regardless of their position in the rhyming string. This revealed a clear difference in performance between the four and five year olds which was not present between the ages of five and six (See Table 4.5).

Table 4.5 - Percentage of correct first rhyme responses and total correct responses in the chronological age groups.

Chronological Age Group	Correct First Responses (%)	Total Correct Responses (%)
4 years		
Mean:	7.5	10.71
S.d.:	10.6	15.15
5 years		
Mean:	56.0	54.33
S.d.:	,30.7	26.3
6 years		
Mean:	53.1	52.67
S.d.:	46.7	45.63

First, the data was examined for alliterative responses (A), and semantic responses (S). No response to items was also recorded (NR). Anything other than these responses were grouped together for later analysis (O). Figure 4.3 shows the results of this initial analysis. These data suggest a difference between the performance of four and five year old. The four year olds made more semantic errors and the five year olds made more alliterations. However, these results are interpreted cautiously because of the small numbers and the generally lower levels of performance in the four year olds.

Figure 4.3 - Percentage of correct rhyme, semantic, alliterative, other and no responses in the chronological age groups.



Second, the "other" error types which occupied 17.7% of the total number of responses were examined. A list of these is presented in Appendix 4-4. Five main categories of "other" errors emerged:-

1. Mixed rhyme and alliteration.
   LOG - gog, dog, leg.
   KEY - king, ping.
   BIN - kin, ben, then, big.

2. Rhyme and Derivation.
   FISH - pish, yish, vish, viscious.
   IRON - ironman, Brian.
   SEW - sewing, mowing.

3. Rhyme and Feature Change.
   COMB - home, tome, wone.
   WOOL - pull, fall, wall, mall.
   MAP - lat, cat.

4. Syntagmatic.
   EYE - I like.
   CAN - jump, can play ball.
   CAN - Keith, Kim, like.

5. Miscellaneous. These were of minimal occurrence and were often idiosyncratic.
   IRON - octopus, because its an "o".
   HEART- flying.
   KEY - boot.

Third, each subject's profile of responses was examined. A summary of these is presented in Appendix 4-5. The two youngest subjects (S1, CA 4:08, and S2, CA 4:11) had a clear predominance of semantic errors. These were not related to reading or spelling performance since S1 was a nonreader/speller while S2 was reading and spelling in advance of his chronological age. There was a negative relationship between semantic errors and rhyming skill in that children who were performing at more than fifty percent accuracy on the rhyme production task did not make semantic errors. In contrast, alliterative responses continued to dominate error types alongside successful rhyme productions.

A most important finding was that a zero score on the rhyme production test did not necessarily indicate that a child could not rhyme. Two children (S2 and S12) attained a zero score on the task presented but only one of them (S2) was a true nonrhymer. An analysis of his errors showed that none of his responses were rhyme or even sound related to the targets (HAT/you wear a hat, FISH/swimming). In contrast, S12's responses contained rhymes to her own errors (BIN/big, pig, dig) and a high proportion of alliterations or other sound based errors (FOUR/fall, fish, fun). Therefore, although these two children are quantitatively the same they are qualitatively at different stages of sound awareness and rhyme development.

Having identified a true non-rhymer as a baseline, the twelve subjects were ranked in order of rhyming ability. On the basis of this ranking a number of rhyming phases were postulated as follows:-

1. Non-rhyming Phase (0% of responses correct).

   S2 - 75% semantic responses. Other errors comprised definitions and derivations (BED/sleep in it; BIN/dustbin).
   S12- Capable of rhyme but unable to produce it to command. Predominance of alliterative errors (65%) with other errors comprising mixed alliterative and rhyme, (LOG/lon on yon).

2. Minimal Rhyming Phase (1-25% of responses correct)

   S1 - Predominance (30%) of semantic errors (WOOL/knitting; CAN/beer; EYE/nose).
   S9 - Predominance of (50%) sound based errors (KEY/kick; BEAR/balloon; SEW/soap).

3. Moderate Rhyming Phase (26-50% of responses correct)

   S7 - Segmentation of onset/rime achieved but not manipulation of initial consonant (KEY/ee; BIN/in; LOG/og; SUN/un).
   S5 - Preponderance (50%) of sound based errors (RING/rabbit; BED/dead, daddy; LOG/gog, dog, leg).

4. Stable Rhyming Phase (51-75% of responses correct)

   S4 - All errors sound based - no semantic associations.
   S6 Simple alliterative responses decreasing to <26% (BED/bear; KEY/king, ping; BIN/kin, ben, then, big).

5. Successful Rhyming Phase (>75% of responses correct)

   S10- 75-85% rhyming response with no semantic associations or
   S11 simple alliterative responses. (FOUR/nor, call, ball, lall; WOOL/Paul, call; MAP/dat, gat, yat).
   S3 - >85% correct rhyming responses. No semantic or
   S8 alliterative errors. Remaining errors at fine tuning level only. (SUN/pum, come, nun ,dum; COMB/home, tome, wone).

Thus, following a non-rhyming stage it seems that the beginner-rhymer is easily swayed by semantic associations. As sound awareness develops, these errors decline quickly to be replaced by sound-related responses such as alliterations. These sound-related errors can persist throughout the period of rhyme development. Six year olds made errors on fine feature differences such as between nasals (COME/sun) or close vowels (WOOL/wall).

The qualitative analyses made explicit a shift in the child's rhyming attempts from semantic to alliterative responses. The findings of this study challenge the view that rhyming skill is an all or nothing phenomena (Calfee, Chapman and Venezky 1972, Stanovich, Cunningham and Cramer 1984). Children's "sudden insight" into rhyming tasks reported in such studies can be explained by acknowledging an early phase of **rhyming readiness** where the child has tacit sound awareness.

INVESTIGATION 2 - CROSS-SECTIONAL STUDY OF SPELLING DEVELOPMENT

To investigate the relationship between phonological and spelling skill, twenty-two children were asked to imitate and spell single words. The nature of their spelling errors was examined to identify stages of spelling development. The following predictions were tested,

1. Nonphonetic spelling is characteristic of the logographic stage of spelling development and will be at a maximum in beginner spellers (Frith 1985, Ehri 1985).
2. Semiphonetic spelling marks the beginning of the alphabetic stage and will peak in young spellers as nonphonetic errors decline (Ehri 1985).
3. Phonetic errors will replace semiphonetic errors as the child becomes more proficient within the alphabetic stage (Marsh et al 1980, Frith 1985, Ehri 1985).

Design and Materials

The paradigm chosen was a simple one in which children were asked to imitate and spell auditorily presented real words and nonwords. Nonwords were included in order to compare normal children's ability to process lexical and nonlexical material and to ensure that alphabetic skills were being tested since real words can be spelled automatically. To investigate developmental changes in performance on this task, the subjects were divided into groups according to spelling age. The between subject variable was Spelling Age and the within subject variable was Word Type. Beginner Spellers' transcriptions of syllables and consonants in real and nonwords were also compared.

The material was selected from that used in the investigation of articulatory skills in young children reported in Chapter 5. It comprised words of differing syllable length and articulatory complexity suitable for investigating the relationship between speech and spelling. Thirty real words (wasp, spider, caravan) and thirty matched nonwords derived by substituting the vowels of the real words (wesp, spoder, kirivin) were used in the present study (see Appendix 4-6).

The stimuli were presented over two sessions so that the children did not tackle matched real and nonword pairs within the same session and presentation was randomised across subjects.

Subjects

Twenty-two subjects were tested - thirteen girls and nine boys. Their chronological ages ranged from 6 years 1 month to 8 years 11 months and their spelling ages on the Schonell Graded Word Spelling Test ranged from 5 years 11 months to 13 years 6 months. The children attended a Birmingham primary school. They all spoke English as a first language, were of normal intelligence and had no physical handicap. To sample a range of normal development, four class teachers were asked to recommend children who were making satisfactory progress in their school work. This was verified by the Headteacher. Children with mild to moderate delay in their reading and spelling development were included in the study. However, none of the children had a history of speech or language problems and none was attending speech therapy.

For the purpose of quantitative analysis, the children were divided into beginner spellers ranging in spelling age from 5 years 11 months to 7 years 2 months, and good spellers ranging in spelling age from 7 years 8 months to 9 years (see Table 4.6). Two children with spelling ages of over ten years (Subjects 21 and 22) were omitted from this analysis.

Table 4.6 - Investigation 2: Details of Subjects (Quantitative Analysis only).

Group		Chronologic Age	Spelling Age	Reading Age	Vocabulary Age
Beginner Spellers (N=12)					
	Mean	7:01	6:06	7:02	5:10
	Range	5:09-8:10	5:11-7:02	6:08-7:10	3:07-7:09
	S.d.	0.94	0.42	0.36	1.44
Good Spellers (N=8)					
	Mean	7:08	8:04	8:07	6:08
	Range	6:01-8:09	7:08-9:0	8:0-9:07	4:10-8:11
	S.d.	0.77	0.53	0.51	1.46

All twenty-two subjects were used for the qualitative analysis where the group was divided into three on the basis of spelling age: (1) Beginner Spellers - 5 years 11 months to 6 years 8 months, (2) Low Spelling Age - 7 years to 8 years and (3)

High Spelling Age - 8 years 5 months to 13 years (see Table 4.7).

Table 4.7 - Investigation 2: Subject Details (Qualitative Analysis only).

Group	Chronologic Age	Spelling Age	Reading Age	Vocabulary Age
Beginner Spellers (N=9)				
Mean	6:11	6:05	7:01	5:10
Range	5:09-8:10	5:11-6:08	6:08-7:08	3:07-7:09
S.d.	0.94	0.32	0.31	1.49
Low Spelling Age (N=7)				
Mean	7:07	7:06	7:11	6:02
Range	7:01-8:08	7:0-8:0	7:05-8:0	4:0-8:11
S.d.	0.54	0.47	0.49	1.59
High Spelling Age (N=6)				
Mean	8:01	9:10	9:05	7:03
Range	6:01-8:11	8:05-13:0	8:06-11:3	4:10-8:11
S.d.	1.06	1.90	1.05	1.43

Procedure

The children were seen individually on two occasions to complete the task. They were told to say the word after the tester and then to write it down immediately. Some of the words would be real words that they had heard before and some would be "made-up" words that they did not know. They were allowed one repetition of the target on request. The children's imitations were transcribed in phonetic script and later analysed (See Appendix 4-7 for data corpus).

Results

The percentage of words correctly imitated and spelled is shown in Table 4.8.

Table 4.8 - Percentage correct on imitation and spelling tasks according to spelling skill.

Group	Imitation		Spelling	
	Real Word	Non Word	Real Word	Non Word
Beginner Spellers (<7:03)				
Mean	92.78	85.83	7.22	8.61
S.d.	2.78	7.54	7.22	11.32
Good Spellers (>7:03)				
Mean	95.41	90.0	47.91	51.25
S.d.	6.65	5.91	12.08	17.18

The imitation data were subjected to a mixed analysis of variance with one between subject factor (Spelling Age) and one within subject factor (Word Type). There was an effect of Word Type, $F(1,20)=17.857$, $p<0.0005$ but the effect of Spelling Age was not significant, $F(1,19)=2.327$, $p<0.14$. There was no significant interaction of Spelling Age and Word Type, $F(1,18)=0.249$, $p<0.62$ (See Appendix 4-8a).

A second mixed analysis of variance analysed the spelling data. This time, there was an effect of Spelling Age, $F(1,19)=68.037$, $p=<0.000$ but not of Word Type, $F(1,20)=1.28$, $p<0.27$. Again there was no interaction between Spelling Age and Word Type, $F(1,18)=0.247$, $p<0.63$ (see Appendix 4.8b).

These results are interpreted cautiously because of possible ceiling and floor effects. However, the suggestion is that spelling age influences children's spelling of real and nonwords but not their imitation of these words and that word type affects imitation but not spelling of real and nonwords. Children were at ceiling on imitating real words but found nonwords more difficult. In contrast, there was no difference between their real and nonword spelling.

To examine the children's spelling performance further, the number of spellings with inaccurate syllable representation (CARAVAN/cavan, BASKET/bast) was calculated and converted to a percentage score (see Table 4.9). Good spellers had no apparent difficulty with this aspect, therefore only data from the beginner spellers were analysed. A related t-test showed a significant difference between syllable representation in real and nonword spelling ($t=-2.59$, $df=11$, $p<0.05$).

Table 4.9 - Percentage of words containing syllable representation errors.

Group		Real Words	Nonwords
Beginner Spellers (<7:03)			
	Mean	20.55	28.61
	S.d.	21.4	25.68
Good Spellers (>7:03)			
	Mean	0.37	1.48
	S.d.	1.11	2.94

Errors of initial and final consonant transcription were also calculated and converted to a percentage score (see Table 4.10). Good spellers again made few errors. Related t-tests were carried out on the beginner spellers' data. The first compared initial and final consonant transcription in real words ($t=-3.928$, $df=11$, $p<0.01$), and the second initial and final consonant transcription in nonwords ($t=-5.52$, $df=11$, $p<0.001$).

Table 4.10 - The mean percentage of errors on initial (IC) and final consonants (FC) transcription on real and nonwords.

Group		Real Words		Non Words	
		IC	FC	IC	FC
Beginner Spellers (<7:03)					
	Mean	6.94	33.89	11.39	45.83
	S.d.	5.94	25.97	9.69	25.35
Good Spellers (>7:03)					
	Mean	0.83	0.83	0	3.33
	S.d.	1.54	1.54	0	3.56

Every response was examined and error types recorded, focussing on consonants rather than vowels. The error classification was not planned beforehand but rather grew from the data. Where there was more than one error per word, each error was recorded in order to establish the range of possible errors but for the final calculation each word spelled incorrectly was allocated to a main category of Phonetic, Semiphonetic or Nonphonetic. The same approach was applied to nonwords but as both rule-based and analogical pronunciations of nonwords were counted as correct, there was no phonetic error category for nonwords.

Although this classification has been influenced by the work of Ehri (1985) and Frith (1985), the allocation of error types to each main category may not necessarily follow their definitions. For example, Ehri would not distinguish between simple and complex semiphonetic errors and accepted simple semiphonetic errors as phonetic.

The open evaluation of the data led to the following classification:-

1. **Phonetic**

Errors in this category reflect normally functioning segmentation skills. Sophisticated awareness of word structure was evident but the child lacked the fine tuning of orthographic rules and knowledge.

A strict criterion was adopted for this category. As a general principle only those errors that could be read back correctly when the target was unknown (BUCKET/bucit; SPADE/spayd; TREASURE/tresher) were included.

In addition, the following were accepted into this category:-

a) Minor sequencing errors (BISCUITS/biskuits; FIRE ENGINE/fier engien)
b) Insignificant letter additions (BUCKET/buccet; PENCIL/pencill).
c) Spelling as a result of exaggerated pronunciation (BURGLAR/burgalar).
d) Reversals (CRAB/crad; WASP/wasq).

2. **Semiphonetic**

Errors in this category revealed that a child was developing segmentation skills but was unable to represent the sounds he had segmented because of a lack of orthographic experience. This category was divided into two subcategories:-

a. Simple

Criteria here were less strict than for phonetic errors in that the reader may not always be certain of the target. Essentially, all consonants and syllables were represented even if unconventionally. Examples included:-

a) Use of letter name to represent a syllable (SPADE/spad; GUITAR/getr; BURGLAR/bgul).
b) Vowel deletion but with correct consonant representation (CARAVAN/crvan; TREASURE/trsher).
c) Grapheme substitutions (TREASURE/trecea; CHIPS/cips).

b. Complex

These errors met the criteria for semiphonetic classification but had additional errors. These were often similar to the simplifying phonological processes noted in normal speech development (Ingram 1976, Grunwell 1982) and included :-

a) Consonant deletion (BUCKET/buci; CHOCOLATE/cokit).
b) wrly confusion or substitution (SLIPPER/srip; ROLLER SKATES/rowisats).
c) Cluster reduction (ORANGE/orage; SNOWMAN/soman).
d) Voicing confusion (GUITAR/kitar; STAR/sdor).
e) Consonant harmony (CARAVAN/cavavan; BASKET/bastit).

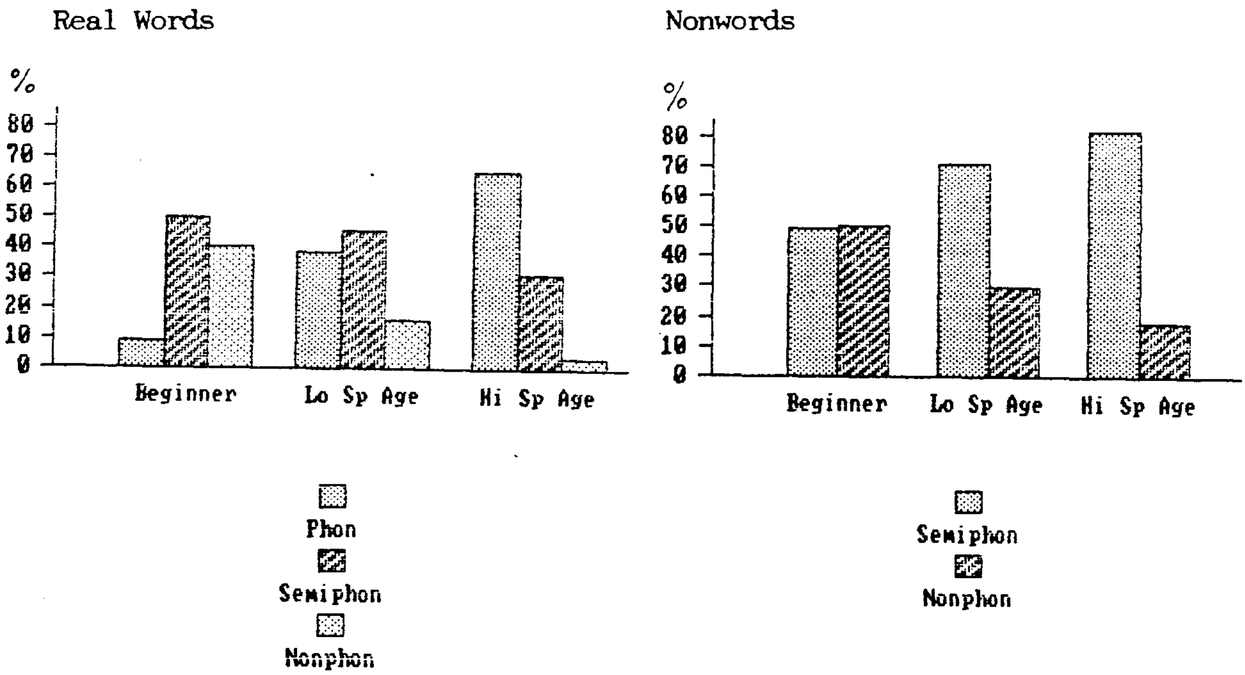
3. Nonphonetic

This category comprised the most serious of spelling errors. Each word contained multiple errors indicative of poor segmentation skill. The reader would be unable to guess the target in most cases as frequently syllable structure was lost and spelling appeared bizarre. The following error types were included in this category:-

a) Syllable deletion or collapse (BASKET/bast; DRAGON/gran; CHOCOLATE/thol).
b) Spelling by word components (SNOWMAN/someman; BUCKET/butsat; CARAVAN/canran).
c) Perseverations (MOTORBIKE/mauebakek; BURGLAR/bglg).
d) Intrusive consonants (SCARECROW/scaedgrow; WASP/wostp).
e) Sequencing errors (CARAVAN/cavaran; CHIPS/chisp).
f) Word substitution (BURGLAR/blind; WASP/water).
g) Unclassified (ORANGE/oearasrie; STAR/sanene; ROCKET/rocnenesli; CHOCOLATE/canp).

To investigate the hypothesis that different error types peak at different stages of spelling development, the number of words falling into each category per child was calculated. This score was converted to a percentage of the total number of errors (see figure 4.4).

Figure 4.4 - Percentage of Phonetic, Semiphonetic and Nonphonetic errors in real and non words per spelling age groups (Beginner Spellers <7:0, Low Spelling Age 7:0-8:0, and High Spelling Age >8:0)



As predicted, nonphonetic errors were mostly committed by the beginner spellers and the fewest appeared in the errors of the high spelling age group. The reverse pattern was true for phonetic errors. There was a decline of nonphonetic errors in the low Spelling Age group and semiphonetic errors dominated both the beginner spellers and low Spelling Age group. Pages L Trend tests were carried out on these data from real words (see Table 4.11).

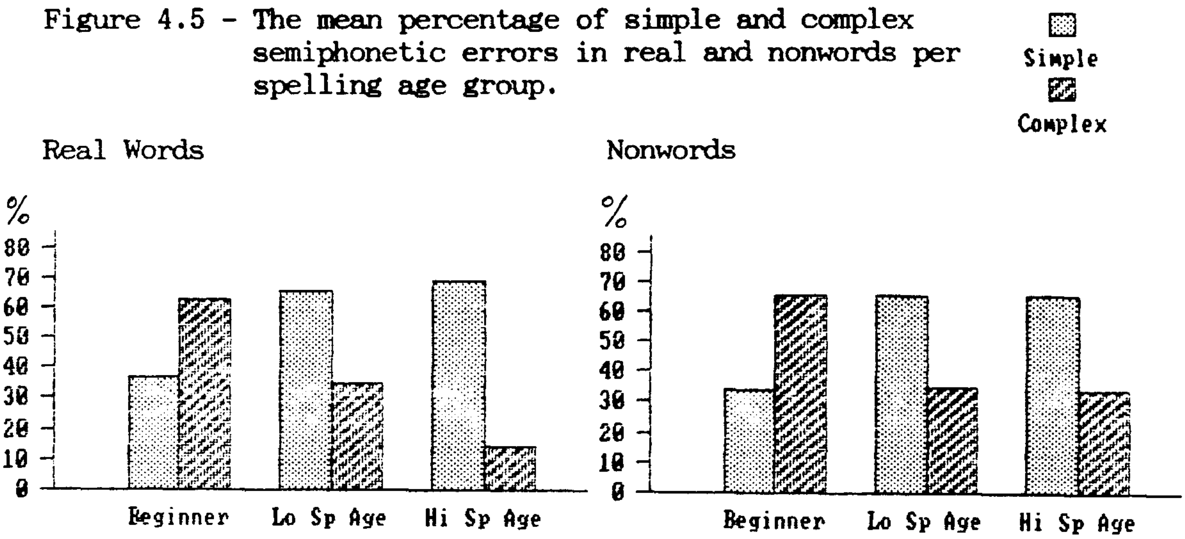
Table 4.11 - Pages L Trend Test results on Real Word spelling errors from each spelling age group.

Group	Least	Trend ->	Most	L	p
Beginner Spellers (<7:0)					
	Phonetic ->	Nonphonetic ->	Semiphonetic	123	<0.001
Low Spelling Age (7:0-8:0)					
	Nonphonetic ->	Phonetic ->	Semiphonetic	91.5	<0.05
High Spelling Age (>8:0)					
	Nonphonetic ->	Semiphonetic ->	Phonetic	80.5	<0.05

The nonword error data were analysed using Wilcoxon matched pair sign tests. There was no significant difference between semiphonetic and nonphonetic errors in the beginner spellers (T=19, p=>0.05). In contrast, there was a significant difference between these two error categories in both the the low (T=4, p=<0.05) and high Spelling Age groups. There was the greatest difference between semiphonetic and nonphonetic errors in the high Spelling Age group (T=0, p=<0.025).

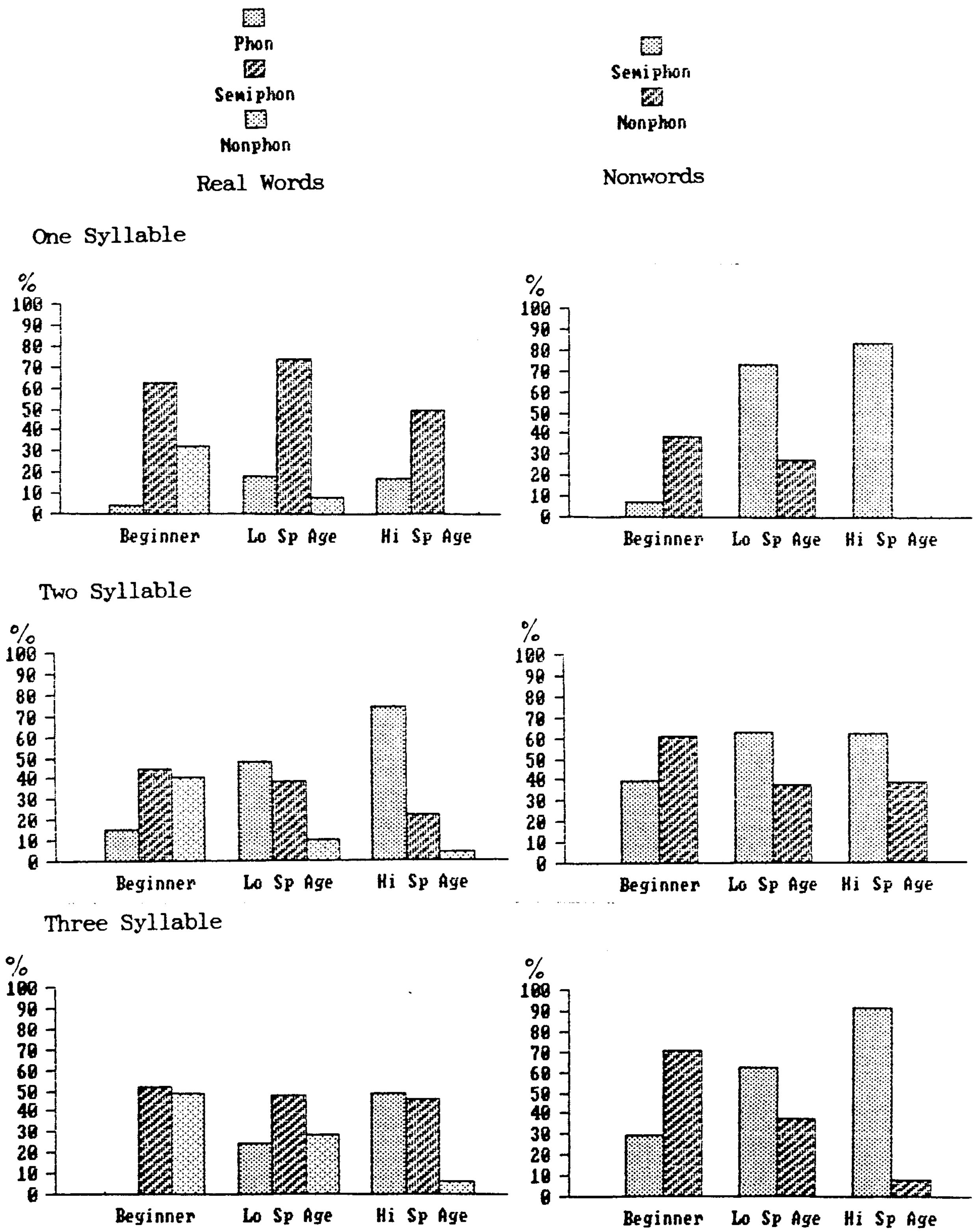
Next, the number of simple and complex semiphonetic errors was examined separately (see Figure 4.5). Complex semiphonetic errors were only predominant in the beginner spellers. In the other two groups there was a majority of simple semiphonetic errors. Complex semiphonetic spelling errors decreased in real words across the spelling age groups. In nonwords however, there was minimal difference between the low and high spelling age groups.

Figure 4.5 - The mean percentage of simple and complex semiphonetic errors in real and nonwords per spelling age group.



Finally as a subject's spelling strategy may change according to syllable length, the responses from one, two, and three syllable words were examined (see Figure 4.6). In real words, the beginner spellers maintained the same trend throughout (Phonetic -> Nonphonetic -> Semiphonetic). Similarly the high Spelling Age group always had a minimum of nonphonetic errors. The performance of the low Spelling Age group was however more erratic on words of increasing syllable length and there was an increase of nonphonetic errors at the expense of phonetic errors in three syllable words (Phonetic -> Nonphonetic -> Semiphonetic).

Figure 4.6 - Percentage of Phonetic, Semiphonetic and Nonphonetic errors in real and nonwords of increasing syllable length per spelling age group.



In nonwords, the beginner speller's nonphonetic errors increased at the expense of the semiphonetic errors.

In contrast, regardless of syllable length, there were always more semiphonetic errors than nonphonetic errors in the responses of children from the low and high Spelling Age groups.

Discussion

Although only a small number of children were tested in each spelling age group, the results indicated that stages of spelling development can be identified. As predicted, the beginner spellers made the greatest number of nonphonetic errors and the least number of phonetic errors. The finding that semiphonetic rather than nonphonetic errors dominated in this group suggested that the beginner spellers have moved out of the logographic stage and are beginning to use alphabetic skills.

Nonphonetic errors were in the minority in the low and high Spelling Age groups suggesting that these decline rapidly as the child enters the alphabetic phase. In order to achieve phonetic spelling however, children pass through a phase of semiphonetic knowledge. This is supported by the majority of semiphonetic errors found in both the beginner spellers and low Spelling Age groups.

The division of semiphonetic errors into simple and complex subcategories allows further comment on the nature of children's spelling errors. Complex semiphonetic errors were characteristic of children in the low Spelling Age group. It is proposed that these errors are the result of a combination of three factors:-

1)articulatory immaturity
2)incomplete phonological development
3)orthographic inexperience.

The first would account for voice/voiceless confusions (g/k, t/d) and frication of clusters (tr/ch, dr/j) and the second would result in phonemic substitutions (l/r, r/w, th/f). Errors such as absence of nasals in nasal clusters (nt/t, sn/s) however, are best explained by lack of orthographic experience since young children rarely omit these nasals in their speech. In contrast, the simple semiphonetic errors found in children from the low Spelling Age group were mainly due to one factor only - lack of orthographic knowledge. Errors comprised graphemic rather than phonemic substitutions (sh/c, ch/c) suggesting that these children have not yet learned how to represent what they can successfully segment and say. This makes sense given the chronological age of the low Spelling Age group (7:0-8:0) as children are articulatorily mature and able to use an adult sound system at around seven years of age (Grunwell 1982, Kirk 1983).

Simple semiphonetic errors were also recorded in the high Spelling Age group. As predicted this group made mostly phonetic spellings and there were few nonphonetic spelling errors. It is likely that the children in this group were already functioning at the orthographic stage although the present study was not designed to investigate this.

As might be expected in a group of normal children, individual variation was present (Bryant and Impey 1986). Although the Beginner Spellers as a group had moved out of the logographic phase, individual children had not. Four subjects

(S1, S4 and S9 in the beginner spellers and S10 in the low spelling age group) could not spell any nonwords. In spite of this, S4 had broken through to the alphabetic phase since he produced phonetic spellings of real words. In contrast S1, S9, and S10 produced no phonetic responses and made few or in some cases no semiphonetic errors (S1 - three, S9 none and S10 two). These three children also had the highest recordings of nonphonetic errors in the whole group, resulting in the highest number of final consonant and syllable transcription errors. It can be stated therefore that all three children were within the logographic phase of spelling development (although strictly speaking only S9 was purely logographic). These children were chosen for further investigation.

Subject 1 aged 6 years 1 month was the second youngest child in the study and had attainment ages in line with her chronological age (Reading Age - 6:09, Spelling Age - 5:11). In contrast, Subjects 9 and 10 were underachieving. Subject 9 was 8 years 10 months with a Reading Age of 7 years 8 months and a Spelling Age of 6 years 8 months. Subject 10 was 8 years 8 months, with a Reading Age of 7 years 10 months and a Spelling Age of 7 years. The qualitative performance of these three children was compared to establish if children who are not progressing in their spelling development are at a similar level to younger children who are at a satisfactory stage of development.

Subject 1 had a preponderance of unclassified errors (92%) in her nonphonetic spelling. Her responses appeared to be a random collection of letters (BASKET/nence; KITE/coien; ROCKET/rocnenesli). This implies that segmentation skills were not being applied to the spelling situation beyond the initial consonant. S9 had 63.2% (TELEVISION/teninxn; BUCKET/buarac) and S10 only 36.6% (SPADE/satag; TREASURE/sevantse) of these unclassified errors.

Unlike S1, S9 and S10 both produced another nonphonetic error type - spelling by word components. S9 produced 26.3% of these (CARAVAN/canran; CRAB/canaer; PENCIL/pieabe) and S10 34.1% (BUCKET/butsat; SNIMON/somemud; KREB/catbed; CHICILOTE/chickengot; GETOR/gatetalk). In addition S9 and S10 were the only children (apart from S11 on one occasion) to substitute a different word for the target (S9: NEST/next; WASP/water, and S10: STAR/start; DRAGON/danger; TELEVISION/telehpone).

These two children were therefore not only distinct from their peers of the same spelling age but also from S1, a younger child and beginner speller. An explanation for their spelling behaviour may lie in Frith's proposal that children with difficulties may develop compensatory strategies to enable them to tackle the spelling of unfamiliar words. S9 and S10 have been unable to breakthrough into the alphabetic phase of spelling development as shown by their lack of sound-based errors. It seems that instead, they were using their orthographic experience gained through sight reading, to support their lack of alphabetic skills. Spelling by word components may be the crude matching of what is perceived auditorily to stored automatic spellings of a small number of familiar words. In contrast S1's bizarre stringing of letters may be appropriate for her early stage of literacy development.

The similarity in scores between children's real and nonword spelling suggests that normally developing children can transfer their spelling skills to unfamiliar words. The spelling of nonwords by analogic and alphabetic strategies lends support to Goswami's (1986) view that the analogy strategy appears earlier in spelling development than previously thought (Marsh, Friedman, Welch and Desberg 1980, Frith 1985). However, qualitative analysis of syllable structure transcription and error types revealed that nonwords were more likely than real words to trigger complex semiphonetic and nonphonetic errors. This indicates that alphabetic skills are being applied but segmentation skills are not always sufficient to support them. In contrast, there was a significant difference between real and nonword imitation. The poorer performance on nonwords cannot be explained by articulatory immaturity since all children were close to ceiling on producing real words. Rather there is a difference between "automatic" and "assembled" production. Since all of the real words were within the children's vocabulary, it can be assumed that they already had motor programmes available for their articulation. When dealing with nonwords however, it was necessary for them to assemble a new motor programme. The success of this will be determined by the child's auditory perception and sound segmentation skill.

The dissociation between speech and spelling performance can be accounted for in the following two ways. First, spelling by analogy will not mirror speech production since the target is matched to a word stored in the orthographic lexicon and has no recourse to articulatory output skill. Second, even if the child adopted an alphabetic strategy for spelling, there are a number of stages at which errors may originate. For example, the child first has to perceive and then to segment the word into its components. It was argued in Chapter 1 that consistent articulatory skill will help maintain the target in auditory memory whilst processing occurs, and aid detection of sound boundaries. Having achieved this, the child still has to assign the appropriate graphemes for the sounds and conventions of the spelling system. This will be more dependent on teaching and orthographic experience than articulatory skill. Therefore even though articulatory/segmentation skills are the foundation for successful spelling, they will only aid it up to the point at which orthographic knowledge is required. A clear mapping of speech and spelling errors will only occur when the child consistently attaches the right grapheme to the wrong sound in his phonological system, for example ROCK/wock; THICK/fick. The complexity of the spelling process limits the occurrence of such simple errors.

In conclusion, the findings of this study are compatible with Read's (1971) suggestion that when spelling, children work from a common phonological representation system which becomes increasingly related to alphabetic knowledge through orthographic experience. Spelling, however, is a complex skill dependent on a a combination of phonological, articulatory and orthographic factors. Variation in children's strengths and weaknesses cause these factors to interact in different ways producing individual differences in spelling development.

GENERAL DISCUSSION

Investigations 1 and 2 show that children's rhyme and spelling development goes through a series of recognisable stages based on increasing sound awareness. On the rhyme detection task, children were first distracted by semantic associations to the target and then by alliterations of the target before being able to select rhyme pairs comfortably. When producing rhyme, a similar pattern emerged. Semantic associations were more common in the younger children and were gradually replaced by alliterations as the child "tuned in" to the rhyming task. When spelling, children's errors were at first nonphonetic but quickly changed to being semiphonetic and finally phonetic, indicating rapidly developing sound segmentation skills.

These investigations have therefore begun to chart the development of children's rhyming and spelling skills. It is argued that their performance on the tasks administered was dependent on the same underlying phonological skills - in particular sound segmentation. This would account for the relationship demonstrated between rhyming development and literacy skills (Bradley and Bryant 1985). However, as rhyme is only one type of segmentation skill which in turn is only one aspect of phonological awareness, it would be unrealistic to expect such a microskill as rhyme to be strongly predictive of such a multifaceted area as reading and spelling. This is not to reduce the status of rhyme when investigating literacy development but puts the findings into perspective. Learning to read and spell undoubtedly acts as a catalyst in the sound segmentation process, but orthographic knowledge is not necessarily required for the successful completion of simple rhyming tasks.

Unfortunately, it was not possible to compare directly rhyme detection and production performance, or rhyme and spelling skills since the investigations reported were carried out in different geographical areas. Thus, future work might examine the development of rhyme and spelling skills within the same subject following the qualitative guidelines presented here. This would shift the focus away from attempts to assign age levels to rhyme and spelling performance in favour of more helpful qualitative information about how these two skills develop and interact.

SECTION 2 - CASE STUDIES

CHAPTER 5

DEVELOPMENTAL VERBAL DYSPRAXIA - A DEVELOPMENTAL PERSPECTIVE

THE CASE STUDIES

Michael and Caroline were chosen for investigation because of their persisting and specific speech, reading and spelling difficulties. When studied, they attended a London comprehensive school where they were integrated in mainstream but attended an attached language unit daily for remedial teaching and twice weekly for speech therapy. They had received articulatory and phonological therapy from the speech therapist and had been phonically trained by their remedial teachers. Intensive speech therapy had been provided within units throughout their schooling.

Both children were unintelligible during their early life and still had obvious speech difficulties. A diagnosis of developmental verbal dyspraxia had been made. Criteria for this diagnosis (applied by an experienced speech therapist) included clumsiness, vocal tract incoordination, groping for articulatory postures and variable production of sounds and words. In addition, they had higher level phonological disabilities not only evident in their speech output but also in their auditory, segmentation and lexical skills as will be revealed.

The children were tested at two periods in time. The first (T1) spanned 1982-84. At the beginning of this testing phase, Michael was 10 years 7 months and Caroline was 11 years 9 months. The follow up study was carried out intensively over a two month period during October to December 1986 (T2). At the start of T2

Michael's chronological age was 14 years 5 months and Caroline's was 15 years 7 months.

Michael

Michael's family are from Barbados but he had always lived in London. He was first seen by a speech therapist at his local clinic when he was four years old. Work was done on auditory discrimination and articulatory skills but his attendance for therapy was spasmodic. Poor concentration and lack of carryover was a problem and his teachers were concerned that he was not speaking to other children - when he did they could not understand him. He was therefore referred for a language unit placement which he filled from the age of six. The intensive speech therapy programme included oral sensory motor work, auditory skills, rhythm work and phonology. Language therapy was also ongoing - concepts, syntax and semantics. Hearing was within normal limits at the time of the study but he had a history of fluctuating hearing loss.

The British Ability Scales were administered when Michael was 7 years 4 months. He scored an overall IQ of 100 but there was a considerable scatter of scores across the various subtests. Spatial skills were above average while verbal skills were below. His performance was age appropriate on the Goodenough Draw a Man Test at chronological age 9 years 10 months (Newton and Thomson 1975).

It was reported that reading, writing and number work were always difficult for Michael and the class teacher was most concerned about his lack of progress in the secondary school. At

T2 he was presenting problems for his school because he was unable to cope with the new GCSE curriculum and exams. However, he was anxious to obtain a qualification while at school like the other children in his class and was well supported by his class mates.

The following passage reveals the extent of his difficulties. It was written in December 1986 (CA 14:07) in response to a picture sequence (see Appendix 5-1) showing a little boy seeing a puppy in a shop and how he goes about buying it:-

> One day they was a little boy was walk down the road them he saw a pet shop he saw a little dog he went back to see he mum to ask can I have him mum said yes he his mum back to the pet shop and buy the dog. them the man give him the shop give it the dog them he talk the dog back home and want to steep.

Michael's verbal description of the sequence was clearer and the content was appropriate. In spite of obvious speech and language difficulties Michael communicated well. Intelligibility had improved by T2 when most of his conversation could be understood when the context was known.

A number of standardised tests were administered to establish performance ages as follows:-

1. Schonell Graded Word Reading and Spelling Tests (in Newton and Thomson 1975).

	T1	T2
Chronological Age:	11:09	14:06
Reading Age :	7:07	7:08
Spelling Age :	6:08	7:09

(The Carver Word Recognition Test (1970) was also administered at T1. He was found to have a reading age of 7:09).

2. British Picture Vocabulary Scales (Dunn, Dunn, Whetton and Pintilie 1982).

	T1	T2
Chronological Age:	11:06	14:06
Vocabulary Age :	7:08	7:09
Centile :	3·0	<1·0

3. Test of Reception of Grammar (Bishop 1983).

	May 85	T2
Chronological Age:	13:0	14:06
Age Equivalent :	6:0	5:06
Centile :	1·0	<1·0

4. Edinburgh Articulation Test (Anthony, Bogle, Ingram, and McIsaac 1971).

	T1	T2
Chronological Age:	10:07	14:06
Articulation Age:	4:03	5:06

In addition, digit span was limited to four digits forwards and two backwards at T2. Michael was therefore performing well below chronological age level on these tests although he had made some progress with speech and spelling since T1.

Caroline

Caroline was four and a half when first referred to her local clinic for speech therapy. At that age her mother described her speech as "nonsense" and it was difficult to analyse because of its inaudibility. Tongue and lip movements were difficult and she could not imitate sounds easily. At five she had an "unanimated" presentation and did not speak at school. Caroline attended a Compensatory Unit for five months when she was eight and was admitted to the language unit when she was ten and a half. Work focussed on oral and articulatory skills with language and rhythm programmes running in parallel. Past hearing tests showed fluctuating acuity.

Performance on the British Ability Scales at 10 years 2 months was within the average range. Caroline had gained a full scale IQ of 111 on the revised Wechsler Intelligence Scale for Children (Wechsler 1977) at an earlier date. Like Michael, she had always found reading, spelling and number work difficult although she had made some satisfactory progress during her school years and it was hoped that she would attempt some examinations involving project work before leaving school. The following is her version of the picture sequence described above:-

> The boy was walking down the street and then he saw a dog looking at him. So, he quickly went home to ask his mother can I have a dog for my birthday so then they quickly went off to find the shop. In a threw seconds the boy find the shop and then they went into the shop to by a dog after they got the dog he was please and then they both went home to have some dinner after that the boy took the dog and put the dog in his bed and went to sleep.

Caroline's speech had a nasal quality indicating low level vocal tract incoordination. Together with her repeatedly inconsistent attempts to make herself understood, this meant that she was less intelligible than Michael. However, this did not stop her from being a friendly and communicative teenager.

The following results were obtained from the standardised tests:-

1. The Schonell Graded Word Reading and Spelling Tests (Newton and Thomson 1975).

	T1	T2
Chronological Age:	12:11	15:08
Reading Age:	7:05	8:03
Spelling Age:	7:05	8:05

(Caroline obtained a Reading Age of 7:09 on the Carver Word Recognition Test (1970) at T1).

2. The British Picture Vocabulary Scales (Dunn et al 1982).

	T1	T2
Chronological Age:	12:08	15:08
Vocabulary Age:	7:07	7:05*
Centile:	2·0	<1·0

*This score is questionable since at Chronological Age 15:0, Caroline had a Vocabulary Age of 8:07.

3. Test of Reception of Grammar (Bishop 1983).

	May 85	T2
Chronological Age:	14:02	15:08
Age Equivalent:	9:0	9:0
Centile :	<10·0	<10·0

4. The Edinburgh Articulation Test (Anthony et al 1971).

	T1	T2
Chronological Age:	11:09	15:07
Articulation Age:	3:0	4:09

In addition Caroline repeated four digits forwards but only two backwards at T2. She was therefore performing well below chronological age expectation but had made some progress with her reading, spelling and speech between T1 and T2.

To investigate Michael and Caroline's skills a range of speech, reading, spelling, segmentation, auditory, and lexical tasks were administered. These will be dealt with in the following chapters.

INVESTIGATION 3: A DEVELOPMENTAL STUDY OF SPEECH ERRORS IN NORMAL AND SPEECH DISORDERED CHILDREN

It was argued in Chapters Two and Three that the confusion over the nature of developmental verbal dyspraxia has arisen from the lack of a developmental perspective and methodological problems. As yet, no study has established whether the speech pattern associated with developmental verbal dyspraxia is either quantitatively and/or qualitatively different from that characteristic of younger normally developing children. To investigate whether or not this was the case, the speech errors of Michael and Caroline were compared with those of younger normally speaking children. It was decided to match the children on the basis of articulation age in order to ensure a similarity in general articulatory maturity so that any qualitative differences to emerge would be of diagnostic significance.

Design and Materials

At T1 Michael and Caroline had an Articulation Age of 4 years 3 months and 3 years respectively on the Edinburgh Articulation Test (E.A.T, Anthony et al 1971). Although they were above the ceiling age of this test, their scores provided a general measure of articulation for comparison purposes. A group of normally speaking children ranging in Articulation Age on the E.A.T from 3 to 5 years were selected to serve as controls for Michael and Caroline.

Speech data were collected in three conditions. The first was imitation and naming at the single word level. This was to contrast phonological use of sounds in spontaneous production with a lower level of imitative ability. The second condition compared spontaneous naming of pictures with the production of the same words in continuous speech. This was important given that older children with speech disorders may have mastered the articulation of single words but be unable to maintain their production in context. Finally, imitation of real and nonwords was compared. Nonwords were included to tap the construction of new motor programmes for unfamiliar words.

The stimuli comprised forty-three articulatorily complex words which were all common nouns. The words were one to four syllables in length (1-kite, 2-rocket, 3-caravan, 4-television), and included consonant clusters (neST, SPider, STaMP). They therefore involved articulatory place, manner and voicing changes. The nonwords were devised by substituting the vowels - short for short, and long for long in the real words. For example nest/nust, spider/spoder. A complete list of the words is given in Appendix 5-2 with a breakdown of the test items in Appendix 5-3.

The entire set of words were given to Michael and Caroline at T1. A reduced set of thirty words were necessary for the preschool children who acted as controls to accommodate their vocabulary experience and attention span. This reduced list was used in the analysis (see Appendix 5-4).

For the continuous speech condition, the words were grouped to make up six mini stories A to F (see Appendix 5-5). Alternate subjects were given stories ABC in their first session and DEF at a second session. For the continuous speech and naming condition each word was represented by a coloured picture. Nonwords were not presented in the same session as their matched real words, that is if stories ABC were presented first, the nonwords from stories DEF were given at that session. Responses were recorded onto audiotape.

The Normal Control Subjects

Ten normally speaking children from a playgroup attached to an infants school in Birmingham were chosen as controls. They were all considered by the playgroup leader to be developing appropriately in all areas. They had no history of clumsiness or speech problems and none were attending speech therapy. They had normal hearing and behaviour. All spoke English as a first language and were from monolingual families. Table 5.1 summarises their chronological and articulation ages (EAT).

Table 5.1 - Investigation 3: Details of Subjects in the Control Group.

	Chronological Age	Articulation Age	Vocabulary Age
Mean :	4:02	4:03	4:03
Range:	3:03-4:08	3:0-5:06	2:06-7:02
S.d. :	0.49	0.8	1.4

Procedure

The children were seen individually, standardised vocabulary and articulation tests being administered first. The preschool children needed two or three sessions to complete the tasks while Michael and Caroline were seen only twice. Each session was transcribed in phonetic script at the time and checked with the audiotape later.

The child was prepared to hear a story and asked to fill in silent gaps by naming pictures. For example the experimenter said "Last night I watched a programme on the _________", and then a picture of a television was presented for the child to name. If the child did not recognise the picture or know the word he was told the name and encouraged to repeat it. This counted as an imitation response. He was later asked to name the picture spontaneously. The pictures were presented one by one so that only when the story was completed were all of its pictures in front of the child. The imitation task was then administered by asking the child to say each of the words after the experimenter pointing to the pictures each time. Finally, for the continuous speech condition, the child was encouraged to tell the story back to the experimenter using all of the pictures on the table. Once the story had been related by the child the pictures were removed and the next ones presented. Any variations on the original story were acceptable since the aim of the story telling was merely for the child to produce the targets in continuous speech. Only the target words were transcribed. The nonword condition was imitation only. The child was told that the experimenter was going to say some funny words for him to copy.

Results

Performance on Imitation, Naming and Continuous Speech Tasks

The percentage of words correctly articulated in each condition was calculated (see Appendix 5-6 for data sample). Normal children imitated as many nonwords as real words. There was therefore no significant effect of word type ($t = 0.98$, df 9, $p>0.01$, NS). Michael's performance on imitation of real words fell within the normal range but his imitation of nonwords was poorer than the articulation age matched controls. Caroline's performance on both real word and nonword imitation was poorer than that of the normal controls but these results are interpreted cautiously since her articulation age is at the lowest end of the normal children's articulation age range. Table 5.2 summarises these results and includes z scores[1] for Michael and Caroline's performance.

Table 5.2 - Michael and Caroline's performance on imitation of real and nonwords at T1 (% correct, * = >1 s.d. below the mean).

	Articulation Age	Imitation Real Words	Imitation Nonwords
Controls:	3:00-5:06	56.99	52.18
S.d.	0.8	21.74	17.74
Michael :	4:03	43.33	30.0
z=		-0.62	-1.31*
p		NS	NS
Caroline:	3.0	23.33	30.0
z=		-1.63*	-1.31*
p		<0.05	NS

[1] Although z scores do not all reach **statistical** significance at the p<0.05 level (z= 1.61), a performance of >1s.d. below the mean is taken to be **clinically** significant throughout (Reynell 1968, Anthony et al 1971)

The normal controls performed equally well on the naming, imitation, and continuous speech conditions. There was no significant difference in their ability to name and imitate real words (t=-0.39, df 9, p>0.1, NS). Michael performed within the normal range on the naming and imitation of real words but performed significantly less well on the continuous speech condition. Caroline again did less well than the controls over all conditions performing significantly less well on the imitation and continuous speech conditions (see Table 5.3).

Table 5.3 - Michael and Caroline's performance on imitation of real words, naming of real words and in continuous speech (% correct, * = > 1 sd below the mean, ** = >2 sd below the mean).

	Articulation Age	Real Word Naming	Real Word Imitation	Continuous Speech
Controls:	3:00-5:06	53.88	56.99	56.73
S.d.	0.8	19.81	21.74	18.51
Michael :	4:03	40.0	43.33	26.66
z=		-0.73	-0.62	-1.71*
p		NS	NS	<0.04
Caroline:	3:0	26.66	23.33	20.0
z=		-1.44*	-1.63*	-2.09**
p		NS	<0.05	<0.02

Differences therefore emerged not only between the speech disordered children and the normal controls but also between Michael and Caroline themselves. Michael's specific difficulty related to nonwords since his performance on imitation and naming of real words was within one standard deviation of the controls'. It is noted that five of his responses were lexicalisations (slipper, ducks, pencil, scarf and fire engine). These will be discussed in Chapter 6. Caroline had a more serious articulatory output difficulty; all of her scores fell below 1 s.d. of the controls' mean performance although she was not so affected by word type on the imitation task. It was noted during testing that she made repeated attempts at the words, particularly in the naming condition. Hearing the model first often reduced the variability in her speech output.

Relationship between Speech Performance and Articulation Age

The normal children's performance on the speech tasks correlated with their articulation age (see Figure 5.1). Spearman's Rank Correlation Coefficients were 0.71 and 0.72 ($p<0.01$) for imitation and naming of real words, 0.74 ($p<0.03$) for imitation of nonwords, and 0.68 ($p<0.02$) for continuous speech. Linear regressions[2] confirmed that neither Michael nor Caroline's performance was necessarily predicted by their articulation ages.

Michael's performance on Imitation of Nonwords (30%) and in Continuous Speech (26.64%) was significantly below the level expected for his Articulation Age (72.[illegible]%, Sem = [illegible]; and 37.[illegible]%, [illegible] respectively). Caroline's performance on the Continuous Speech condition ([illegible]%) was her only score to be significantly less than expected for her Articulation Age (37.94%, Sem = 13.83). All other scores fell within the range expected for the children's Articulation Ages.

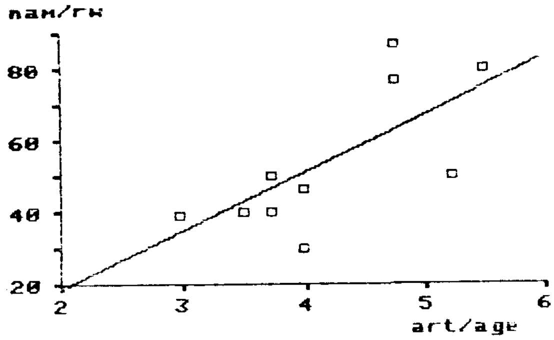
In summary, Michael and Caroline were more variable than the normal control children across the conditions. Furthermore, there was no significant correlation between the words that normal children found easy to articulate and Michael and Caroline's ease of response (Spearman's Rho Correlation Coefficients ranged from -0.55 to 0.12, $p>0.05$). These results imply that the speech disordered children may not be simply delayed in their development. A qualitative analysis was carried out to investigate this hypothesis.

(2) Ideally, the coefficients should have been at the >0.8 level to do this but it was decided to proceed with the analysis

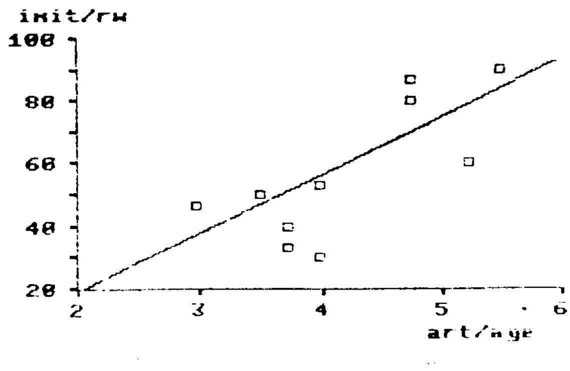
given the significance levels of the results.

Figure 5.1 - Spearman's rho correlations between articulation age and a)naming of real words, b)imitation of real words, c)imitation of nonwords, and d) continuous speech.

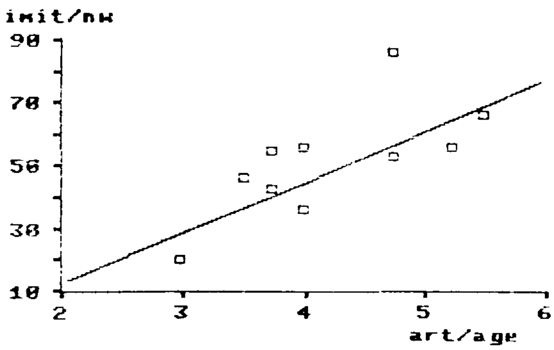
a)Naming of Real Words



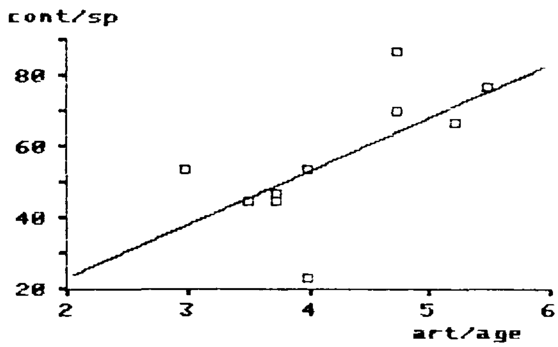
b)Imitation of Real Words



c)Imitation of Nonwords



d)Continuous Speech



Qualitative Analysis of Error Types

No published phonological analysis procedure was adopted. Error types emerged from the data rather than being determined beforehand. These are listed in Appendix 5-7.

The analysis revealed that few speech errors were unique to the speech disordered children. Those that were, included glottal replacement of clusters (BISCUITS/[bɪsɪʔ]), use of non-English sounds such as flapping (TREASURE/[s̪tɛɾəz]) and frication (CARAVAN/[kxæɾəvæn]), BURGLAR/[bɜɡləx]), and intrusive vowels (CRAB/[kəˈʋæb], SLEPPER/[s səˈlɛpə]). Moreover the incidence of these was very small - flapping being peculiar to Caroline.

There were also errors that only occurred in the normal children. These were backing of consonants (CHOCOLATE/[ɡɒʔlət]) and interdental articulation (SPADE/[s̪peɪd]). The high incidence of interdental articulation confirms that "lisping" is often a normal immaturity.

The biggest difference between the groups was on the use of the glottal stop, groping for articulations, and vowel changes. With reference to the first, it is important to note that the speech disordered children were from the East End of London and the normal controls from an inner city area of Birmingham. It is therefore quite likely that the increase of glottals in Michael and Caroline's speech was due to accent rather than a specific speech disorder. This would also account for their substitution of /ʋ/ for /l/. The groping for sounds however, was not due to regional variations.

Caroline in particular made repeated attempts at the target (TREASURE/[s'st'stɛɾə'stɛvə'dʒɛvə'stɛɾə'dʒɛlɪʃ'dʒɛdə]).

Although groping for targets was noted in the normal children it was not so varied or persistent (for example compare Subject 7's production of TREASURE/[tʃʊs 'trɛzə]).

These results challenge the traditional diagnostic characteristics of dyspraxic speech since normal children's errors also included double articulations, groping and metathesis. Furthermore, Michael and Caroline showed different proportions of these classic dyspraxic signs. Metathesis only occurred in Caroline's data and she groped for articulations far more than did Michael. Conversely, there was more evidence of double articulations in Michael's speech. Overall, Caroline made many more errors than Michael and some of her errors were never committed by Michael (cluster reversal, syllable addition, +dental, stopping, weak friction, flapping, metathesis and nasal emission). On the other hand, four errors were unique to Michael (cluster omission, + nasal, + glottal, and intrusive vowel).

It would therefore be difficult to make a diagnosis of developmental verbal dyspraxia on the basis of individual error types alone. Following Crary, Landess and Towne (1984) and Parsons (1984) the data were organised into error categories.

Five error categories were chosen as follows:-

A. Syllable structure processes.
B. Substitution Processes.
C. Articulatory Incoordination.
D. Articulatory Incoordination Affecting A.
E. Vowels.

Syllable structure (A) refers to any process that adversely affects the overall structure of the word. This may be as simple as consonant deletion (SPADE/[speɪ]) or cluster reduction

(SLIPPER/[sɪpə]) or may be complicated by articulatory incoordination (D) such as groping (BASKET/[bəˈbæsɪʔˈbæsˈbæskɪʔ]), metathesis (WASP/[wɒps] , CARAVAN/[kævəræn]) and intrusions (SCARECROW/[skʋɛəskʋəʊ]).

Substitutions (B) result from normal phonological simplifying processes, for example fronting (SCARF/[staf]) and stopping (TREASURE/[trɛdə]). As discussed above, the substitution of /ʔ/ for plosives /t/ and /k/, and of /ʋ/ for /l/ are accounted for by accent in the case of the speech disordered children and were therefore dropped from this particular analysis.

Voicing errors were difficult to categorise. Prevocalic voicing is referred to as a normal simplifying process disappearing around the age of three years (Grunwell 1982) and may be regarded as a substitution process. Persisting problems with voicing however may be due to articulatory incoordination. As the normal children were all over three years of age, voicing errors were classified along with errors of nasalisation (ORANGE /[bʊɪʒ], FIRE/[faɪɪn]), frication (BURGLAR/[bɜgləx]), assimilation (CARAVAN/[kævəvæn]) and double articulation (STAMP/[st͡nœmp] , BOAT/[bəʊt͡k] under Articulatory Incoordination (C) and not Substitution Processes (B).

Finally, as the focus of this study was on consonant articulation, vowel errors were recorded separately in category E. Table 5.4 shows the mean number of errors per category and z scores pertaining to Michael and Caroline's performance. (A breakdown of the these error types is given in Appendix 5-8 and a summary of the differences between controls and the speech disordered children on error types is summarised in Appendix 5-9).

Table 5.4 : The mean error rate within each category for the normal controls and speech disordered children at T1 (* = >1sd ** = >2sd, *** = >3sd above the mean).

Error Category	Controls	Michael	Caroline
A. Syllable Structure			
Mean	4.07	9.33	13.0
S.d.	3.63	2.52	10.0
z		1.45*	2.46**
p		NS	<0.01
B. Substitutions			
Mean	7.85	8.2	9.0
S.d.	11.4	9.46	11.17
z		0.03	0.1
p		NS	NS
C. Articulatory Incoordination			
Mean	1.83	7.0	7.67
S.d.	1.33	2.61	3.33
z		3.89***	4.39***
p		<0.0001	<0.0001
D. Articulatory Incoordination Affecting Syllable Structure			
Mean	1.23	4.0	10.67
S.d.	1.33	3.46	9.81
z		2.08**	7.1***
p		<0.02	<0.0001
E. Vowels			
Mean	1.47	5.0	5.33
S.d.	0.25	2.65	4.51
z		14.12***	15.44***
p		<0.0001	<0.0001

This analysis showed a difference between the normal and speech disordered children on syllabic structure processes but not on substitution processes. Michael actually made fewer substitution errors than the normal children. Both Michael and

Caroline had significantly more problems with articulatory coordination and made more vowel errors than the normal controls. Overall, Caroline made more errors than did Michael.

The nature of the errors within these categories was examined to establish whether Michael and Caroline were making similar but more errors than the normal controls, or whether their errors were qualitatively different.

The Nature of the Error Types

Errors such as cluster reduction can manifest in different ways. For example, the cluster /st/ in the word STAR is normally simplified by young children to /t/ ("tar"). It is less common in normal development for the /t/ to be omitted ("sar"), and it is considered abnormal if the cluster is reduced to a non- English articulation such as /ç/ as in /tɒç/ (Anthony et al 1971). These three errors comprise the error type "cluster reduction" but differ in their nature.

Thus, (after Ingram 1976 and Grunwell 1982) the children's errors were categorised into:-

1. Normal immaturities for articulation age 3:0-5:0.
2. Unusual processes - rarely occurring in normal development or so immature as to be found in children under three years of age.
3. Abnormal Processes - not part of normal development or extremely rare.

This analysis revealed that the normal controls made on average only 11.7% unusual or abnormal errors

while 46% of Michael and Caroline's errors fell into these categories. These will be discussed under the following error category headings:-

A. Syllable Structure

a) Syllable Deletion - Michael had a much larger incidence of syllable deletion than Caroline and the normal controls, but this always occurred on the unstressed syllable which is typical of normal development. Caroline was more likely to add a syllable to her utterance particularly when making more than one attempt at the word. Her reduplication of the last syllable on CARAVAN to /[kæɹɪbænbæ̃] is extremely immature and only occurred in one of the normal subjects (Subject 1) also on CARAVAN ([væˑvæn]).

b) Consonant Deletion - Michael and Caroline's persisting consonant deletion is a "primitive" error (Sommers 1983). Normal children do delete consonants but are less likely to do so at the beginning of words. Thus, Michael's GUITAR to [əʔtɑ] is abnormal and Caroline's BASKET to [bæsɪʔ], and BISCUIT to [bɪsɪʔ] , is unusual even within the East London accent.

c) Consonant Clusters - Apart from their use of the glottal stop which has already been discussed (as accent), Michael and Caroline's clusters were not qualitatively different overall from those produced by the normal children. In general, the nature of the cluster reduction (st/t) and assimilation (sl/ɬ) was the same for the two groups. Exceptions were Carolines /sp/ to /ɸ/ which is a very immature process and her /sp/ to /ɬθ/ in WESP is abnormal.

B. Substitutions

a) Fronting and Stopping - Fronting (k/t, g/d, th/f, the/v, sh/s, zh/z) and stopping, (f/p, v/b, s/t, z/d) were similar in nature in both the normal and speech disordered children. An exception was Caroline's zh/v on imitation of TREASURE. It is important to differentiate fronting in a pure form (CAR/tar), and fronting as a result of consonant harmony (CAT/tat) where the presence of word final /t/ triggers a /t/ at the beginning of the word. The latter shows an inabilty to change the place of articulation if the child can produce the target sound in a more conducive context. Michael and Caroline's fronting errors are better explained by this consonant harmony suggesting an articulatory basis to their difficulty.

b) Glottaling - Although the higher rate of glottaling in Michael and Caroline may be attributed to regional accent, it was still an area of concern, possibly masking a genuine confusion between plosive sounds. When one sound /ʔ/ replaces others (normally /t/ and /k/) a child may only learn the target through orthographic experience. Given that Michael and Caroline are both limited in such experience a phonological confusion could be exacerbated. Although their glottaling occurred mainly in syllable final position as expected, there were exceptions such as Michael's GUITAR to [əʔ'tɑ] and Caroline's SPIDER to [spaɪʔə] which is atypical even within the East End accent.

c) wrly - The /wrly/ group of sounds are amongst the last to develop in normal children and Michael and Caroline persisted in the normal labialisation of sounds, particularly /r/, which is expected up to the age of seven or eight years of age. Gliding of laterals is also evident in normal development as in Michael's TELEVISION to [tɛjɪvɪʃn], but /j/ for /r/ is less common, as in Caroline's /ærɪndʒ/ to [æjĩʒ]. Their use of glides plus /h/ or /ʔ/ (Michael's /bægli/ to [bahji] and Caroline's SPIDER to [spɑʔhjə]), did not occur in the normal controls and is indicative of weak articulatory placements. Caroline's use of /l/ for /r/, as in CARAVAN to [kæləvæ̃] and ORANGE to [ɒlɪʒ] is most unusual and she was the only child to use a flap /ɾ/ for /r/. Intrusive laterals (Michael's CRAB to [klʊæb] and Caroline's /bɛskæt/ to [bɛstæl]) were not found in the normal controls. Their use of /ʊ/ for /l/ is best explained by their London accent.

C. Articulatory Incoordination

a) Voicing - Although Michael and Caroline did present with the normal simplifying process of prevocalic voicing, there were some exceptions. They devoiced sounds initially, for example Caroline's GUITAR to [tɪ'dɒ] may have been the result of a sequencing or timing difficulty. Michael was not always able to time voice onset either, for example SCARECROW to [skɛəkgʊəʊ]. Caroline also had poor control over aspiration, for example /gæ'tɔ/ to [tɪ'tɔ]. Both children devoiced the second fricative of TELEVISION.

b) Nasalisation - Similarly, Michael and Caroline were less able than the normal children to control nasalisation of sounds because of incoordination of the vocal tract - specifically the palatopharyngeal sphincter. Michael nasalised words which did not contain any nasal consonants (ROLLER SKATES to [ʊ̃ɔ̃:'skeɪʔ] and /tʃɪkɪləʊt/ to [tʃɪkɪ̃ləʊʔ]. There was also abnormal nasalisation of CARAVAN and TELEVISION. Denasalisation is equally important since the oral/nasal contrast is one of the first distinctions to be made (Caroline's

PENCIL to [pesɪʊ] and ORANGE to [ɒLɪʒ]). Nasal emission of the airstream also occurred. When this happened in normal children it was on high fortis utterances where the vocal tract is tense as in /s/ clusters. However, this was also apparent on nasal segments in Michael and Caroline.

c) Friction - The most obvious difference between Michael and Caroline's fricative sounds and those of the normal controls was an intrusive non-English velar fricative on release of the velar stop (Michael's CRAB to [kxwæb] and Caroline's CARAVAN to [kγæɾə.væn]). This sound also intruded in word final position (Caroline's BURGLAR to [bɜgLəx]). Affricate reduction (/dʒ/d/) occurred in both groups but Michael and Caroline were distinct in their deletion of the stop consonant in favour of the fricative (/dʒ/ʒ/) as in Michael's FIRE ENGINE to [faɪ'ɛʒɪn] and Caroline's ORANGE to [ɒɔɪʒ]. Substitution of affricates for single consonants was peculiar to the clinical children and may be considered abnormal (Michael's GUITAR to [tʃɪ'ʔɑ] and Caroline's CARAVAN to [dʒæLɪbəbæn]).

d) Double Articulations - Although normal children did make double articulations in certain contexts (GUITAR[dgɪ'tɑ], [gɪ'tkɑ]), these errors were most noticeable in Michael's speech (CARAVAN/[tkæ.væn], KITE/[kaɪtk]) but not necessarily in Caroline's.

The prevalence of these errors in Michael and Caroline's speech indicate a mistiming of the vocal tract.

D. **Articulatory Incoordination Affecting Syllable Structure**

a) Articulatory Groping - Groping for sounds and words comprised one of the biggest difference between the normal controls and speech disordered children. Although groping for sounds was not exclusive to Michael and Caroline, their attempts were far more complex than those of the normal controls. For example on the spontaneous naming condition, normal children's attempts might best be described as "hesitancies" and occurred in relation to the initial sound or cluster (BISCUITS/[bə'bɪskɪts], CHIPS/[tʃ'tʃɪps]). Only on one occasion when imitating a nonword did a normal child repeatedly grope over the whole word (TREASURE /[tʒɛʒə'tɒɛʒə]). Michael and Caroline's increased groping for sounds and words renders their utterances more variable. The most extreme variability in the normal group was Subject 7's imitation of the nonword /tɒlə'vʌʒn̩/ as [tɒlɒvʌv, tɒlɒvə'ʃɪʃn, tɒlɒvʌ'ʒɪnɪ, tɒlɒvʌʒn̩]. Compared with Caroline's attempts at GUITAR/[tɪ'ta, tɪ'ta tɪ'da tɪ'də] the normal child's repeated attempts results in a closer match to the target, but this is not guaranteed for Michael or Caroline. Complexity of groping and extreme variability are therefore supported as characteristic of speech disorder and were particularly evident in Caroline's speech.

b) Metathesis - This was surprisingly less frequent in the speech disordered children than suggested by the literature. However, it was noted that there was only one example of metathesis in the whole data corpus from the normal controls (Subject 9 /kɪrɪvɪn/ to [kɪvɪrɪn]) indicating that occurrence of this error is not typical of normal development.

In sum, examination of the nature of articulation errors has made explicit specific differences between the speech disordered children and normal controls of similar articulation age (see Appendix 5-9 for summary of similarities and differences between the speech disordered children and the normal controls). However, this piecemeal approach to data analysis does not tap the cooccurence of errors within a word. The cumulative effect of multiple and simultaneous "normal" errors may be an "abnormal" and quite unintelligible production of the word. Parsons (1984) commented on a multiple error pattern in a group of speech disordered children but he did not pursue this analysis. Therefore the data in the present study was examined for the number of errors occurring within each word response.

Number of Errors per Word

The number of different errors made in each word by individual subjects was calculated. For example, TREASURE pronounced as [dʒɛdə] contains three errors: (1) affrication of the cluster, (2) voicing of initial segment and (3) stopping of the fricative. The results of this analysis are summarised in Table 5.5 and the word by word analysis is presented in Appendix 5-10.

Table 5.5 - Number of errors per word made by the normal controls and speech disordered children on each condition at T1, (*=<1sd, **=>2sd above the mean).

	Real Words Naming	Real Words Imitation	Nonwords Imitation	Continuous Speech
Controls				
Mean	1.21	1.24	1.28	1.28
Range	1-1.83	0-1.85	0-2	0-1.75
S.d.	0.3	0.36	0.45	0.38
Michael				
Mean	2.08	1.67	1.61	1.88
S.d.	1.52	1.09	0.96	1.14
z	2.9**	1.19*	0.73	1.58*
p	<0.02	NS	NS	NS
Caroline				
Mean	3.0	2.0	1.79	2.37
S.d.	2.42	1.37	1.2	1.36
z	5.97**	2.11**	1.13*	2.87**
p	<0.001	<0.02	NS	<0.002

Michael and Caroline made more errors per word than the normal controls overall and were more variable in their performance. Table 5.6 shows the number of words containing between 0 and 8 errors for each condition.

This analysis revealed that it was not simply the case that speech disordered children produced multiple rather than single errors. Although multiple errors were clearly characteristic of the speech disordered children, Michael and Caroline were able to articulate perfectly well more words than the normal controls. This suggests that they had developed word specific knowledge in their speech output. Unlike the control children, Michael and Caroline either **do** or **do not** have an articulatory programme for a word. When they do, they are able to produce the word as well as normal controls. When they do not, it is difficult for them to assemble one. In contrast, the control children have the skills to assemble a new motor programme but not necessarily the articulatory maturity to carry it out. Errors are therefore more gently graded and are almost always closer to the targets.

Table 5.6 - The number of words containing 0-8 errors in the normal controls and speech disordered children on each condition at T1 (Max number of words = 30). *Lexical responses were omitted from this articulatory analysis.

	Number of Errors per Word								
	0	1	2	3	4	5	6	7	8
NAMING									
Controls	-	24	6	-	-	-	-	-	-
Michael	6	12	4	5	1	1	1	-	-
Caroline	5	8	6	3	3	2	1	-	2
REAL WORD IMITATION									
Controls	1	25	4	-	-	-	-	-	-
Michael	9	12	5	3	1	-	-	-	-
Caroline	5	13	4	4	3	1	-	-	-
NONWORD IMITATION									
Controls	2	23	5	-	-	-	-	-	-
Michael	9	7	7	2	-	-	-	-	-
Caroline	10	8	5	2	2	-	-	-	-
CONTINUOUS SPEECH									
Controls	1	21	8	-	-	-	-	-	-
Michael	6	10	9	3	2	-	-	-	-
Caroline	3	8	8	5	5	1	-	-	-

Discussion of Results at T1

Examination of speech data collected at T1 when Michael and Caroline were aged 10 years 7 months and 11 years 9 months respectively revealed similarities and differences between their speech errors and those of normally developing controls. Performance within each condition (imitation, naming and continuous speech) correlated with articulation age in the normal controls, but this was not the case in the speech disordered children where performance was more variable. Overall, the speech disordered children performed more poorly than the normal controls.

The majority of errors found in the normal controls were in the substitution error category and could be attributed to immature but normally developing articulatory skills. This makes sense given that preschool children are still developing their physical structure and motor skills for speech (Baken 1983). Very few of their errors were due to articulatory incoordination. In contrast, many of Michael and Caroline's errors were due to articulatory incoordination and they also experienced greater difficulties with syllable structure and vowel sounds. There was no difference, however, between the normal controls and speech disordered children on substitution errors.

These findings are compatible with those of Crary, Landess and Towne (1984) who found a predominance of errors on syllable structure processes (syntagmatic) over substitution processes (paradigmatic) in children with developmental verbal dyspraxia. It was argued in Chapter 2 that Parson's (1984) failure to replicate these results was due to a difference between the ages of subjects tested in the two studies. Parson's selection of younger children for study meant it was difficult to separate immature articulation from specific difficulties. Substitution processes in particular diminish as a result of increased phonological awareness and of articulatory maturity which allows sounds to be contrasted (Hewlett 1985). The present study was able to examine these different levels of articulatory skill during development by including a younger normal control group matched on articulation age.

In addition to the paradigmatic/syntagmatic distinction made in earlier studies, difficulties at the level of articulatory coordination were identified in the speech disordered children. This constitutes a serious barrier to their speech development. Children have normally achieved near adult level of articulatory timing by the age of three years (MacNeilage 1980).

A most important finding was that although the speech disordered children made multiple errors within words, they could articulate perfectly well more words than the normal controls. This suggests that their speech errors were not the result of articulatory immaturity. Rather, a higher level of difficulty was indicated. Evidently, the speech disordered children have developed word specific knowledge but they cannot easily assemble motor programmes for new or difficult words. This does not preclude them from having additional lower level articulatory difficulties as the qualitative analysis revealed.

In conclusion, Michael and Caroline's speech development is atypical rather than delayed in that their speech errors were different from those of younger normally developing children. A specific difficulty assembling motor programmes for new words was apparent. This may result from input phonology or sound segmentation difficulties. The following chapter examines their performance on tests of lexical, auditory processing and segmentation skills.

CHAPTER 6

PHONOLOGICAL PROCESSING DEFICITS

It is widely held that reading disability is associated with a variety of phonological deficits (Frith 1981). These include problems with speech perception (Brady, Shankweiler and Mann 1983), the use of phonological memory codes (Rack 1985), sound categorisation (Bradley and Bryant (1978), verbal repetition (Snowling, Goulandris, Bowlby and Howell 1986) and verbal naming (Katz 1986). Snowling (1987) has suggested that the precise nature of a child's reading and spelling difficulties is dependent on the extent of underlying phonological processing deficits. Thus, a child with a mild phonological deficit should be less impaired in his reading and spelling development than one with pervasive phonological problems. The indications from Chapter 5 are that Michael and Caroline's problems are more extensive than lower level articulatory difficulties. To investigate just how pervasive their phonological deficit was, tests of auditory discrimination, lexical decision and sound segmentation were administered at T1. At this stage Michael had a Chronological Age of 11 years 9 months and a Reading Age of 7 years 7 months. Caroline was aged 12 years 11 months and had a Reading Age of 7 years 5 months.

INVESTIGATION 4: COMPLEX NONWORD AUDITORY DISCRIMINATION IN NORMAL AND SPEECH DISORDERED CHILDREN

Language disordered children generally perform poorly on tests of auditory perception (Lasky and Katz 1983). Studies investigating their performance have adopted a range of techniques and comprise both nonlexical and lexical materials. For example, the extensive work by Tallal and her colleagues examined children's detection and processing of rapidly changing nonverbal stimuli (Tallal and Piercy 1980, Tallal, Stark and Mellits 1985), while Newton and Thomson (1975) presented single syllable minimal pairs for children to detect same versus different pairs (fun/fun, dog/hog).

There are problems with both of these approaches. First, the psychoacoustic techniques used by Tallal et al do not reveal how a child copes with linguistic information which may be perceived differently from nonspeech signals (Lieberman 1972). Second, older language disordered children with auditory processing difficulties may perform perfectly well on routine auditory discrimination tests at the single syllable level (Locke 1980). Indeed, Michael and Caroline were at ceiling on both the Wepman (1958) test of single syllable real word auditory discrimination and an experimental test devised by McCarthy and Warrington (1983) for discrimination of nonwords (pom/gom, keet/keet). It can be argued that discrimination of simple minimal pairs such as these can take place at an automatic level within the auditory modality. In contrast, the processing of more complex material may be dependent on other skills. It therefore remained a possibility that Michael and Caroline would show deficits in auditory discrimination tasks which require the use of segmentation and articulation skill. Thus, the performance of normally developing children in a task tapping the auditory discrimination of complex nonword material was assessed for comparison with the performance of Michael and Caroline.

Design and Materials

A simple auditory discrimination paradigm in which children were asked to judge if two spoken nonwords were the same or different was chosen. Stimuli were nonwords to ensure that the children could not draw on semantic or orthographic experience. Their only support in the task would be auditory and articulatory. The nonwords were articulatorily complex in order to investigate the role of articulation in auditory discrimination tasks. Young children may not perform so well on complex auditory discrimination tests because their articulatory immaturity may not allow them to "rehearse" the stimuli sufficiently clearly to make a same/different decision.

The nonword material was taken from Investigation 3 (a developmental study of speech errors) to allow a comparison of children's auditory input and articulatory output. The stimuli comprised forty nonword pairs (see Appendix 6-1). The pairs differed in place of articulation (spobe/spode), voicing (bate/pate), manner of articulation (cusel/cusen), cluster sequence (wesp/weps), vowel change (tant/tint) and as a result of metathesis (bikut/bituk). Fourteen pairs of words were the same (daks/daks) and twenty-six were different.

The list was pseudo-randomised into four parts (A-D) so that there was a balance of same/different pairs in each quarter. This enabled the list to be presented in sections, as appropriate for the attention span of the child. The test was administered in four parts over two to three sessions to the youngest children.

The older children were administered the test in two parts and sometimes within the same session. Presentation was counterbalanced so that half the subjects received parts A and B first and half received parts C and D first. Michael and Caroline completed the test in two sessions.

Subjects

Forty-two children (20 girls and 22 boys) from a Birmingham primary school were tested. Their chronological ages ranged from 3 years 3 months to 8 years 11 months (see Table 6.1). All of the children had normal speech development, spoke English as a first language and had no learning difficulties.

Table 6.1 - Investigation 4: Details of subjects in control group.

Chronological Age Group		Chronological Age	Reading Age	Vocabulary Age
3:0-4:0 (N=12)				
	Mean	4:03	-	4:05
	Range	3:03-4:10	-	2:06-7:02
	S.d.	0.5	-	1.52
5:0-6:0 (N=15)				
	Mean	6:02	6:10	5:05
	Range	5:01-6:11	6:02-8:06	3:02-7:02
	S.d.	0.57	0.61	1.42
7:0-8:0 (N=15)				
	Mean	7:11	8:05	6:08
	Rang	7:01-8:11	7:03-11:03	4:00-8:11
	S.d.	0.65	1.12	1.52

Procedure

The children were seen individually. They were told that they would hear some funny words made up by the experimenter. They were to listen to two words each time and decide if the experimenter had said them the same or not. The ten youngest children indicated this by a Yes/No response. The older children enjoyed "marking" the experimenter's performance by scoring a tick if she said the two words "right" or a cross if she got one of them "wrong". The children were allowed one repetition of the stimuli and the number of repetitions requested was noted. Michael and Caroline indicated their judgement by a Yes/No response. The number of correct same and different responses were recorded on the test sheet.

Results

The total number correct and the same/different scores are shown in Table 6.2. A one way Analysis of Variance for unequal numbers was carried out on the children's total number of correct responses (see Appendix 6-2). The main effect of Chronological Age ($F(2,39)=8.974$, $p<0.001$) was significant indicating a significant developmental progression on this auditory discrimination task.

A series of Spearman's Rank correlation coefficient tests were carried out on the data from the normal controls (see Figure 6.1) to enable comparison with Michael and Caroline. The percentage of total correct responses correlated significantly with chronological age in the normal group ($r(41)=0.71$, $p<0.001$).

Table 6.2 - Performance of normal children on the complex auditory discrimination test (%).

Chronological Age Group	Total % Correct	Same % Correct	Different % Correct
3:0-4:0			
Mean	61.25	77.77	54.32
S.d.	18.18	18.71	24.16
5:0-6:0			
Mean	82.5	93.33	72.28
S.d.	13.32	9.26	18.83
7:0-8:0			
Mean	90.66	96.92	87.65
S.d.	7.5	4.7	10.96

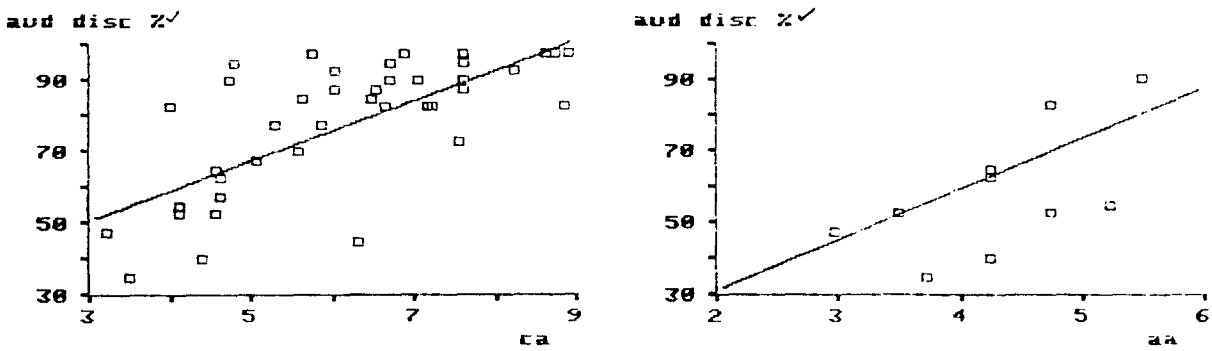
The different responses were examined separately. These data also correlated significantly with the children's chronological ages ($r(41)=0.61$, $p<0.005$). Given that children may call up orthographic cues to help them with this task, the normal children's reading age was correlated with their percentage of total correct scores. There was a low but significant correlation on these data ($r(41)=0.41$, $p<0.02$).

Finally, as the ten youngest children had also been tested on the Edinburgh Articulation Test (see Chapter 5) it was possible to look at the relationship between auditory discrimination and articulatory performance. There was a significant ($r(9)=0.66$, $p<0.02$) correlation between the normal children's percentage of total correct responses on the auditory discrimination test and their Articulation Ages (See Figure 6.1).

Figure 6.1 - Spearman's rho correlations between percentage of correct responses on the auditory discrimination test and a)chronological age and b)articulation age.

a) Chronological Age

b) Articulation Age



Michael and Caroline's performance was nearest to the 5:0-6:0 year old group (see Table 6.3).

Table 6.3 - Michael and Caroline's performance on the complex auditory discrimination test at T1 compared to normal controls.

	Chronological Age	Total % Correct	Same % Correct	Different % Correct
Controls	5:0-6:0	82.5	93.33	72.28
Range		45-97.5	69.23-100	22.22-96.29
Michael	11:02	80	100	69.23
Caroline	12:03	80	100	69.23

Although Michael and Caroline attained similar scores to each other, they did not make exactly the same errors. They both made errors on the items: gil/dil, trizhar/trithar, loathise/loathife, kirivin/kirivim comprising place change, and on the sequencing item: bikut/bituk. Michael also made errors on other sequencing items (ibikus/ikibus, rallyskotes/larryskotes, mitiboke/mikibote) and Caroline made errors on sequencing (besket/bekset, reket/retek) and manner items (kusel/kusen).

Michael and Caroline were less good than normal controls at detecting different stimuli even though they could detect same stimuli perfectly well. This may have been due to a response bias. However, they performed less well than expected for their reading ages of 7 years 7 months and 7 years 5 months respectively. Although the correlation coefficient was not strictly high enough to support linear regression, it was noted that Michael and Caroline's total percentage correct was approximately equivalent to a Reading Age of 5 years 7 months.

Finally, Michael and Caroline's performance on the total number of correct responses was at an equivalent articulation age level of 5 years 11 months which was better than their actual articulation ages of 4 years 3 months and 3 years respectively. Therefore, although there was a close relationship between articulation age and auditory discrimination in the young normal controls, this was not the case for Michael and Caroline.

Discussion

The finding of a developmental progression on the auditory discrimination task suggests that children may rely on other processes such as articulation in order to make auditory judgements of a complex nature. Support for this notion comes from the significant correlation found between the youngest children's articulation ages and total number of correct responses. The low correlation between these responses and reading age indicates, not surprisingly that orthographic experience plays a minimal role in the auditory discrimination of nonwords.

Michael and Caroline were poor at discriminating complex nonwords presented in the auditory modality. They accepted more different responses as the same compared to the normal controls but recognised as many same responses. Given that they had discriminated simple real and nonwords perfectly well on earlier occasions, peripheral perceptual deficits cannot explain their results. The hypothesis that Michael and Caroline may be disadvantaged because of their distorted and inconsistent speech output is not fully supported since they performed better than their articulation age predicted. However, both children had difficulties in discriminating the temporal ordering of sounds, placing their deficit at a later stage of processing where item order must be encoded. If this is the case, then problems in establishing lexical representations in an auditory lexicon can be anticipated. This possibility was explored using a lexical decision task.

INVESTIGATION 5: LEXICAL DECISION SKILLS IN NORMAL AND SPEECH DISORDERED CHILDREN

The ability to distinguish real and nonwords is assumed to develop early in young children. According to Waterson's (1981) model discussed in Chapter 1, Underlying Representation 1 develops very early and enables young children to recognise possible phonetic patterns of the language to which they are exposed. However, Michael and Caroline's sequencing difficulties and persisting speech problem are likely to interfere with their lexical development. Preliminary evidence for this hypothesis appeared when administering the nonword repetition task reported in Chapter 5. It was noticed that Michael and Caroline sometimes produced the matched real word for the nonword. This rarely occurred in the case of normal control children who on average produced 1.6 real words for nonwords (range 1 to 3 words). Caroline was at the top of the normal range range at T1 producing three real words for nonwords but Michael produced seven.

Second, in a pilot study of nonword spelling (after Campbell 1982), Michael and Caroline had unexpected difficulty with the lexical decisions entailed. The children were asked to listen to a list of randomised single syllable real words (bird, chair) and nonwords (sork, treed). Whenever they heard a nonword, they were to write it down (see Appendix 7-6). Although both children found this difficult, Michael performed less well than Caroline. He falsely accepted 81.25% of the nonwords and falsely rejected 3.17% of the real words. He accepted nonwords confidently and would give "made-up" definitions (SCRANE/you rub out with a cloth - clean; SNOOD/smoothe out) or produce a similar sounding real word (YITE/light; HANE/hair; TEED/tea). Caroline falsely accepted 58.06% of the nonwords and rejected no real words. Although her overall performance was better than Michael's she was very unsure of herself and requested repetition of the stimuli on 38.46% of her correct responses.

To evaluate the extent of these difficulties it was decided to test a small sample of normally developing children using a lexical decision paradigm. The task involved a decision as to whether auditorily and visually presented letter strings were real or nonwords.

Design and Materials

The material was selected from Coltheart's (1980) Easy Lexical Decision task. Twenty-four short and very common English nouns were used. These words had accompanying legal nonwords generated by altering one letter so that the resulting nonword conformed to English spelling rules (floor/floon). For the present study, a third list of illegal nonwords was devised by substituting one letter in the real word to produce a word that did not conform to English spelling rules (floor/fnoor). Anagrams of the real word (school/shcool) were avoided since young children attend to letter presence rather than letter order (Stuart 1986) and therefore could be expected to cause confusion particularly in the visual modality.

The 24 real words together with their 24 matched legal and 24 matched illegal nonwords (giving a total of 72 words in all) were equally divided into two sets of thirty-six real and nonwords (see Appendix 6-3). The items were randomised within each set. The order of presentation was alternated so that half the subjects received a visual task first and the other half received an auditory task first. For visual presentation the items were printed on white card.

Subjects

Thirty-three children (17 girls and 16 boys) from a Birmingham primary school were tested. Their chronological ages ranged from 4 years 8 months to 8 years 9 months and their reading ages from <6 years to 9 years 9 months (Schonell Graded Word Reading Test). All of the children spoke English as a first language and were making satisfactory progress in school. None were receiving remedial help or speech therapy. They were assigned to four Reading Age groups: (1) <6:0, (2) 6:02-6:11, (3)7:0-7:10, and (4) 8:0-9:09 (see Table 6.4).

Table 6.4 - Investigation 5: Details of subjects in control group.

Reading Age Group	Chronological Age	Reading Age
<6:0 (N=6)		
Mean	4:10	<6:0
Range	4:08-5:01	-
S.d.	0.14	-
6:0 (N=9)		
Mean	6:05	6:06
Range	5:08-6:11	6:02-6:11
S.d.	0.43	0.29
7:0 (N=9)		
Mean	7:03	7:04
Range	5:07-8:10	7:00-7:10
S.d.	1.13	0.28
8:0 (N=9)		
Mean	7:09	8:08
Range	6:01-8:09	8:00-9:09
S.d.	0.80	0.61

Procedure

Each child was seen individually. The task was presented as a "word game". Real and nonsense words were discussed and examples given. For visual presentation, the pack of word cards was placed face down in front of the child. Also on the table were two response cards bearing the symbols " ✓" and "X". The child was asked to turn over the pack of cards one by one and put all the real words by the " ✓" card, and all the nonwords or words they were not sure about by the "X" card. Four practice items were given on which the child could receive help.

No help was given with the test items. The same response cards were used for auditory presentation of the task when the child was asked to point to the appropriate card after the tester had said each word.

Results

A. The Normal Controls

The percentage of correct real and nonword detection scores was calculated for each subject. These percentages were converted to P(A) scores (McNicol 1972) to correct for guessing. The means and standard deviations for each Reading Age group are shown in Table 6.5.

Table 6.5 - Performance of normal controls on the lexical decision task presented in auditory and visual modalities (P(A) scores).

Reading Age Group	Visual	Auditory
<6:0		
Mean	-	92.17
S.d.	-	11.43
6:0		
Mean	72.56	97.56
S.d.	10.77	1.74
7:0		
Mean	83.89	97.11
S.d.	18.07	3.26
8:0		
Mean	97.0	98.44
S.d.	3.81	1.94

A mixed design analysis of variance was carried out on these data from reading age groups 6:0, 7:0 and 8:0 years (see Appendix 6-4).

There was a significant effect of both the between subject variable, Reading Age ($F(2,26)=7.43$, $p<0.003$), and the within subject variable, Modality ($F(1,27)=39.12$, $p=<0.000$). The interaction between the two variables was also significant ($F(2,24)=10.35$, $p<0.001$) and may have arisen because the 8 year olds were at ceiling in both modalities. The normal controls could therefore decide at a very early age which were real and nonwords when the stimuli were auditorily presented. In fact they were at ceiling on this task. In the visual modality, performance increased with reading age and beginner readers rejected more real words as nonwords than accepted nonwords as real words.

B. The Speech Disordered Children

Michael and Caroline's raw scores were converted to P(A) scores for comparison with the normal controls (see Table 6.6). In the visual modality they performed similarly to reading age matched controls. This is in contrast to their performance in the auditory modality where Michael in particular showed a significant difficulty.

Table 6.6 - Michael and Caroline's performance (P(A) scores) at T1 on the lexical decision task in visual and auditory modalities at T1 compared to Reading Age (7:0) control group (*z=>1 sd below mean).

	Visual	Auditory
Controls		
Mean	83.89	97.11
Range	38-100	89-100
Michael	91	91
z	0.39	-1.87*
p	NS	<0.03
Caroline	93	93
z	0.5	-1.26*
p	NS	NS

Discussion

The results of this study provide unequivocal evidence that young children can easily detect the difference between real and nonwords, particularly in the auditory modality. In accordance with Waterson's (1981) model, "Underlying Representation 1" is not dependent on literacy in normally developing children but reading experience enhances performance in the visual modality. In contrast to the normal controls, Michael and Caroline accepted more nonwords as real words particularly in the auditory modality. Thus, they have specific difficulties with auditory lexical processing. Since they are more likely to accept unfamiliar words as familiar, this suggests that their lexical representations are not as clearly defined as their reading skill and vocabulary knowledge suggests. The poor performance of Michael and Caroline on both auditory discrimination and lexical tasks indicates a difficulty with phoneme analysis. More formal tests of segmentation skills were therefore administered.

INVESTIGATION 6: RHYMING SKILLS IN NORMAL AND SPEECH DISORDERED CHILDREN

Michael and Caroline have had considerable assistance with syllable and phoneme segmentation. At T1 they could segment at the syllable level when presented with words of up to three syllables but made errors on multisyllabic words such as CATERPILLAR or HIPPOPOTAMUS. Their inability to produce these words consistently interfered with their ability to count the number of syllables.

On the Bradley Test of Auditory Organisation (1984), both children performed at less than the five year level when detecting the final consonant odd-one-out (sun gun **rub** fun), equivalent to the five year level on rhyme detection (mop hop **tap** lop) and less than the six year level on initial consonant detection (**mop** dog doll dot). Their performance is therefore considerably below that expected for their chronological and reading ages (Bradley 1981).

To investigate whether this poor performance could be attributed to an inability to hold the presented items in memory whilst carrying out the decision, Michael and Caroline were presented with a simpler task. When asked to match two out of three words by initial consonant (**car cat** peg) presented in both auditory and visual (pictorial) modalities, Michael scored at chance level only. Caroline scored 80% correct when the stimuli were pictures, but only 40% correct when the stimuli were presented auditorily. These results suggested that Michael and Caroline have specific difficulties with sound segmentation. To establish the extent of their problems the rhyme detection and production tasks from Investigations 1A and 1B were administered.

INVESTIGATION 6A: RHYME DETECTION

Michael and Caroline were tested on the rhyme detection test described in Chapter Four. It will be recalled that this test comprised only three stimuli per item and was therefore felt suitable for administration to children of limited memory span. The procedure was the same as for the normal younger children in Investigation 1A. The target stimulus was presented, for example CAT, and the children were asked to select the one that rhymed with the target (mat) from two further stimuli. The nonrhyming stimulus in the pair was either semantically related (fish) or an alliteration (cap) to the target. The stimuli were pictures when presented in the visual modality and spoken words when presented in the auditory modality.

Results and Discussion

When rhyme detection was tested through the use of pictures, Michael's performance was above chance (70%) and Caroline's was perfect. Thus, both children understood the concept of rhyme. However, they did less well in the auditory modality. Michael's performance was not significantly better than chance (60%) and Caroline was correct on only 85% of occasions.

The children's error responses were examined and compared to those from the normal reading age controls (see Table 6.7). The controls had few alliterative responses and minimal semantic errors. In contrast, Michael's errors were variable and involved semantic associations. Although Caroline did not make semantic errors, she selected more alliterations than did the controls.

Table 6.7 - Michael and Caroline's performance at T1 on the rhyme detection task in visual and auditory modalities (Number of errors - max = 10).

	Visual		Auditory	
	Semantic	Alliterative	Semantic	Alliterative
Controls:				
Mean	0	0.67	0.17	0.33
Range	0	0-2	0-1	0-2
S.d.	0	0.82	0.41	0.82
Michael :	2	4	3	5
Caroline:	0	0	0	3

Thus, it can be concluded that Michael and Caroline are delayed in their ability to detect rhyme even when compared with younger Reading Age-matched controls. This is particularly so in the auditory modality. In contrast, the normal controls had no modality preference and there was a significant correlation between their rhyme detection scores and their reading age.

Compared to each other, Michael may be at an earlier stage of rhyme detection development than Caroline since his persisting semantic errors placed him below the four year level of rhyme development. These results are interpreted cautiously, however, because of Michael's chance level of performance. Caroline's predominance of alliterative errors suggests that she may be at a later stage of making sound associations even though she lacked confidence in her responses.

INVESTIGATION 6B - RHYME PRODUCTION

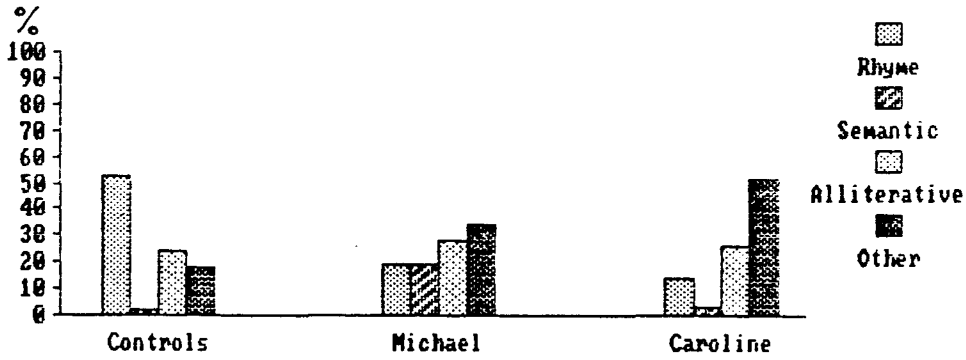
Michael and Caroline were asked to produce rhyming strings to the twenty words used in Investigation 1B. Their performance was compared to the younger children without speech problems ranging in age from 4 years 8 months to 6 years 9 months from this investigation. Their errors were also analysed qualitatively. (See Appendix 6-5 for data corpus).

Results and Discussion

Michael and Caroline's response accuracy was nearest to that of the four year olds in the group. Twenty-five percent of Michael's first responses were a correct rhyme (z=-0.59, p=NS), and 18.66% of his total responses were correct rhymes (z=-0.8, p=NS). Twenty percent of Caroline's first responses were correct (z=-0.72, p=NS), and 13.79% of her total responses were correct (z=-0.94, p=NS). Quantitatively therefore, Michael and Caroline's performance fell within the normal range of the control group. Any difficulties encountered were not due to difficulties with verbal fluency. On average the younger non-speech disordered children produced 2.0 responses per item. Michael in particular produced more than this (3.75, z=1.52, p=NS) while Caroline was near the top of the normal range (2.9, z=0.78, p=NS). On no occasion did Michael and Caroline fail to respond. In contrast, four year olds gave no response on 17.5% of the items and five year olds on 4.26% of the items.

The data was analysed qualitatively as for the normal children in Investigation 1B. Although the performance of Michael and Caroline was quantitatively nearer to the four year old controls, it was qualitatively different from them. Their predominance of alliterative over semantic errors was more like that seen in the five year olds (see Figure 6.2).

Figure 6.2 - Michael and Caroline's percentage of rhyme, semantic, alliterative and other errors at T1 compared to normal children of chronological age 5:0 years.



However, this increased sound awareness was not reflected in their rhyme response accuracy. Furthermore, Michael and Caroline had a high percentage of "other" errors not seen in the older age groups. These other errors were analysed into the five categories developed from the normal data in Investigation 1B:-

1. Mixed rhyme and alliteration (LOG/gog, dog, leg).
2. Rhyme and derivation (IRON/ironman, Brian).
3. Rhyme and feature change (COMB/home, tome, wone).
4. Syntagmatic (CAN/jump, can play ball).
5. Miscellaneous/random (KEY/boot).

The most striking result from this analysis was that Michael and Caroline had a greater number of unusual responses than the normal children who on average only made one miscellaneous response. In contrast, Michael made seven and Caroline thirteen responses that did not fit into the classification developed from the normal data. These were examined further.

Michael's miscellaneous errors were a more complex mixture than seen in the younger normal children. For example, his response to CAN included syntagmatic, definitions, alliterations, rhyme, feature change and final consonant match, (CAN/open the can, like can of stars, cape, cake, cran, queen, cake, make, like). There were only two similar examples from the normal children, (S11's FOUR/foot, your, core, fourteen, and S12's DRAWER/what you write with, door, Dawn). Michael was distracted by his own responses, for example the semantic association in KEY/bee, ee, wasp, tea, ee, bee; RING/watch, earings, king and queen. He found it difficult to maintain the rhyming strategy and mixed alliterative responses with more primitive semantic or derivation responses (MAP/train map, trap, hatch, mat, mop). On one occasion his alliteration differed in voicing to the target (BED/bacon, bread, time to bed, blackboard, **purse**) and on another he misheard or misunderstood the target (SHELL/shed, shoulder, books shed, books, something you put on the wall, book shelf). No such errors occurred in the normal children.

Caroline's miscellaneous errors indicated that she was using speech unsuccessfully to help her to rhyme. She often repeated the target or responses as though reflecting on the word (SHELL/shell, sea shelly, shore, shell, shell; RING/ring, king, ring, king, king) and would sound out parts of the words (SUN/sun, san, s or n, s; HEART/hat, har, ha, ham). She appeared to be "groping" for rhyme as she had "groped" for articulations in Investigation 3 (see Chapter 5). Articulatory intrusions occurred (SEW/sue, sing, wina, sh, boy, sew, low, solo, hello, no, doe).

Thus, Michael and Caroline had great difficulties with rhyme production. Qualitatively, their errors were more complex than those from the younger normal children. Although their minimal rhyming response indicated an early phase of development, their preponderance of alliterative over semantic errors placed them at a later one. Unlike the normal children they were not applying their increased sound awareness to the rhyming situation and were less stable in their rhyming strategies. The larger number of "other" error types in Michael and Caroline's data suggested that other levels of phonological development such as auditory discrimination and articulatory output may have been interfering with their successful rhyme production responses. To circumvent these difficulties, the children were presented with a written rhyme test.

INVESTIGATION 6C - WRITTEN RHYME DETECTION IN NORMAL AND SPEECH DISORDERED CHILDREN

Design and Materials

To investigate the relationship between rhyme detection skill and reading age whilst also avoiding the use of auditory input and spoken reponses, a written word rhyme test was devised. This consisted of twenty items each comprising three words, two of which rhymed. Half of the items were orthographically regular words (mop map pop) and half were irregular (sew new no). In the regular word condition, the two rhyming words look similar (mop pop) and the third word of the item was chosen to also be visually similar to the rhyming pair (map). In the irregular word condition the two rhyming words looked different from each other (sew no) and the distractor was chosen to be visually similar to the irregular word in the rhyme pair (sew new). This was to identify children who were unable to abstract sound from print.

If this were the case a child would merely circle all the pairs that looked visually similar regardless of sound.

Regular and irregular word items were placed in random order on the test sheet (see Appendix 6-6). Position of the odd-word-out in each item was also randomised across items. Performance on this test was correlated with reading age in a group of normal children for comparison purposes.

Subjects

The test was administered to fifty-six children (22 boys and 34 girls) ranging in age from 7 years 1 month to 9 years 6 months. Their Schonell Reading Ages ranged from 5 years 9 months to 11 years 10 months. They all attended the same Birmingham primary school and were making satisfactory progress in their school work. None of the children were receiving remedial help or speech therapy and none had a history of speech or language problems.

Procedure

The test was administered in the classroom to one quarter of the group at a time. The children were already familiar with the experimenter and were prepared to play a rhyming game. Examples were given of rhyming pairs and these were written on the board along with a word that did not rhyme. The children were asked to identify if the two words rhymed or not.

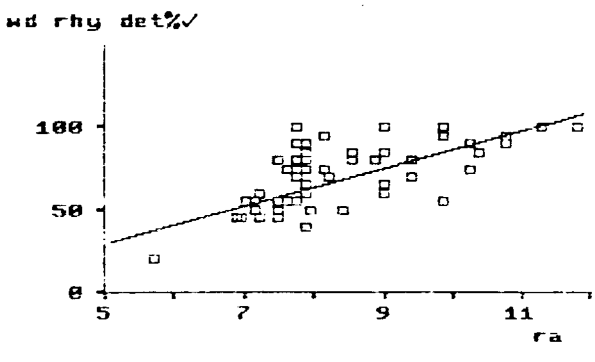
Each child received a test sheet. The practice items were pointed out. The children were asked to look at the first one and to put a circle around the two rhyming words. The experimenter then said each one out loud and indicated which two rhymed and which was the odd-one-out. The children completed practice item two in the same way with the experimenter giving the correct response. After any queries had been dealt with the children were asked to complete all of the items on the sheet. They were told not to rush through but to think about each one carefully. If they became stuck on an item they should move on to the next one. No further help was given with the test items. The sheets were collected in only when everyone had finished.

Performance was scored in three ways: (a) total number correct, (b) number of regular items correct and (c) number of irregular items correct.

Results and Discussion

Performance on the written rhyme detection test not surprisingly correlated with reading age ($r(55)=0.68$, $p<0.001$ - see Figure 6.3).

Figure 6.3 - Spearman's rho correlation between performance by the normal controls on the written word rhyme detection task and their reading ages.



This information was used to predict Michael and Caroline's reading age from their performance on this task using a regression equation. Michael's total correct score of 40% was equivalent to a reading age score of only 5 years 4 months at actual reading age of 7 years 7 months. Caroline's score of 45% gave her an equivalent reading age of 5 years 10 months which was also less than expected for her actual reading age of 7 years 5 months. However, it can be seen from Figure 6.3 that normal readers of this age are also variable.

Next, the regular and irregular word conditions were examined separately. Michael performed less well on the irregular word condition (10%) than the regular word condition (70%) giving him reading age equivalents of 5 years 1 month and 5 years 11 months respectively. In contrast, Caroline performed less well on the regular word condition (60%) giving an equivalent reading age of 4 years 5 months and better on the irregular word condition (30%) with an equivalent reading age of 6 years 8 months.

Thus, Michael's scores on the regular and irregular conditions suggested reliance on a visual strategy. He circled items more randomly than did Caroline and was distracted by the visual similarity of the stimuli. Michael was therefore not abstracting sound from the visual stimuli. In contrast, Caroline showed evidence of more phonological processing. Her greater accuracy score on the irregular items indicated that she could draw upon her sight vocabulary to recognise familiar rhyming words. The poorer performance on the regular word condition may be accounted for by the unsuccessful application of a phonological strategy. The stimuli were auditorily and phonetically similar and therefore difficult for her to decode.

Although the task did not require a verbal response, the children often used verbal rehearsal while making the rhyme detection judgement. Caroline's output difficulties therefore affected her performance even on this "silent" test.

DISCUSSION OF RESULTS at T1

The findings at T1 suggested that Michael and Caroline were not merely delayed in their development of auditory, lexical and segmentation skills. Rather, their performance overall was different to what might be expected for their reading age. Although problems were evidenced in both modalities, difficulties were more pronounced in the auditory modality and in particular when nonword material was used.

Although both Michael and Caroline had the same articulatory diagnosis and had similar literacy experience, they did not perform identically on tasks. Compensatory strategies were evident. Michael showed the greater deficit with input and detection tasks and was particularly poor on lexical decision. In contrast, although Caroline's performance was better than Michael's overall there was a greater discrepancy between her input and output skills. She had more difficulties than Michael when the task required an articulatory response as in rhyme production but was better than he on rhyme detection. Furthermore, Caroline had difficulties when the task involved decoding skills as in the written rhyme detection even though a spoken response was not required.

The results challenge the assumption that children with developmental verbal dyspraxia only have deficits at the level of output phonology. Michael and Caroline clearly also had input phonological, lexical and sound segmentation difficulties. Michael and Caroline's poor performance on input tasks could be the result of a cumulative effect of deficits rather than a lower level auditory discrimination problem per se. Their ability to discriminate simple Consonant/Vowel/Consonant structures but not words comprising consonant clusters suggests that they have not satisfactorily developed a clear representation of syllable structures. This inability to segment the syllable into its components is compounded by the articulatory difficulties which interfere with consistent rehearsal of the target. Michael and Caroline's poor performance on this task is therefore due to a higher level sequencing and segmentation difficulty rather than a lower level input difficulty.

The inability to process and maintain the sequence of consonants will have lexical repercussions. For example, the failure to detect metathesis errors (kit/tick, steak/skate) or sequencing changes (clasp/claps, task/taks) may result in words becoming wrongly accomodated in the lexicon, thereby increasing the inherent disorder within the system. Both children, but particularly Michael who had specific problems on the detection tests, performed poorly on the lexical decision tests. Seymour and MacGregor (1984) have suggested that children with specific phonological difficulties may expand their lexicon visually rather than truly orthographically. In the case of Michael and Caroline, their visually based lexicon is not linked to phonological representation. They are more ready than normal controls to accept nonwords as real words, indicating that they may lay down less specific representations of words.

In view of these phonological input, lexical and segmentation difficulties, it can be predicted that Michael and Caroline will have problems in developing alphabetic skills. Their reading and spelling performance should therefore be of a logographic nature and will be reported in the following chapter.

CHAPTER 7

READING AND SPELLING DEFICITS

This chapter will examine Michael and Caroline's reading and spelling performance. It was predicted that both children would exhibit serious problems when reading and spelling since their pervasive phonological disability would present a barrier to the alphabetic phase of literacy development. It follows that their reading and spelling performance should be "logographic" in nature and characterised in the following way according to Frith (1985):-

1. Inaccurate reading with a preponderance of visual errors.
2. Absence of regularity effect.
3. Inability to read new or nonsense words.
4. Nonphonetic or bizarre spelling as a result of an inability to utilise phoneme-grapheme correspondence rules.

Nevertheless, it does not follow that Michael and Caroline will perform identically. Indeed, because of the differences between them on the tasks presented in Chapters 5 and 6 it is expected that the precise nature of their errors will also differ (Snowling, Stackhouse and Rack 1986). A variety of reading and spelling tasks were administered at T1 when Michael had a Reading Age of 7 years 7 months and a Spelling Age of 6 years 8 months. Caroline's Reading and Spelling ages were 7 years 5 months.

INVESTIGATION 7 - READING SKILLS

Michael and Caroline's ability to process words by a direct visual strategy as compared to their ability to use a phonological strategy was tested systematically with reference to

Figure 1.1. The first task examined an early stage in information processing according to this model (Pring and Snowling 1986). The children were asked to copy and match nonwords (wup, klab, prant, sploch) in order to test the functioning of the peripheral mechanism used for visual analysis. Both children scored at ceiling on this test ruling out the possibility that deficits at an early stage of visual processing could account for their reading difficulties.

Next, to examine whether they could identify single letters Michael and Caroline were presented with tests of letter-sound and letter-name knowledge.

LETTER KNOWLEDGE

This was tested by a grapheme-phoneme conversion task. A randomised set of lower case letters (t, e, s) was presented for letter sound production and a set of upper case letters (T, E, S) was presented for letter name production. In addition, the children were asked to pronounce consonant blends (bl, sp, scr, thr) from their written form.

Results and Discussion

There was a clear discrepancy between Michael and Caroline's ability to name letters and to sound out letters (see Table 7.1). Thus, although they had learned to label letters efficiently, they had difficulty with letter sounds and especially with consonant blends (see Appendix 7-1).

Table 7.1 - Michael and Caroline's performance when naming and sounding out letters and blends (C=consonant) at T1 (% correct).

	Names	Sounds		
		Single	CC blend	CCC blend
Michael:	92.3	61.5	36.84	0
Caroline:	100	65.4	36.84	20

Thus, contrary to the pattern usually seen in normal development (Ehri 1983), Michael and Caroline's learning of letter names was no guarantee for successful abstraction of the letter sound. Furthermore, their articulatory difficulties interfered with their pronunciation and learning of consonant blends.

READING STRATEGIES

To investigate the use of visual and phonological reading strategies, the children were asked to read 31 regular (lime, market), 31 irregular (flood, double), and 31 nonwords (garket, louble) presented in random order from Snowling, Stackhouse and Rack (1986). In each case 19 were of one syllable and 12 of two syllables (see Appendix 7-2). Both rule based and analogical pronunciations of the nonwords were counted as correct.

If Michael and Caroline are reading within the logographic phase of literacy development there will be little to no difference between their reading of regular and irregular words since alphabetic skills cannot be applied to unfamiliar regular words. Furthermore, without such alphabetic skills Michael and Caroline would not be able to read nonwords. Their performance was compared to that of twelve normal 7 year olds whose reading age ranged from 7 years to 7years 3 months taken from Snowling et al (1986).

Results and Discussion

Table 7.2 shows the effect of regularity on performance.

Table 7.2 - Michael and Caroline's performance on tests of regular and irregular word reading correctly at T1 compared with Reading Age controls (* = >1sd, ** = >2sd, *** = >3sd below the mean).

	Regular	Irregular	Regularity Effect
RA Control (7:0-7:3)			
Mean:	55.65	31.45	24.2
Range:	29.03-90.32	9.68-70.97	
Michael:	22.2	16.1	6.1
z=	-5.97***	-2.95**	
p	<0.0001	<0.002	
Caroline:	25.9	22.6	3.3
z=	-5.31***	-1.70*	
p	<0.0001	<0.05	

These data show a clear regularity effect for the normal readers. This is usually taken to mean that alphabetic skills have been acquired. In contrast, neither Michael nor Caroline showed this effect and their significantly poor performance on regular words in particular indicates a specific problem with alphabetic skills. In this respect they were similar to other phonological dyslexics reported by Snowling et al (1986).

A second indication that children have made the transition to the alphabetic phase is that they can read nonwords. Both Michael and Caroline failed to score on the nonword reading test.

They did significantly less well than reading age matched controls and again resembled other phonological dyslexics. Thus, they were unable to use a phonological strategy when tackling unfamiliar words. To examine the nature of this phonological problem further, a qualitative analysis of Michael and Caroline's reading errors was carried out.

QUALITATIVE ANALYSIS OF READING ERRORS

A developmental error classification based on Snowling et al (1986) but extended was used as follows:-

1. Logographic Errors (L) - Visual errors arising from a logographic approach to the printed word. The error shared at least 50% of the target's letters (ORGAN/orange; WARD/word) and the response was usually immediate and confident.

2. Lexical Sounding Errors (LS) - The result of partial phonological knowledge and an attempt at an analogy with a real word. The response was therefore always a real word and usually visually similar to the target but shared less than 50% of its letters (TONGUE/tangerine; SUEDE/superman). The child appeared to analyse part of the word - usually the beginning - and then guessed the remainder.

3. Unsuccessful Sound Attempts (USA) - Related to lexical sounding errors in that they reflected partial use of alphabetic skill. The word was segmented into its components either correctly or with intrusions but these components were not synthesised into the target (SLOT/sof, slof; GLOBE/kelub, kelob). Errors classified in this way were therefore always nonwords.

4. Regularisations (R) - Acceptable phonic renderings of irregular words (WAND/wanned; VASE/vaize). They demonstrate that the child is able to use a phonological approach to the printed word and has entered the alphabetic phase of reading development. These errors are characteristic of surface dyslexia but would not be expected in cases of phonological dyslexia.

5. Semantic (S) - Related in meaning to the target (AUNT/uncle; LIME/lemon). They are characteristic of deep dyslexia in patients with acquired brain damage following a stroke or head injury, but few have been found in developmental disorders. Coltheart (1980)

recommends that over 50% of semantic errors should be observed before a diagnosis of deep dyslexia can be made.

6. Derivation (D) - A real word arising from the target (LOSER/lost; PRINCE/Princess Anne).

7. Unsuccessful Analogy Attempt (UAA) - The explicit rejection of the first analogy response as a result of noting other information, followed by an inability to synthesise the new information (ORGAN/not orange, orgrer; SWORD/(with finger covering the s) word, (with finger off the s) swerse).

As Michael and Caroline's difficulties were so great, there was little benefit in comparing their performance qualitatively to normal children of the same reading age. Instead, their reading errors were compared with those of a group of low reading age dyslexics reported by Snowling et al (1986) and described in Chapter 1. These children were reading within the logographic phase but they did not have serious speech difficulties. They had all been referred to psychological services for assessment of reading and spelling difficulties. J.M. had received speech therapy during preschool years and still exhibited articulatory difficulties such as voice/voiceless contrast (pin/bin). He was however perfectly intelligible and communicated well. Neither T.W. nor A.S. had any noticeable speech difficulty (see Table 7.3).

Table 7.3 - Details of low reading age dyslexic control children taken from Snowling, Stackhouse and Rack (1986).

S	IQ (Wisc-R)	Chronological Age	Reading Age (Schonell)	Spelling Age (Schonell)
J.M.	123	8:05	7:05	6:07
T.W.	85	8:10	6:11	6:01
A.S.	*	13:10	7:05	6:02

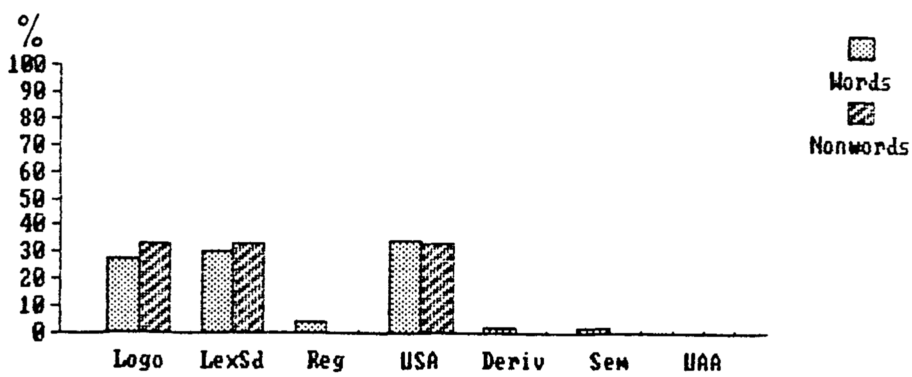
*IQ score not available. Subject judged to be of average ability.

Results and Discussion

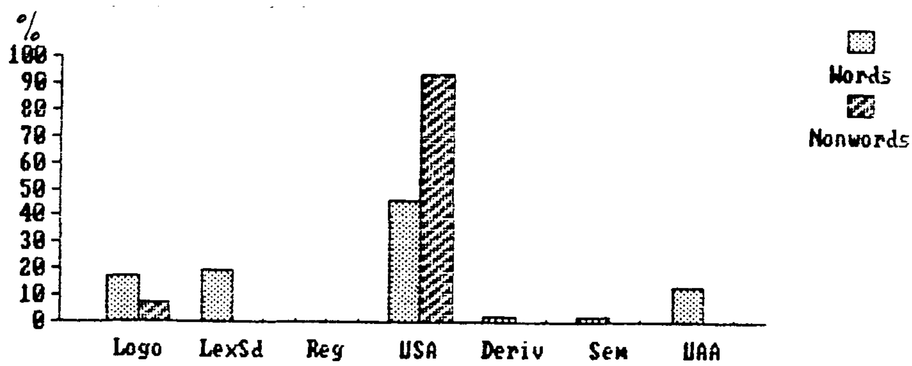
The results of the error analysis are illustrated in Figure 7.1

Figure 7.1 - Michael and Caroline's percentage of error types in real and nonsense words at T1.

Michael



Caroline



The performance of the two children is discussed separately. In Michael's case, over fifty percent (57.5%) of errors in real word reading had a strong visual similarity to their targets. These logographic errors included PINT/paint, FLOOD/foot, LEVER/liver, DRUG/drum, SNAIL/nail, and lexical sounding errors included VASE/varnish, COLONEL/cocacola, GRILL/glue. The next highest proportion of errors were unsuccessful sound attempts for example, TUTOR/[tərʊwə'tʌk'tʌkwə 'tʌf 'tʃɑ't?ʌptʃɑ]; STEADY/[ʃæd 'ʃæd 'ʃɛd 'sləʊt 'sləʊk] DOUBLE/[bə'wəʊt 'bwəʊp 'wəʊp 'dəʊt]. Michael made one semantic error but strictly speaking this error could be classified as visual because it shares 50% of letters with the target (LIME/lemon). One further error was derivational (LOSER/lost) and only two regularisations were recorded (WAND/[wænd], GLOVE/[gə'ləʊb]). Although this might indicate some sound processing, normal children of the same reading age as Michael make on average 19% regularisations on one syllable and 6% on two syllable words (Snowling et al 1986).

A similar pattern of errors emerged when reading nonwords. Most errors fell into the visual similarity category, that is these nonwords were read as though real words (lexicalisation) for example GARKET/garden, ISLANK/island, TATCH/tissue, HIGN/hide. Nonetheless, a large proportion were unsuccessful sound attempts (KOLICE/['kɒŋk], PILM/[f tʃəmə'lɪn pɪlʂ]).

In contrast, fewer than forty percent (37.1%) of Caroline's errors were visually similar to their targets (logographic - PLUG/plum, SHIN/shine, PINT/paint, WARD/word; lexical sounding - MIXTURE/minute, SHOVE/shadow, BISCUIT/beautiful). The highest proportion of her errors were unsuccessful sound attempts for

example BLEAT/[bə bə lə'ɪt'itɪn 'itɪn bə'leɪ'bleɪ'ɪtɪn]; GRILL/[grɛ gərəwə gərə grə'grə]
CASK/[skɑds sk'skɑ 'ski kələ'sʌl]; BREATH/[brɛdzə 'beɪ,kʌpt 'beɪtʌʔ'bɪtæ]
LETTUCE/[tə'lɒt tə'lɛp] ; DOUBLE/ [də'wæt də wə'læt]

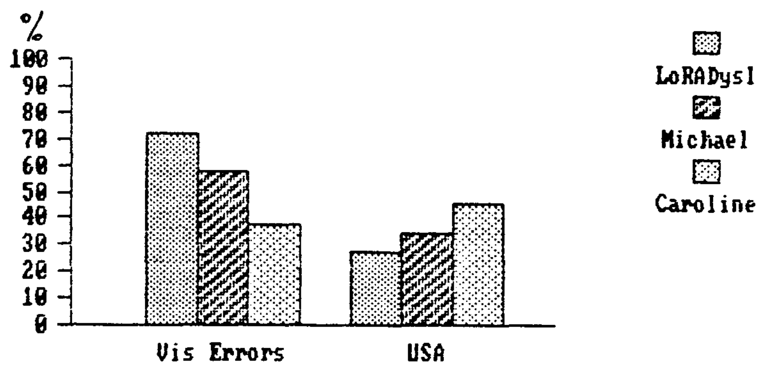
This pattern was more pronounced in the nonword condition when all but one of her errors were unsuccessful sound attempts (TATCH/[tʌt 'tɒt tə'læk]; GARKET/[gəɜk 'gɒt'gɒk]; ISLANK/[ɪnə'pæŋk æɪnəkæ]
The remaining error was lexicalisation (WOLT/wolf). Other attempts at an analogy strategy were noted. For example, when reading LIME she achieved the correct response by saying "if it said te it be time - le - lime". However, this strategy was not always successful as in BITTER/"better, batter, butter or butterfly - not butter cause its a u". Also see ORGAN and SWORD examples given in the error classification above. In addition, there was one derivation (PRINCE/Princess Anne) and one semantic error (AUNT/uncle). There were also a number of occasions when she made a semantic association to her own response (GLOBE/gull, swan; SWAN/worms, snake; FLOOD/food, felunfetan - name of who that lives in the water; CHOIR/ghost, holy ghost, no - something like a star).

Comparison with Low Reading Age Dyslexics

Although the low reading age dyslexic children were of similar reading age to Michael and Caroline they did not perform in an identical way to them. First, the dyslexics made a greater number of visually based errors than did Michael and Caroline (between 69% and 75% compared to Michael's 57.5% and Caroline's 37.1%). Second, they made fewer unsuccessful sound attempts (between 25% and 29% compared to Michael's 34.1% and Caroline's

45.7%). See Figure 7.2.

Figure 7.2 - Distribution (%) of visual errors and unsuccessful sound attempts in the reading performance of Michael and Caroline and the low reading age dyslexics taken from Snowling, Stackhouse and Rack (1986).



Thus it can be argued that, like reading age matched dyslexic children, Michael and Caroline were reading within the logographic phase since there was a high percentage of visual errors and they could not use phonological reading strategies. However, their pattern of errors was different to the dyslexic children without severe speech difficulties. When Michael and Caroline attempted to use grapheme-phoneme conversions, intrusive articulations hindered the segmentation and blending process making them unable to synthesise the target. This was particularly noticeable in the case of Caroline.

Michael and Caroline may therefore be expected to progress less well with their literacy development since their speech difficulties interfere with their alphabetic skills. To differentiate difficulties at the articulatory level from those at a higher phonological processing level, Michael and Caroline were administered two silent phonology reading tests.

F. SILENT READING

First, Michael and Caroline were asked to sort into two piles pairs of homophones written on cards (see Appendix 7-3a). One pile comprised words that sounded the same (fid/phid) and the other words which sounded different (fid/prid). Both real and nonsense words were used (After Coltheart 1980).

Second, their knowledge of orthographic rules was examined using a task devised by Baron and Strawson (1976). In this task the children were asked to tick a nonsense word if it sounded like a real word (caik knoe) or cross it if it did not (hapy penk). See Appendix 7-3b.

For comparison with phonological skills, a third silent reading semantic odd one out test was presented as a control (see Appendix 7-3c). Each item on the test comprised three words two of which were closely related and the third not (beer coffee tea). The children were asked to circle the two that went together the best, that is the two that were closest in meaning.

Results and Discussion

Michael and Caroline scored at chance level only on both the silent tests of phonology. In contrast, they were at ceiling on the semantic odd one out test. Thus, they were using primarily visual strategies for reading at T1. Inspite of intensive phonic teaching they found it difficult to apply grapheme-phoneme correspondences. Their output difficulties alone cannot account for their reading difficulties and they do not have a specific semantic deficit. A problem in using alphabetic skills is indicated. It follows from Frith's (1985) theory that children who are reading within the logographic phase will have spelling difficulties. It should not be possible for such children to produce phonetic renderings of spoken words.

INVESTIGATION 8 - SPELLING SKILLS

Michael and Caroline's performance on the reading task showed them to be at the logographic phase. It follows that they should be unable to tackle the spelling of nonwords and more generally they should be dysphonetic spellers. A systematic investigation of Michael and Caroline's spelling performance therefore focussed on their attempts to use phonological and alternative strategies.

SYLLABLE LENGTH

Michael and Caroline were asked to spell 10 one syllable (pet, lip, bump), 10 two syllable (apple, kitten, tulip), and 10 three syllable (membership, catalogue, refreshment) words. Their performance was again compared with that of the low reading age dyslexics reported in Snowling et al (1986) who also spelled these items. It is relevant that the dyslexics were themselves poorer than reading age controls in these tasks. Errors were scrutinised for normal immaturities, phonetically acceptable spellings and nonphonetic spellings.

Results and Discussion

The entire corpus of Michael and Caroline's spelling errors is presented in Table 7.4.

Table 7.4 - Michael and Caroline's spellings of one, two and three syllable words at T1 (+ = correct).

Syllables	Michael	Caroline
One:-		
pet	+	bet
lip	lepp	+
cap	+	+
fish	+	+
sack	satk	suak
tent	tean	+
trap	thew	unekiry
bump	borr	+
nest	nexts	net
bank	back	+
Two:-		
apple	+	+
puppy	pats	puppet
packet	pater	balk
trumpet	trpbbie	duidry
kitten	keten	kittle
traffic	stop tarres	fittip tiffip
collar	koler	kiltoy
tulip	tottper	tolip
polish	poter	bybrdwn
finger	figger	finder
Three:-		
membership	mabsttb spht splt sthp	bnbship
cigarette	satesatarhaelerari	silonwet
catalogue	catcolg catdog	catanlog
September	sabarber smber	+
adventure	arterer	andbackself
understand	rarato-sand rarde	undercellow
contented	kitr	contartit
refreshment	lpohet	withfirstmint
instructed	nisokder	indivrd
umbrella	rberherrelrarlsrllles	umber umturd

The number of correctly spelled words, phonetically acceptable and nonphonetic errors are shown in Table 7.5 where they can be compared to those of children designated as phonological dyslexics.

Table 7.5 - Michael and Caroline's number of words (max=10) spelled correctly (C), phonetically (P), and nonphonetically (NP) in one, two and three syllable words at T1 compared to the low reading age dyslexic controls (Snowling, Stackhouse and Rack 1986).

	One Syllable			Two Syllable			Three Syllable		
	C	P	NP	C	P	NP	C	P	NP
Michael:	3	0	7	2	0	8	0	0	10
Caroline:	6	0	4	1	0	9	1	0	9
Dyslexics:	3	0	7	0.33	0	9.67	0.33	0.33	9.33
Range:	2-4	0	6-8	0-1	0	9-10	0-1	0-1	8-10

Michael spelled 3 out of the 10 one syllable words correctly. This was poorer than to be expected considering his reading age but similar to low reading age dyslexics. Caroline spelled 6 out of the 10 one syllable words correctly and was within the range of the reading age matched control group in this respect. Like dyslexics of low reading age, Michael and Caroline made nonphonetic spelling errors. Moreover, only a minority of these spelling errors resembled the mistakes made by young normally developing children. These were Michael's spellings of LIP/lepp, BANK/back, COLLAR/Koler, KITTEN/keten, FINGER/figger, and Caroline's spellings of SACK/suak, NEST/net, TULIP/tolip. A comparison of the spelling errors made by Michael and Caroline not only revealed broad similarities between the children but also striking differences. First, Michael transcribed the initial consonant correctly 90% of the time while Caroline was only 76.7% accurate on this. Second, whereas Michael only maintained the syllable structure on 45% of the words, Caroline did so on 75% of them. These results suggest that Michael and Caroline were utilising different strategies when spelling. Michael was attempting a sound by sound strategy (with great difficulty) while Caroline had opted for a syllable by syllable strategy. These strategies are described more fully below.

In Michael's case, his spelling by phoneme strategy was compromised by his segmentation difficulties. Three syllable words were often reduced (CONTENTED/kitr, REFRESHMENT/lpohet). Phoneme segmentation was further complicated by his output difficulties. For example, intrusions in spelling were common as they were in his speech (SACK/satk, PUPPY/pats). In two syllable words he would often only attempt the first and last sound (TULIP/tottper, PACKET/pater, POLISH/poter - this last example was understood by knowing that at that time Michael stopped the fricative "sh" to /t/ in his speech). Although these responses at first appeared bizarre a consistent pattern emerged. Michael was able to identify the initial sound but not sounds embedded within words. He exaggerated his articulation of the final consonant - hence the sound plus "er" was transcribed.

The same pattern was true of the more bizarre errors. Clusters in words (sp, spl tr, str) were an added complication because of his poor segmentation skills. Michael's spelling of TRAP as "thewenmt" may be the result of attempting to segment the initial cluster /tr/. The T/the marks the added aspiration when forcing a /t/, the R/we is the result of Michael labialising /r/ sounds in his speech to /w/, and the last three letters "nmt" comprise the manner and place of P but are mistimed. The vowel (A) is not attempted. Such intrusive sounds and manner changes may reflect vocal tract incoordination, typical of dyspraxic speech, during the segmentation process and take Michael further away from the target.

Finally, the three syllable words provided a real challenge to the view that Michael's bizarre spelling may in fact have an underlying strategy. Errors such as "satersatarhaelerar" for CIGARETTE would at first appear to defy analysis. However, these errors can be partly explained by his repeated attempts to segment and spell parts of the word. He records each of these attempts and backtracks several times in order to either transcribe a particular segment to his satisfaction or as a way into the following segment. This searching behaviour when spelling has a parallel in dyspraxic speech - articulatory searching or "groping" for sound positions (see Chapter 6). Dividing the targets into their syllable components as follows allows clearer identification of Michael's repeated attempts to transcribe parts of the word:-

1) understand/rarato-sand, rarde

un	der	stand	/	ra	ra	to	sand,	ra	r	de
1	2	3		2	2	2	3	2	2	2

2) September/sabarber, smber

Sep	tem	ber	/	Sab	ar	ber,	Sa	bar	ber,	S	m	ber
1	2	3		1	3	3	1	3	3	1	2	3

3) umbrella/rberherrelrarlsrllles

um	bre	lla	/	r	be	rhe	rre	l	ra	r	l	sr	l	l	les
1	2	3		2	2	2	2	3	2	2	3	2	3	3	3

4) cigarette/satesatarhaelerari

ci	gar	ette	/	sa	te	s	at	ar	hael	er	ari
1	2	3		1	3	1	3	2	2	2	2

In summary, although Michael's errors appeared bizarre and unsystematic, closer examination of his responses suggested that they reflected a phoneme-by-phoneme spelling strategy which is compromised by severe segmentation and speech difficulties.

Caroline's spelling attempts, like Michael's, were compromised because of segmentation and speech difficulties. For example, her spelling of PACKET as "balk" omits the unstressed syllable which is a normal immaturity but includes an intrusive sound /l/ so that the stressed syllable was not correctly transcribed. It was noted that throughout Caroline's spelling she wrote /p/ as "b". This was not a writing error but reflected a difficulty with voice/voiceless consonants.

Searching behaviour was present in Caroline's spelling to a lesser extent than in Michael's. For example, when spelling TRUMPET as "duidry" she only attempted the first syllable (TRUM) but did so twice - "dui dry". As in her speech, she collapsed syllables so that when spelling POLISH her response "bybrdwn" shows a repeated attempt to transcribe the cluster PL/by, br, dw, n. The addition of the nasal /n/ is a common substitution for the lateral /l/ and it was noted that Caroline's speech had a hypernasal quality. In addition to the above, Caroline attempted to spell words twice on three occasions (TRAFFIC/fittip, tiffip; FINGER/finger, finder; UMBRELLA/umber, umturd). The last two examples show that the second attempt was not necessarily closer to the target.

A major feature of Caroline's spelling which was quite different from Michael's was that she adopted a "word-component" strategy rather than persisting with the attempt to spell phoneme-by-phoneme. This involved using familiar spellings similar in sound to syllables within the target for example, PUPPY/puppet, CIGARETTE/silonwet, CATALOGUE/catanlog, ADVENTURE/andbackself,UNDERSTAND/undercellow, CONTENTED/contartit, REFRESHMENT/withfirstmint). This is potentially a more effective strategy than the sound-by-sound one adopted by Michael. It preserved the syllable structure of the word and therefore spelling resembled the correct version more closely.

This pattern of spelling by word-components was observed in two of the normal children reported in Investigation 2 (see Chapter 4), both of whom were having difficulties with their spelling development. Similarly, one of the low reading age dyslexic children studied by Snowling et al (1986), T.W., also spelt by word components (MEMBERSHIP/boatseary, REFRESHMENT/threesleling) and was thought to be having difficulties with input phonology. It may be that this strategy is adopted following identification of "peaks" in a word when finer segmental discrimination is not possible. It is a potentially more effective strategy than Michael's endless groping for letters and could therefore be seen as a strength rather than a weakness.

Caroline may have developed a greater appreciation of syllable structure than Michael and be using this to compensate for her poor segmental spelling. Certainly, her rhyme detection skills were better than Michael's (see Chapter 6). This would suggest that Caroline had a greater metalinguistic awareness. Responses to a questionnaire (Francis 1982) goes some way in supporting this view (see Appendix 7-4).

Thus, Michael and Caroline were clearly unable to use alphabetic skills when spelling real words at T1 but have adopted different spelling strategies in an attempt to compensate for their difficulties. To investigate Michael and Caroline's orthographic representation of spellings the above spelling errors were presented to them in a systematic way.

ORTHOGRAPHIC REPRESENTATION

To see whether Michael and Caroline could identify correct versus incorrect spellings, they were presented with their own spelling errors, an acceptable phonetic/immature spelling or an anagram of the target, and the correct form of the above one, two and three syllable real words, for example CIGARETTE SIGURET SILONWET; BUMP BUP BORRT; TRAP PART THEWENMT. The position of each word type was randomised across items. The presentation of one, two and three syllable words was also randomised on the test sheet (see Appendix 7-5). The children were asked to look carefully at the three words per item on the test sheet and to circle the word spoken by the experimenter.

Results and Discussion

Michael and Caroline were better at recognising than producing one and two syllable words. However, their performance on recognition of three syllable spellings was at chance level only (see Table 7.6).

Table 7.6 - Michael and Caroline's recognition of correct spellings of one, two and three syllable words at T1 (max=10).

	Syllables		
	One	Two	Three
Michael:	9	7	4
Caroline:	10	8	5

Michael accepted two phonetic spellings as correct (CATALOGUE/catalog, PACKET/pakit) and an equal number of immature (REFRESHMENT/rifeshmet) and his own errors (TRUMPET/trpbbie). Caroline accepted as correct one phonetic (TULIP/choolip), one immature (INSTRUCTED/instuktid), and five of her own errors. Four of these were spellings by word components (REFRESHMENT/withfirstmint) and one was a speech error (FINGER/finder). Neither child selected anagrams of the target in their responses.

Thus, although Michael and Caroline were generally better at recognition than production, they were still willing to accept bizarre spellings as correct particularly on longer words. Their nonacceptance of anagrams shows that a visual sequencing difficulty cannot account for their performance on this test. Rather, a phonological checking deficit is indicated. The findings suggest that orthographic representations are not being developed satisfactorily.

The persisting dissociation between reading and spelling performance is not characteristic of normal reading and spelling development (Frith and Frith 1980, Bryant and Bradley 1980) but may be typical of the early logographic phase. Certainly, Michael and Caroline's spellings of words of increasing syllable length indicate that they have particular difficulties with sound segmentation skills. It follows from this that nonword spelling will prove problematic for them.

LEXICALITY

Michael and Caroline were asked to spell 31 nonwords from the lexical decision task (Campbell 1982) reported in Chapter 6 (see Appendix 7-6). Their performance was extremely poor. Michael spelled only two of these correctly (MORKE and SHEED), Caroline did not spell any. The discrepancy between their initial and final consonant transcription indicated that they had severe difficulties with segmenting the word and applying phoneme grapheme rules. Michael transcribed 82.75% of the initial consonants correct but only 17.24% of the final consonants. Similarly, Caroline spelled 77.4% of initial consonants correctly but only 38.7% of final consonants. Indeed, given their reading age this was a very poor performance and confirmed that they were both spelling within the logographic phase.

In order to compare performance on nonword spelling with Spelling Aged-matched controls, Michael and Caroline were asked to spell thirteen words and nonwords from Investigation 2 (Cross-sectional Study of Spelling Development) reported in Chapter 4. The words comprised consonant clusters and the nonwords were matched to them by substituting a different vowel. Examples of one syllable items were WASP/WEPS, CHIPS/CHUPS and examples of two syllable items were SPIDER/SPODER, and SNOWMAN/SNIMON.

The twenty-two spelling age controls from Investigation 2 ranged in age from 6 years 1 month to 8 years 11 months and had a spelling age range from 5 years 11 months to 13 years 6 months.

Results and Discussion

Michael and Caroline's spelling attempts are presented in Table 7.7. Michael spelled 3 out of 13 words correctly which by linear equation gave him a projected spelling age of 6 years 10 months and Caroline spelled 5 out of 13 correctly giving her a projected spelling age of 8 years 4 months. Their performance was therefore within the range of normal spelling age controls on this condition. However, neither child could spell any of the nonwords and in this respect they were worse than controls who could spell over half of the nonwords by spelling age of 7 years and 2 months.

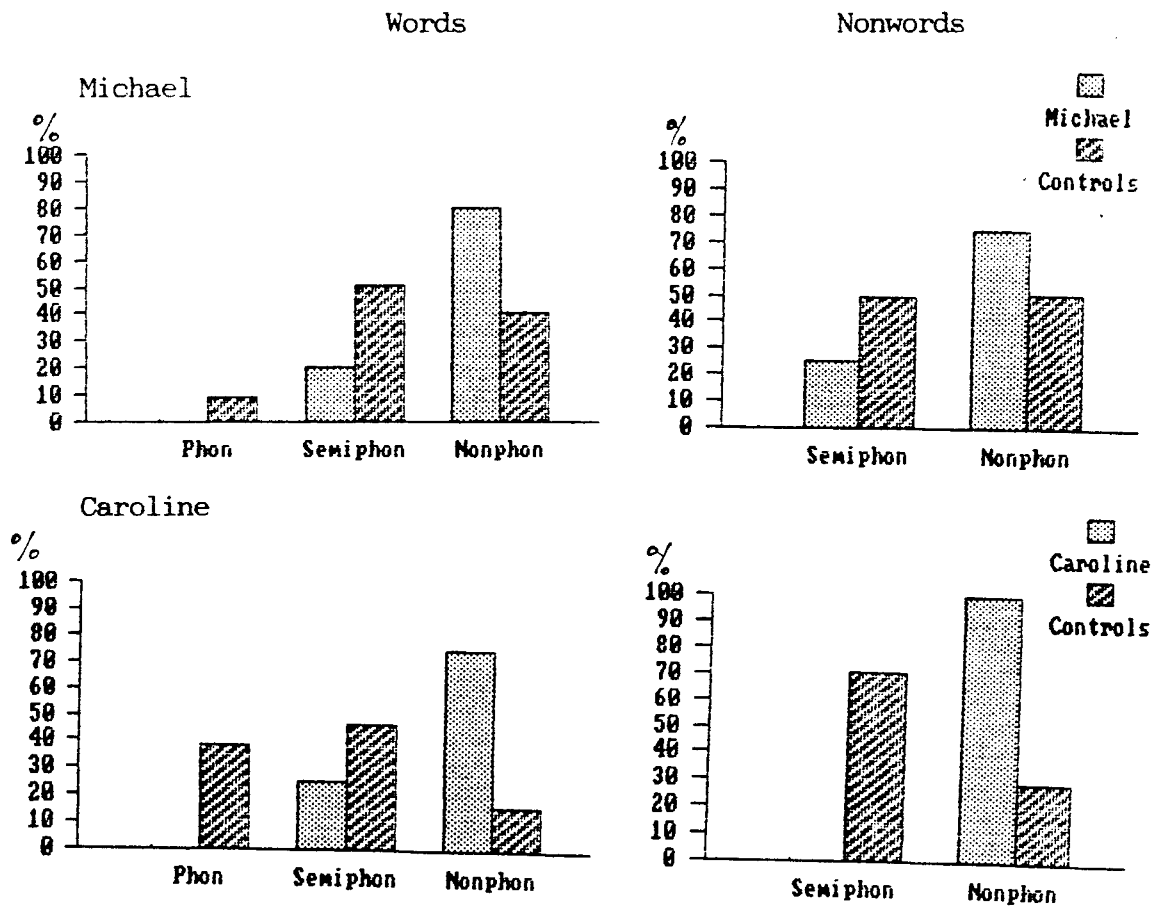
Table 7.7 - Michael and Caroline's spellings at T1 of real and nonwords (+ = correct, - = no response).

Target		Michael		Caroline	
Real	Nonwords	Real	Nonwords	Real	Nonwords
nest	nust	nes	nus	net	bust
spider	spoder	sd	spd	sqied	sankorg
wasp	wesp	wot	west	yeeb	wet
snowman	snimon	sawin in a swmo sowinman swon	son	+	sisdn
bucket	bickut	butg	bk	bant	bittrat
spade	spode	sddin	-	sandig	sbon
crab	creb	cnrp	snlt	crust	tunsang
star	stee	+	sdl	+	stent
kite	koit	citk	cwot	+	-
guitar	gator	gtur	gte	tiptart	dartnsg
basket	beskat	brs	beat bsetcat	beaktelel	bests
pencil	pinsel	pdeplepi	psoun	+	pinsand
chips	chups	+	cttene	+	chod

Qualitative Analysis of Spelling Errors

Since Michael and Caroline's spelling of words was within the normal range, a qualitative comparison of their errors with those of normal spellers was legitimate. The errors shown in Table 7.7 were classified according to their phonetic resemblance to targets. Phonetic, Semiphonetic and Nonphonetic were used in the accepted way and as defined in Chapter 4. Their spelling errors on nonwords were also examined qualitatively although the comparison with normals was made cautiously given the different levels of performance. Plainly a phonetic rendering of a nonword was correct, therefore only two error categories applied in this case (see Figure 7.3).

Figure 7.3 - Michael and Caroline's percentage of phonetic, semiphonetic and nonphonetic spelling errors in words and nonwords at T1 compared with spelling age controls



The majority of Michael and Caroline's spelling errors fell into the nonphonetic category. This was true for the spelling of both real and nonwords. In contrast, normal children of a similar spelling age made primarily phonetic or semiphonetic spelling errors. When spelling nonwords, the beginner spellers had an equal number of semi and nonphonetic spellings but this changed to a semiphonetic bias by spelling age of seven years.

As Michael and Caroline made very few semiphonetic responses, the simple/complex division discussed in Chapter 4 was not pursued. Instead, the nonphonetic errors were scrutinised further to look for similarities and differences between those of the normal and speech disordered children as well as between Michael and Caroline themselves.

Thirty-five percent of Michael's nonphonetic errors were unclassifiable at T1 (PENCIL/pdeplepi, CRAB/cnrp, CHUPS/cttene, CREB/snlt). A further 41% were due to speech and segmentation difficulties (WASP/wot, STEE/sdl). Two of his errors suggest sequencing and speech difficulties (BUCKET/butg; BESKAT/beat, bsetcat) and one error in particular highlighted his segmentation problems in his repeated attempts to tackle the nasal cluster at the beginning of SNOWMAN (sawin, in, a, swmo, sowinman, swon). When the nasal cluster SN was written for him, Michael immediately accessed the correct spelling of the word. There was a similar balance of errors in the nonwords.

Caroline also had unclassifiable errors at T1 in real (33.33%) and nonwords (38.46%). In her real word spelling there were examples of two error types which had not been present in Michael's data: semantic association (SPADE/sandig, WASP/yeeb -

that is, bee backwards) and word components (GUITAR/tiptart). In nonwords, spelling by word components also occurred (KREB/tunsang, GATOR/dartnsg, BIKUT/bitrat, PINSEL/pinsand) and there were examples of articulatory interference (NUST/bust, SPODE/sbon, SNEMON/sison, WESP/wet).

Thus, Michael and Caroline spelled real words at the level to be expected given their spelling age but they had specific difficulty when spelling nonwords. Their spelling errors were qualitatively different from those of normal controls because of the preponderance of nonphonetic errors and there was a suggestion that some of these may have been attributable to segmentation and articulatory deficiencies.

INVESTIGATION 9 - SPEECH AND SPELLING

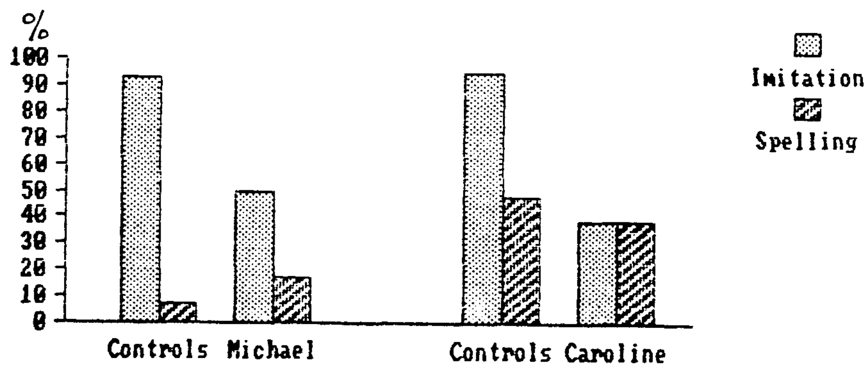
To establish if there was any direct relationship between Michael and Caroline's verbal production and written spelling of words, imitation and spelling performance in the above investigation was examined. In this task, Michael and Caroline had been asked to repeat the target word prior to spelling it (See Appendix 7-7a). A second task followed the procedure reported in Snowling and Stackhouse (1983) and compared the imitation and spelling of simple Consonant-Vowel-Consonant words, for example pop, cat, pet cab, peg (see Appendix 7-7b).

Results and Discussion

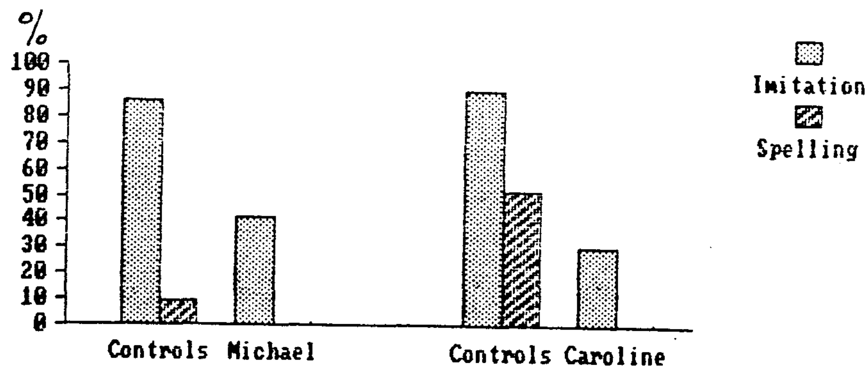
As expected, Michael and Caroline's ability to imitate words was poorer than the normal controls who were at or near ceiling (see Figure 7.4). More importantly there was no direct correspondence between speech and spelling performance. Michael found imitation easier than spelling for both real and nonwords. Caroline imitated and spelled real words equally well but pronounced nonwords better than she could spell them. Neither child spelled nonwords any better if they had or had not pronounced them correctly.

Figure 7.4 - Imitation and spelling of real and nonwords by Michael and Caroline at T1 compared with spelling age controls (% correct).

Real Words

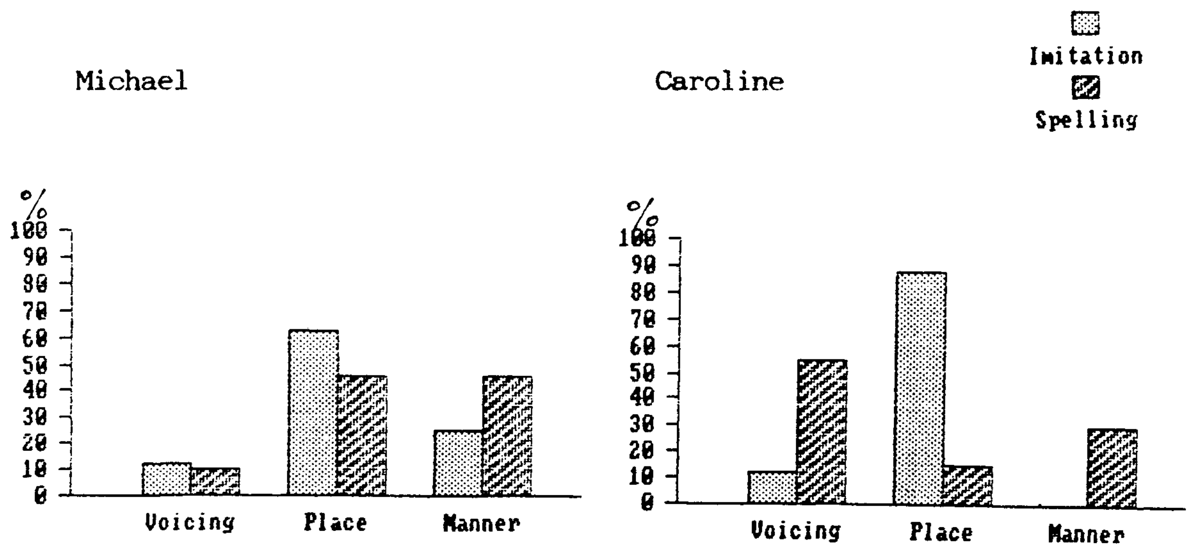


Nonwords



On the second test Michael's imitation and spelling responses were more similar than Caroline's but again there was no direct correspondence between the speech and spelling errors. A qualitative analysis of the speech and spelling errors revealed different errors occurring on imitation compared to spelling (See Figure 7.5). For example, Michael made mostly articulatory place errors when speaking but when spelling, errors corresponded to an equal number of articulatory place and manner changes. Caroline's errors were also predominantly of articulatory place change when speaking but these were in a minority when spelling where voicing errors were the most common.

Figure 7.5 - Distribution (%) of voicing, articulatory place and manner errors in Michael and Caroline's imitation and spelling of CVC words at T1.



Thus, these results support earlier findings that there is no direct relationship between speech and spelling errors in children with serious speech difficulties (Robinson, Beresford and Dodd 1981, Snowling and Stackhouse 1983, Bishop 1985). Graphemic spelling errors do not necessarily reflect phonemic speech errors.

DISCUSSION OF RESULTS at T1

As predicted Michael and Caroline, who both have severe speech difficulties and pervasive phonological processing problems, were found to be arrested at the logographic phase of literacy development (Frith 1985). Although they had received specific and intensive remedial help with phonological skills, they were unable to read nonwords and unless they knew the spelling of a word their spelling errors were primarily nonphonetic.

When compared to low reading age dyslexic children, Michael and Caroline made fewer logographic (visual) errors and more unsuccessful sound attempts when reading. What might explain these data? It could be that the dyslexics have stronger visual skills than Michael and Caroline and therefore they rely upon these more during reading. There seems no particular reason why this should be so.

An alternative explanation could be that the dyslexic children had been able to take advantage of specialist phonics training and as a result had developed some alphabetic skills, albeit at a later age than normally expected. Frith (1985) certainly does not rule this out in her theory. The result might be that the dyslexics are better than Michael and Caroline at using a combination of visual and phonological skills in order to decipher new words. They could also use their consistent articulation to aid their segmentation and blending skills. In contrast, whenever Michael and Caroline attempted to make use of their taught grapheme-phoneme skills, their own phonology sent them awry. Even though individual letters or letter groups may have been sounded correctly, they were unable to synthesise the segments to assemble the appropriate output phonological code. Furthermore, because of their dyspraxic speech difficulties (characterised by variability and groping for sounds) the greater the number of attempts made, the further away from the target the response became.

This faulty "sounding-out" procedure had serious lexical consequences. For example Michael read TASK as "arch", and Caroline read COMMAND as "cabinet", and TEMPER as "chemist". As the children were confident that their responses were correct these words become inappropriately accommodated in the lexicon.

When spelling, Michael and Caroline adopted different strategies to compensate for their difficulties. Michael continued to attempt the taught phoneme-grapheme conversion rules even though this was unsuccessful. Caroline's syllable segmentation strategy preserved the structure of the word even though its segments were inaccurate. Although their recognition of correct spellings was better than their ability to produce these, they were still willing to accept with confidence bizarre errors comprising illegal sound combinations. Thus, their lexical representation must have been affected.

In short, although Michael and Caroline's reading and spelling errors seemed on first consideration to be similar to those of other low Reading Age phonological dyslexics, they were more deficient in their use of phonological strategies. It can be argued that if alphabetic skills are to be used effectively in reading and spelling there are at least three prerequisites. The child must have knowledge of letter-sound correspondences, be able to synthesise (assemble) an output phonological code from individual components, and finally must recognise when the resultant output phonology constitutes a word. Michael and Caroline's difficulties could not be explained by a lack of letter-sound knowledge but they did have difficulties in assembling output phonology and demonstrated an inability to discriminate between real and nonwords. Thus, it is argued that their output phonological difficulties militate against the successful operation of phonological reading strategies and they become arrested within the logographic phase of literacy development.

CHAPTER 8

FOLLOW UP OF CASES AT T2

Frith (1985) suggested that dyslexic children can compensate for their difficulties and breakthrough to the alphabetic phase of literacy development albeit later than in normal development. Indeed, the high reading age dyslexic children of around ten years reported by Snowling, Stackhouse and Rack (1986) had done this to varying degrees. Michael and Caroline were therefore retested four years later during October to December 1986 (T2) to establish if they had developed alphabetic skills. The tasks discussed in Chapters 5 and 6 were repeated to investigate if any improvement in speech, auditory processing, segmentation and lexical development had been made. Their reading and spelling performance was then examined for signs of phonological processing by using the procedures presented in Chapter 7.

At this point Michael was 14 years 6 months and Caroline was 15 years 8 months. Michael had a Reading Age of 7 years 8 months and a Spelling Age of 7 years 9 months. Caroline's Reading Age was 8 years 3 months and her Spelling Age was 8 years 4 months.

SPEECH

The follow up study of Michael and Caroline's articulatory development allowed a within child comparison over time as well as a comparison between them and the normal controls from T1. Both Michael and Caroline had improved their articulation as measured by the Edinburgh Articulation Test (Anthony et al 1971). Michael now attained an Articulation Age of 5 years 6 months and Caroline an Articulation Age of 4 years 9 months. As this meant that Michael was now at the top of the articulatory age range of the normal controls (3:00 - 5:06) and Caroline was above the mean of 4 years and 3 months, the results of the following comparisons are interpreted cautiously.

Michael and Caroline were administered the set of thirty real and nonwords as at T1 (see Chapter 5).

Performance on Imitation, Naming and Continuous Speech Tasks

The number of words correctly articulated were compared with the scores achieved by the normal controls whose data was described earlier (see Appendix 8-1 for Michael and Caroline's responses at T2). Table 8.1 summarises the results.

Table 8.1 - Michael and Caroline's performance at T2 on imitation of real and nonwords, naming of real words and continuous speech conditions (% correct).

	Imitation		Naming	Continuous
	Word	Nonword		Speech
Michael	90	46.7	73.33	46.7
z=	1.6	-0.33	1.04	-0.57
p	<0.05	NS	NS	NS
Caroline	60	56.7	46.67	43.33
z=	0.15	0.27	-0.38	-0.76
p	NS	NS	NS	NS

these was well below the predicted score of 72.[illegible]% (SEm = 12.08), and 7[illegible]% (SEm = [illegible]) respectively. Caroline's performance on the [illegible] [illegible] and on real word naming (46.17%) e[illegible], and 63.12%, SEm = 13.91 respectively). [illegible] children had increased their scores overall between T1 and T2, their profile of strengths and weaknesses remained the same.

Michael's persisting difficulty with the imitation of nonwords cannot be explained by lack of articulatory precision per se since he could imitate and name real words as well as the controls. Rather, breakdown prior to articulation at the level of auditory processing and sound segmentation was indicated. In addition, he made more lexicalisations at T2 than he had at T1 (scarecrow, television, castle, fire engine, crab, star and chips).

Caroline's persisting difficulty was on naming real words. As her imitation of real words was in line with the normal controls it seemed that hearing the target prior to producing it aided her articulatory performance. This suggested that her difficulties were in the generation of consistent motor programmes. Complex errors arose from her repeated attempts to get the word right. This implies that she was aware of the target words but unable to sequence and coordinate her articulatory output. Compared to Michael, there was greater evidence of vocal tract incoordination in her errors which may explain her more variable performance.

Both children still performed most poorly on the continuous speech condition. This may have resulted from a lack of integration or "asynergy" of linguistic and articulatory levels (Crary and Towne 1984). The story-telling task required the children not only to generate articulatory programmes but also to link these with phonology, syntax and semantics. Moreover, producing sentences is more taxing on the articulatory mechanism.

Qualitative Analysis of Speech Errors

The error classification which emerged from the data collected at T2 is presented in Appendix 8-2. A number of errors present at T1 were no longer observed at T2 (see Table 8.2).

Table 8.2 - Michael and Caroline's speech errors (listed in error categories) present at T1 but not at T2.

Syllable Structure	Substitution	Articulatory Coordination	Vowels
Weak cluster reduction	Stopping	Denasal	Intrusive
Cluster replaced by /2/	+ Dental	+ Nasal	Neutralised
Cluster assimilation	Gliding	Nasal emission	
Cluster omission	r/l		
Cluster reversal	nasal/l		
Syllable addition			

At T2 the children were better at producing clusters and coordinating the oral pharyngeal sphincter to control nasalisation in speech. There was therefore evidence of more articulatory maturity at T2. However, error types occurring under the category of Articulatory Coordination at T1 were still present at T2.

To confirm that there had been progress in some levels of speech development but not others, z scores were calculated to describe Michael and Caroline's performance (see Table 8.3).

Table 8.3 - Mean error rate per category in Michael and Caroline's speech at T2.

Error Category		Michael	Caroline
A. Syllable Structure			
	Mean	4.67	5.0
	z	2.57	2.8
	p	<0.005	<0.003
B. Substitutions			
	Mean	1.33	3.33
	z	-0.21	0.44
	p	NS	NS
C. Articulatory Incoordination			
	Mean	2.29	4.29
	z	-0.13	0.43
	p	NS	NS
D. Articulatory Incoordination Affecting Syllable Structure			
	Mean	2.33	8.0
	z	0.83	5.09
	p	NS	<0.0001

In spite of improved Articulation Age both children still had difficulties at the syllable structure level. Their performance on this level was worse than at T1 (cf Table 5.4) when compared with the normal controls. This was particularly true of Michael. However, the number of errors attributable to substitution processes were not significantly different from those of the normal controls. Overall Michael had made more progress on articulatory coordination than had Caroline between T1 and T2. Therefore, although both Michael and Caroline were more articulatorily mature at T2, they still had a problem at a higher programming level which in the case of Caroline was compounded by a lower level difficulty with articulatory coordination. This affected syllable structure in particular. Their improved intelligibility at T2 was related more to general articulatory maturity than to improvement in specific syllable structure planning skills.

Number of Errors per Word

To examine whether Michael and Caroline still made more errors per word than the younger normally developing children matched on articulation age, the same error count procedure as at T1 was carried out (see Appendix 8.3). Table 8.4 summarises these results.

Table 8.4 - Mean number of errors per word made by Michael and Caroline at T2 compared to normal controls.

	Real Words Naming	Real Words Imitation	Nonwords Imitation	Continuous Speech
Controls				
Mean	1.21	1.24	1.28	1.28
Range	1-1.83	0-1.85	0-2	0-1.75
S.d.	0.3	0.36	0.45	0.38
Michael				
Mean	1.38	1.67	1.5	1.19
Sd	0.81	0.59	1.01	0.67
z	0.57	1.19	0.49	-0.23
p	NS	NS	NS	NS
Caroline				
Mean	2.06	1.75	2.1	1.76
Sd	1.35	1.02	1.29	1.17
z	2.83	1.42	1.83	1.26
p	< 0.002	NS	< 0.03	NS

In contrast to T1 (cf Table 5.5), Michael's performance fell within the normal range across all conditions but he did least well on nonword imitation. Caroline again did less well than the controls across all conditions, falling outside of the normal range on all but real word imitation. Therefore, both children had difficulty with the programming of nonwords but in additon Michael showed input phonology/lexical confusions when imitating nonwords. Eight of his responses were lexicalisations (scarecrow, scarf, television, castle, fire engine, crab, star, chips). In contrast, only three of Caroline's responses were lexicalisations (scarf, slipper, fire engine) but her added difficulty with output phonology at the level of articulatory coordination affected her general articulatory performance.

Finally, Michael and Caroline's word specific knowledge was examined by calculating the number of words containing between 0 and 8 errors (see Table 8.5). This showed that there was an even greater difference at T2 compared to T1 between the speech disordered children and normal controls on the number of words that they could produce perfectly well (cf Table 5.6). As at T1, Michael and Caroline produced more words with a multiple error pattern than did the controls.

Although more articulatorily mature by T2, Michael and Caroline's specific speech difficulties had not changed. Syllable structure planning was a persisting problem particularly when new words were being tackled. They still relied on word-specific knowledge to produce words correctly. These findings suggested that Michael and Caroline's persisting speech difficulties were not just the result of an articulatory problem per se but rather they arise at the levels of input phonology, programming and coordination. It follows that there would still be difficulties on auditory and segmentation tasks at T2. Further, any longstanding affect of these deficits on lexical development should be apparent.

Table 8.5 - The number of words containing between 0 and 8 errors produced by Michael and Caroline and the normal controls on each condition at T2 (max = 30). *Lexicalisation responses were omitted from this articulatory analysis

	Number of Errors per Word								
	0	1	2	3	4	5	6	7	8
NAMING									
Controls	-	24	6	-	-	-	-	-	-
Michael	22	7	-	-	1	-	-	-	-
Caroline	14	6	6	2	1	1	-	-	-
WORD IMITATION									
Controls	2	23	5	-	-	-	-	-	-
Michael	27	2	-	1	-	-	-	-	-
Caroline	18	6	3	3	-	-	-	-	-
*NONWORD IMITATION									
Controls	2	23	5	-	-	-	-	-	-
Michael	15	5	1	-	1	-	-	-	-
Caroline	17	5	2	1	1	1	-	-	-
CONTINUOUS SPEECH									
Controls	1	21	8	-	-	-	-	-	-
Michael	14	13	3	-	-	-	-	-	-
Caroline	13	10	2	4	1	-	-	-	-

PHONOLOGICAL PROCESSING

In addition to repeating the procedures carried out at T1, two further investigations were added. The first examined Michael and Caroline's written rhyme production and compared their performance to Reading Age-matched control children. The second tested Michael and Caroline's sound blending skills.

AUDITORY DISCRIMINATION

The complex nonword (ibikus/ikibus) auditory discrimination test administered to Michael and Caroline at T1 was repeated at T2. Both children were at ceiling when detecting same nonword pairs but performed less well when detecting different nonword pairs. On this condition Michael scored 88.9% and Caroline 96.3%. In contrast to T1, both children were better than expected for their reading ages: Michael performed at the level characteristic of Reading Age 8 years and Caroline at an estimated 10 year level. Furthermore, Michael and Caroline performed better than expected for their articulation age on this test.

The children had therefore improved on this test and were near ceiling at T2. Michael made four errors overall. He accepted loathise/loathife, spobe/spode and reket/retek as the same and judged smike/smike as different. He requested repetition of four items which he subsequently got right. Caroline only made one error kirivin/kirivim and only requested repetition of one item. These findings suggest that Michael but not Caroline has some persisting difficulty with input phonology.

LEXICAL DECISION

Given Michael and Caroline's tendency to produce words on the nonword imitation test reported in Chapter 5, the 30 words and their matched nonwords (wasp/wesp, ducks/dacks) from Investigation 3 were randomised and presented auditorily as a lexical decision task. Michael and Caroline were asked to say if they heard a real word or a nonsense word. Michael falsely accepted sixteen of the nonwords, and Caroline falsely accepted six (see Appendix 8-4). To investigate whether Michael and Caroline still had a specific lexical difficulty in the auditory modality compared to reading age matched controls, the word versus nonword lexical decision task presented at T1 was repeated.

Michael and Caroline's scores at T2 were converted to P(A) scores and compared with the normal controls from T1 (see Table 8.6 and cf Table 6.6). Michael and Caroline detected real versus nonwords as well as the normal controls in the visual modality. In contrast, both children performed less well in the auditory modality; Caroline's score being significantly poorer than that of the normal controls.

Table 8.6 - Michael and Caroline's performance on word vs nonword detection in visual and auditory modalities at T2 compared to Reading Age-matched controls (P(A) scores/% correct).

	Reading Age	Visual	Auditory
Controls	7:00-7:10		
Mean		83.89	97.11
Range		38-100	89-100
Michael	7:08		
Score		99	96
z		0.84	-0.34
p		NS	NS
Controls	8:00-9:09		
Mean		97	98.44
Range		88-100	95-100
Caroline	8:03		
Score		98	94
z		0.26	-2.29
p		NS	<0.01

Thus, although Michael's performance on the lexical decision task had improved between T1 and T2, both children presented with a persisting auditory lexical difficulty.

RHYME

RHYME DETECTION

The rhyme detection test comprising semantic and alliterative distractors from Investigation 6 was repeated at T2 in both auditory and visual modalities. Michael made three alliterative errors on the picture presentation of the test and no errors when items were presented auditorily. Although his performance on the picture presentation test was only at Reading Age equivalent of 5 years 10 months, his pattern of errors at T2 was more like the normal controls than at T1 when he had made semantic errors (see Table 6.7). Caroline made no errors in either modality at T2. Thus, both children had made progress with their rhyme detection skills and were at ceiling on this test at T2.

RHYME PRODUCTION

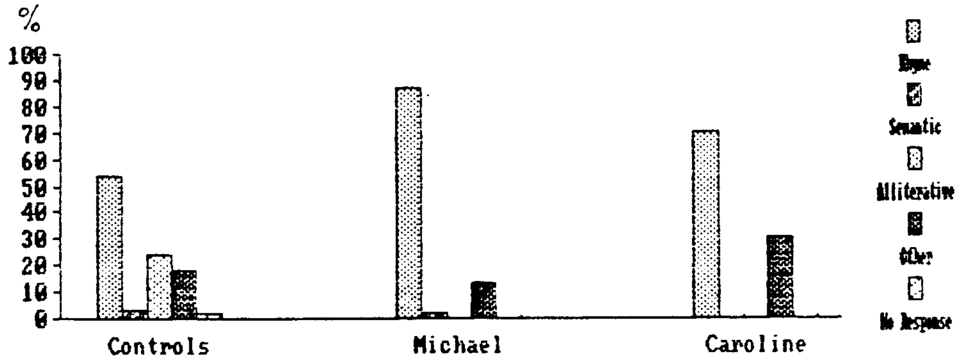
Michael and Caroline were asked to produce rhyming strings to the words presented at T1 (see Appendix 8-5). At T2 the accuracy of their rhyming responses had dramatically increased (see Table 8.7)

Table 8.7 - Percentage of correct first response and of correct total responses made by Michael and Caroline at T2 compared to younger normal children.

	First Response	Total Response
Michael		
% Correct	80	86.67
z	0.9	1.16
p	NS	NS
Caroline		
% Correct	80	69.84
z	0.9	0.68
p	NS	NS

Michael had reduced his overall number of responses and was more like the normal controls in this respect than at T1. He produced an average of 2.25 words per item (z=0.22). In contrast, Caroline had increased her number of responses to an average of 3.15 per item (z=1.0) and she had more difficulty in maintaining a rhyming string than in producing a rhyming word on the first response. Even though both children were better than normal six year olds in their overall number of correct rhyming responses at T2, a qualitative error analysis revealed that their pattern of errors was similar to that at T1 (see Figure 8.1 and cf Figure 6.2).

Figure 8.1 - Histograms to show distribution of rhyme, semantic, alliterative, other and no responses made by Michael and Caroline at T2 compared to normal six year olds.



Unlike the normal children, Michael and Caroline made no alliterative error responses and their predominant error type was "other". This was particularly true of Caroline. Michael only made one semantic error (WOOL/sheep). The remainder of his errors were the result of feature changes (MAP/cat, COMB/moan). He would not always retain the target long enough to produce rhyming strings and was easily distracted by similar sounding lexical items. He had however made progress since T1 and had moved into a "fine tuning stage" of rhyme production.

Caroline's persisting articulatory difficulties, particularly with vowels and semivowels, militated against her producing rhyming responses successfully. For example, groping for articulatory postures was evident in the following: WOOL/wiu, wiulloou, will, dill, bill; IRON/ilen, farlin [filing], narlin [nylon]. The majority of her errors was due to feature change (BED/net, led, reck, ret).

Thus, Michael and Caroline were still experiencing difficulties with rhyme production at T2.

WRITTEN RHYME DETECTION

As at T1, Michael and Caroline were presented with a test sheet of twenty items. Each item comprised three words, two of which rhymed and the third was a distractor. Half of the items were regular (mop map pop) and half were irregular (sew new no).

On this occasion, both children scored better than expected given their reading ages. Michael's score of 85% was equivalent to that expected at Reading Age of 9 years 10 months and Caroline's score of 90% was equivalent to a 10 year 4 month level. Michael and Caroline made no errors on the regular word condition. On the irregular items, Michael scored 70% and Caroline scored 80%. This improvement on the irregular word condition suggested that both children had improved their sight vocabulary - a change which was not reflected in their reading attainment ages at T2, when Michael in particular demonstrated very little change in his reading age as measured by the Schonell reading test.

WRITTEN RHYME PRODUCTION IN NORMAL AND SPEECH DISORDERED CHILDREN INVESTIGATION 6D

To investigate rhyme production further at T2, the children were asked to produce written rhyming strings to the twenty words used in the spoken rhyme production task reported in Chapter 4. The words comprised ten regular (hat, map) and ten irregular (comb, heart) words that were randomly presented in a written list format.

Subjects

Fifty-seven normally developing children (25 boys and 32 girls) comprised the normal sample. The children ranged in age from 7 years to 9 years 10 months. Their Schonell Reading Ages were in the range of 5 years 9 months to 11 years 10 months. All attended the same Birmingham primary school and none were receiving remedial help or speech therapy.

Procedure

The test was administered in the classroom to one quarter of the group at a time. The children were prepared to play a rhyming game. Examples of rhyming pairs and strings to common words were given verbally and then written on the board. The test sheet was handed out to each child and the two practice items were completed one by one with help from the experimenter.

The children were then instructed to complete the test sheet without help. They were told to write as many rhyming words as they could by the side of each word on the sheet. They were not to rush through the items but if they got stuck they should move on to the next word. The sheets were collected in only when everyone had finished (see Appendix 8-6a for data sample).

Four scores were calculated: a) percentage of first response correct, b) percentage of total rhyme responses correct, c) percentage of correct responses on the regular word condition and d) percentage of correct responses on the irregular word condition. In addition, the mean number of responses per item was recorded.

Results and Discussion

The performance of the normal children (as measured by the above four scores) correlated with reading age (see Table 8.8)

Table 8.8 - Spearman's rho correlations between reading age and percentage of correct rhyme responses (normal children).

% Correct	r	p
First response	0.5	<0.01
Total response	0.51	<0.01
Regular Words	0.4	<0.05
Irregular Words	0.54	<0.01

Michael and Caroline's responses are presented in Appendix 8-6b. According to these data, Michael's scores on the first response (60%) and total number of rhyming responses (58.82%) were in line with his actual Reading Age of 7 years 8 months. Separate examination of the regular and irregular word conditions, however, showed that he was far better at producing rhyme strings to regular words (100% correct) than to irregular words (13.04% correct). Michael clearly understood the principles of rhyme and applied them without question. All of his written errors were due to orthographic rather than sound matching (WOOL/dool, lool, bool; FOUR/dour, lour, mour; HEART/deart; IRON/liron).

In contrast, Caroline's performance was above that expected for her Reading Age of 8 years 3 months on all four measures: percentage of first response correct was 75%, percentage of total rhymes correct was 76.36%, percentage of rhyme responses correct on the regular word condition was 94.12% and percentage of rhyme responses on the irregular word condition was 47.62%. Unlike Michael, few of her errors were orthographic matches. She was distracted by the final consonant of the target on two occasions (SHELL/fall, tail; WOOL/loo, do) and produced an intrusive final consonant on another occasion (SEW/bowl). There was a stress confusion (IRON/lion, nylon) and a mixed response of feature change, matching of final and initial consonant on articulatory place, followed by an alliteration (COMB/phone, door, dawn).

Thus, the predominance of orthographic errors in Michael's data suggested that he was relying on visual cues to produce rhyming words rather than attempting sound processing. In contrast, Caroline's errors showed that she was attempting phonological processing although not always successfully. Even on this "silent" test of rhyme production, her problematic speech output affected her performance.

SOUND BLENDING

Another facet of phoneme manipulation is the ability to blend sounds once they have been segmented. Michael and Caroline had long standing difficulties with sound blending and had received extra help with this from both their remedial teachers and speech therapist. Sound blending skills were therefore examined systematically at T2.

Given Michael and Caroline's articulatory difficulties, it was felt important to separate out their ability to blend sounds "silently" and verbally. First, the children were asked to detect the written form of words presented in a segmented form verbally by the experimenter and then later to verbally produce the words from the same segmented stimuli. Second, their verbal sound blending skills on real and nonword stimuli was compared since segmentation of nonwords had proved more problematic for them on earlier investigations.

1. "Silent" vs Verbal Sound Blending

Design and Materials

Twelve single syllable words whose anagrams comprised another real word (pram/ramp, slot/lots) were selected for the silent sound blending task. The children were presented auditorily with the segments of a word (p-r-a-m) and asked to identify the target (pram) from a choice of three written words. One of the distractors was the anagram of the target (ramp) while the other was similar in sound to the target. Six of these similar sounding distractors were the result of changing the vowel in the target to produce another real word (pram/prim, loaf/leaf) and six were the result of changing the final consonant (slot/slop, bowl/bone). The position of the target, anagram distractor and sound distractor was varied across the items. For the production task only the target words were presented for sound blending.

Procedure

Michael and Caroline were presented with the sound blending detection test sheet (see Appendix 8-7). Their attention was drawn to practice item one. They were told that the experimenter would say the sounds of one of the words written in front of them. They were to look carefully at all three words and then to circle the one that the experimenter was saying. Help was given if necessary on the practice items to ensure that the children understood the task. On the test items only one repetition of the stimulus was allowed by request.

The production task was presented on a separate occasion. The children were told to listen carefully to the sounds of a word spoken by the experimenter and then to say the word in full. Again help was given with the practice items and the children were allowed one repetition of the test items by request. The responses were transcribed phonetically at the time and checked with an audio recording later (see Appendix 8-8).

Results and Discussion

On the silent sound blending test Michael made no errors and Caroline only one anagram error involving a nasal cluster (sang/snag). In contrast, both children found the production task difficult. Michael made two errors. One on PRAM where he searched for the lexical item. His first response was that it did not make a word. He then attempted "prom" and "promp". Finally, he informed the experimenter that "we call it a pushchair"! His other error was on SANG when he produced the letter names "S-A-I-M" and pronounced it as "spring".

Caroline scored poorly on the production test. Only one error showed a simple blending difficulty (SENT/s-e-n-t, snet). The remainder were compounded by intrusive articulations and an inability to repeat the target consistently prior to sound blending (LUMP/l-u-l-p, lup; POTS/poter, potsel; SANG/s-a-zn-g, sigger, slag). Furthermore, her inaccurate articulations militated aginst successful lexical access (BUST/b-u-s-t, busst, basket). Table 8.9 summarises Michael and Caroline's performance on the "silent" and verbal sound blending subtests.

Table 8.9 - Michael and Caroline's performance on silent detection and verbal sound blending of one syllable words at T2 (% correct).

	Detection	Production
Michael	100	83.33
Caroline	91.67	41.67

Thus, both Michael and Caroline understood the principle of sound blending but were unable to blend sounds verbally into words because of articulatory difficulties. As might be predicted given her performance on earlier articulatory tasks, verbal sound blending was particularly difficult for Caroline. Furthermore, as her faulty articulation often caused her to access a different word from the target, a lexical difficulty was occurring.

Word and Nonword Sound Blending

Design and Materials

In the first of these tasks, the children were asked to produce two and three syllable real words and nonwords in response to the experimenter's production of their segmented syllable form (tea-cher, po-ta-to). The real words were familiar to the children and the nonwords were devised by changing the consonants but keeping the stress pattern of the real word (pea-sher, bo-ka-ko). there were six words per condition (real words and nonwords of 1 and 2 syllables) giving a total of 24 test items (see Appendix 8-9a).

Second, the children were asked to produce single syllable words to the experimenter's production of their segmented sound form (g-o, p-e-n). The words contained between two and five sounds and the four and five sound condition involved consonant clusters (plate, stamp). The nonwords were devised by the same procedure as above (ko, sen, klate, spamp). There were six words for each condition (real words and nonwords of 2, 3, 4 and 5 sounds) giving a total of 48 test items (see Appendix 8.9b).

Procedure

Michael and Caroline were prepared to hear the experimenter say "bits of a word" and then they were to produce the word in full. They were told that some of the words would be real words and that some would be nonsense words. At the beginning of each condition they were told if the following six words would be real or nonsense. Real and nonword conditions were alternated. The responses were transcribed in phonetic script at the time and checked with an audiorecording later (see Appendix 8-9b).

Results and Discussion

In the syllable blending tasks, Michael and Caroline synthesized real words easily but they had specific difficulty when required to blend nonwords (see Table 8.10).

Table 8.10 - Michael and Caroline's performance on syllable blending of real and nonwords at T2 (% correct).

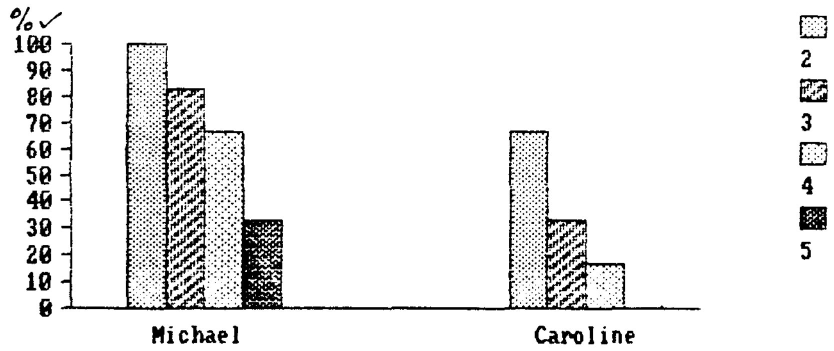
	Two Syllables		Three Syllables	
	Real Words	Nonwords	Real Words	Nonwords
Michael	100	33.33	100	16.67
Caroline	100	33.33	100	33.33

A specific difficulty with nonwords was also evident in the sound blending condition (see Figure 8.2). Michael achieved some success blending 2-4 sounds into real words but performed less well on nonwords. Caroline was particularly poor on this task and was therefore not given the 5-sound condition. Blending simple nonwords was tortuous for her and she was hampered by articulatory inconsistencies (FUP/fekup, fe-up, ferp-up, ferp an up, ferp). Her variable articulation resulted in accessing a number of lexical possibilities in the real word condition (SWEEP/sweet, swert, squawk, sheep; LAMP/lock, lam, lap, lamb, lamp).

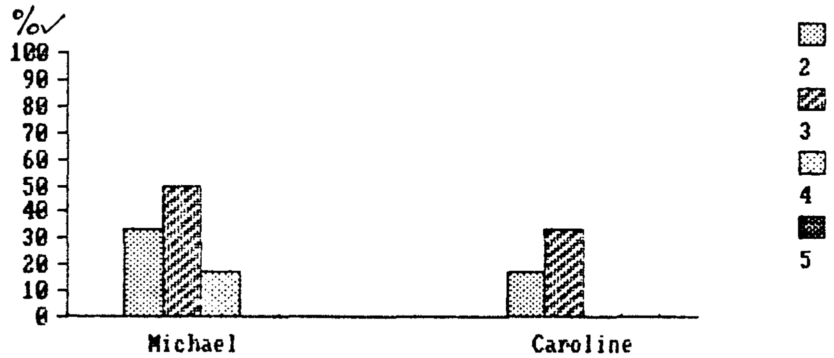
In summary, both Michael and Caroline experienced difficulties at the level of sound rather than syllable blending. Moreover, their difficulty was most pronounced when nonword blending was required. Furthermore, their errors had lexical repercussions in that words other than the target were accessed as a result of their articulatory difficulties. This was particularly so in the case of Caroline.

Figure 8.2 - Michael and Caroline's performance on sound blending of words and nonwords of increasing length (2-5 sounds) at T2 (% correct).

Real Words



Nonwords



In summary, the investigations of Michael and Caroline's phonological processing at T2 confirmed that they were still unable to tackle unfamiliar material such as nonwords in the auditory modality particularly when a verbal response was required. Overall, they performed up to or above their reading ages on real word tasks presented within the visual modality. They had specific difficulty with sound segmentation and blending tasks which affected the successful analysis and assembly of novel material for which they had no well practised motor pattern. Furthermore, they were unable to take advantage of lexical facilitation on this task because they lacked specificity of phonological representations. This specific difficulty was further hampered by an attentional deficit in Michael's case. Caroline was more at risk for a lexical difficulty because her inconsistent articulatory output led her away from the target. Given these findings it is predicted that Michael and Caroline will have developed minimal alphabetic skills for reading and spelling.

READING SKILLS

Letter Knowledge

At T1 it was noted that Michael and Caroline had difficulty with letter sounds on a grapheme-phoneme conversion task. As this difficulty may have been compounded by their articulatory problems particularly in consonant blends, it was decided to compare their "silent" and verbal performance on this task. For the "silent" task, that is phoneme-grapheme conversion, letter names and sounds were given verbally to the children for them to transcribe (see Appendix 8-10).

Both children were perfect at transcribing letters when given their letter names verbally by the experimenter. When asked to name letters from a sheet of graphemes, Michael only made one error and Caroline was perfect. However, they still had difficulties with letter sounds. Michael produced 20/26 letter sounds correctly from the grapheme presentation but could write 25/26 to dictation. The opposite pattern occurred with consonant blends - he verbally produced more (18/24) than he could write down (9/24). In fact, he did not transcribe any three element blends, for example "spl". Caroline produced 19/26 letter sounds correctly and wrote 22/26 to dictation. In contrast to Michael, she was able to write down more consonant blends to dictation (18/24) than she could produce verbally from grapheme presentation (12/24). Table 8.11 summarises the results.

Table 8.11 - Michael and Caroline's performance on verbal production of letter names and sounds from the letter stimulus (grapheme-phoneme conversion) and on written production following a verbal stimulus (phoneme-grapheme conversion) at T2 (% correct).

	Letter Name	Letter Sound		
		Single	CC blend	CCC blend
Michael				
Grapheme->Phoneme	96.2	76.9	84.2	40
Phoneme->Grapheme	100	96.15	47.37	0
Caroline				
Grapheme->Phoneme	100	73.1	52.6	40
Phoneme->Grapheme	100	84.62	84.21	40

The results are in keeping with previous findings. Neither child is proficient at abstracting sounds from letters. Michael's input phonology and sound segmentation difficulties prevent him from analysing consonant blends when verbally presented for dictation even though he is able to write down single sounds successfully. Caroline's persisting difficulties with output phonology militate against her producing accurate verbal responses on the grapheme-phoneme conversion task.

Reading Strategies

Michael and Caroline were again asked to read the 31 regular, 31 irregular and 31 nonwords presented at T1 (see

Appendix 8.11 for data corpus). At T2 the regularity effect was apparent (see Table 8.12). Michael and Caroline's performance was not significantly different from that of the controls (range 7:0 to 7:3).

Table 8.12 - Michael and Caroline's performance on tests of regular and irregular word reading at T2 compared with Reading Age controls (% correct).

	Regular	Irregular	Regularity Effect
RA Control			
(7:0-7:3)	55.65	31.45	24.2
Range:	29.03-90.32	9.68-70.97	
Michael	48.14	25.8	22.34
z	-0.4	-0.34	
p	NS	NS	
Caroline	70.37	48.38	21.99
z	0.81	1.01	
p	NS	NS	

By T2, Michael and Caroline were able to read some nonwords. However, Michael did less well than Reading Age controls although Caroline's performance fell within the normal range (see Table 8.13).

Table 8.13 - Michael and Caroline's nonword reading at T2 compared to Reading Age controls (% correct).

	One syllable	Two syllable
RA/Control:	49.9	29.75
Range:	16-84	0-75
Michael:	26.32	16.67
z	-1.24	-0.54
p	NS	NS
Caroline:	57.89	41.67
z	0.42	0.5
p	NS	NS

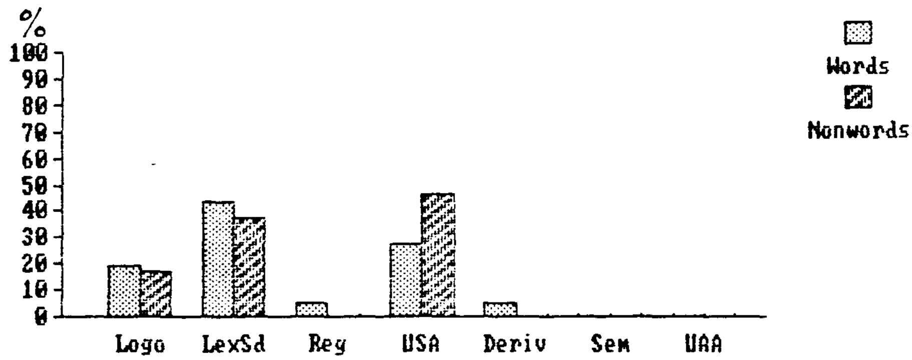
Thus, in the four years that had elapsed between T1 and T2, Michael had developed some alphabetic skill. However, his ability to read nonwords was still much worse than that of reading age matched controls. Caroline had done somewhat better and her nonword reading was in line with her reading age level.

Qualitative Analysis of Reading Errors

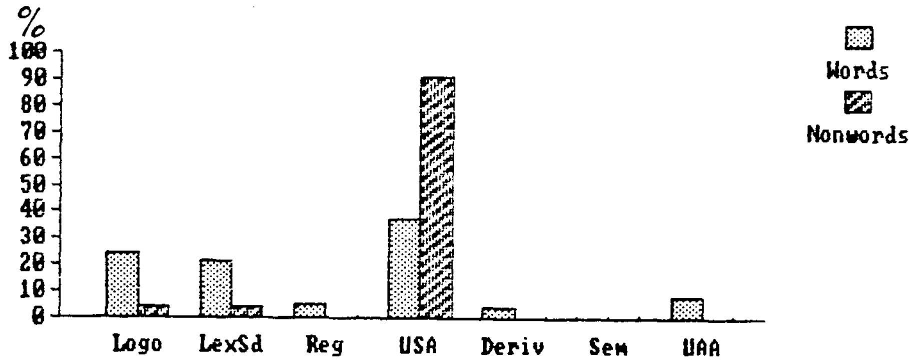
Michael and Caroline's reading errors were classified as at T1. Results are shown in Figure 8.3 for comparison with Figure 7.1. Taking Michael's word data first, it can be seen that the majority of his errors, some 62.1%, were still visually based. However, fewer were logographic than at T1 (ORGAN/orange, BOWL/blow) and a greater number fell into the lexical sounding category suggesting use of lexical analogies (SPADE/spaghetti or spam, TONGUE/tonight). Importantly, the proportion of unsuccessful sound attempt errors had slightly decreased (CASK/[kas 'katʃ 'kɒts] ; BREATH/[brɛf 'britʃ brɛdʒ]). Finally, two of Michael's errors were regularisations (GLOVE/ [gləʊv] , SHOVE/[ˈʃəʊfə]) and two were derivational (FILM/films, BISCUIT/biscuits).

Figure 8.3 - Distribution of Michael and Caroline's reading errors at T2 (Logo - Logographic, LexSd - Lexical Sounding, Reg - Regularisation, USA - Unsuccessful Sound Attempt, Deriv - Derivation, Sem - Semantic, UAA - Unsuccessful Analogy Attempt).

Michael



Caroline



Caroline made a similar number of visually based errors at T2 as at T1. (44.5% vs 39.2%). However, at T2 all of her visual errors were on irregular words. She no longer made a greater number of unsuccessful sound attempts (GLOBE/[kəˈlʌb kəˈlɒb] , COLONEL/[klɒk ˈklʌk kləˈnu]) than visual errors (logographic - DOVE/drove, THIMBLE/tumble; lexical sounding - TONGUE/tangerine, STEADY/staring) suggesting an improvement in her use of grapheme-phoneme correspondences. She also produced two regularisations (LOSER/loss, losser; WAND/rand) and one derivational error (MIXTURE/mix, mixt). There were no semantic errors and her unsuccessful attempts at analogy were also reduced (ORGAN/[ɒrɪ̃ʒ], not orange but [ɔʒɪn]; LETTUCE/letter, not letter, [lɛtr̥ 'lɛtrɪs]).

Turning now to the attempts made to pronounce nonwords, the majority of Michael's errors (55.76%) were lexicalisations. For example, he read RASK as risk, SWAD as swan, DRINCE as darts, and KISCUIT as kissed. In contrast, Caroline only made two lexicalisations; DRINCE/dice, SPAKE/spike). The majority of her errors (over 90%) were unsuccessful sound attempts (URGAN/[hʌn'græn'hæŋgræn], PEMON/[pæm pæb], SOSER/[səʊz̥ 'səʊhə'səʊzz̥], WOLT/[wʊf'wʊfɪstə'wʊftɒd]).

These data were compared with the errors made by the low Reading Age dyslexic children studied by Snowling, Stackhouse and Rack (1986). Michael's performance was more like that of the dyslexic children than was Caroline's. His 62.1% of visual errors were similar in number to those made by the dyslexics (69%-75%) and he made a similar number of unsuccessful sound attempts (25%-29%) too. In contrast, Caroline still made fewer visual errors than the dyslexics (44.5%) but a greater number of unsuccessful sound attempts than their 37.5% even though her Reading Age was actually above that of the children who comprised this comparison group.

Thus, Michael had reduced the number of unsuccessful sound attempts he made between T1 and T2. This may be associated with his improved articulatory performance.

However, because of a lack of alphabetic competence he needed to rely on visual skills to support his reading and spelling. The predominance of visually based errors may be the result of an overloading of his visual system. Caroline's fewer visual errors suggested that she was not as reliant as Michael on visual skills for reading but her persisting articulatory groping for targets prevented successful synthesis of unfamiliar words.

Silent Reading Tests

Coltheart's (1980) homophone matching test was readministered at T2. Again Michael performed at chance level on this test but Caroline had improved to a 70% accuracy level on both real and nonwords. These results suggest that Michael was still unable to use phoneme-grapheme rules but Caroline, in contrast, had improved her phonological processing skills even though her articulatory difficulties were more severe than Michael's at T2.

In summary, follow up after some four years revealed only a slight improvement in Michael and Caroline's alphabetic skill when reading. The improvement was greater in Caroline's case; she could read nonwords to some extent and applied phonic knowledge in a silent reading test. Michael's use of alphabetic skills had improved less; he continued to use visual strategies when reading, his nonword reading remained poor and he made predominantly visual reading errors. On the basis of these results it was predicted that Caroline's ability to spell phonetically would have progressed more than that of Michael.

SPELLING SKILLS

Syllable Length

The one, two and three syllable real words from T1 were readministered (see Table 8.14 for error corpus). Both children were now perfect at transcribing the initial consonant of the words but still had difficulties representing the correct number of syllables. Caroline made the most improvement on the former (only 76.7% correct at T1) and Michael on the latter. He represented the correct syllable structure 57.9% of the time (compared to 45% at T1).

At T1 it had been more fitting to compare Michael and Caroline's performance with the low Reading Age dyslexics (see Table 7.5) reported by Snowling, Stackhouse and Rack (1986), but on this occasion their performance was more in keeping with that of Reading Age-matched controls in terms of accuracy. However, qualitative differences still emerged. Table 8.15 shows the number of words spelled correctly, phonetically and nonphonetically. In contrast to the normal controls, Michael and Caroline's spelling errors were predominantly nonphonetic with the exception of one of Michael's attempts which was phonetic (COLLAR/koler). As at T1 very few of their errors fell into the immature category. Michael made three of these (BUMP/bup, PUPPY/pupe, POLISH/plish) and Caroline made two (POLISH/plash, COLLAR/cl).

Table 8.14 - Michael and Caroline's spellings of one, two and three syllable words at T2 (+ = correct).

Syllables	Michael	Caroline
One:-		
pet	+	+
lip	+	+
cap	+	+
fish	+	+
sack	+	+
tent	+	tenret
trap	+	+
bump	bup	+
nest	+	nets
bank	bark	+
Two:-		
apple	+	+
puppy	pupe	puppus
packet	pack	+
trumpet	tuper	trump
kitten	cipt	+
traffic	traffer	+
collar	coler	cl
tulip	+	trumlup
polish	plish	plash
finger	fling	+
Three:-		
membership	miship	+
cigarette	sicerk somke	cigettare
catalogue	catlong	+
September	septmber	+
adventure	Addever	atforch
understand	under stand	unstander
contented	contenter	ktened
refreshment	read fash me	refreshed
instructed	intaimp	instaranded
umbrella	urmpt	umburan

Table 8.15 - Number of words (max=10) spelled correctly (C), phonetically (P) and nonphonetically (NP) in 1, 2, and 3 syllable words by Michael and Caroline compared to Reading Age controls.

	One Syllable			Two Syllable			Three Syllable		
	C	P	NP	C	P	NP	C	P	NP
Michael:	8	0	2	3	1	6	1	0	9
Controls: (6:11/7:5)	7.75	2.45	1.58	1.83	4.42	3.75	1.42	1.33	7.25
Caroline	8	0	2	5	0	5	3	0	7
Controls: (8:3)	8.62			6.5			3.57		

Michael's nonphonetic errors were not as perseverative as at T1. This time he reduced syllables (CIGARETTE/sicerk, MEMBERSHIP/miship, UMBRELLA/urmpt), had sound intrusions and substitutions (FINGER/fling, BANK/bark) and again transcribed exaggerated articulation of sounds during the segmentation process by "er" (CONTENTED/contenter, TRAFFIC/traffer, TRUMPET/tuper). He also adopted the strategy used by Caroline at T1 of spelling by word components. He did this on three occasions (CATALOGUE/catlong, ADVENTURE/addever, REFRESHMENT/read fash met).

Caroline, however had abandoned this word-component strategy completely by T2. She reduced syllables (TRUMPET/trump, UMBRELLA/umburan), and had sound intrusions (PUPPY/puppus, TULIP/trumlip), substitutions (ADVENTURE/atforch, REFRESHMENT/refreshed) and omissions (CONTENTED/ktend). Unlike Michael, she added syllables on two occasions (TENT/tenret, INSTRUCTED/instarended), and had sequencing difficulties (NEST/nets, CIGARETTE/cigettare, UNDERSTAND/unstander).

Thus, Michael and Caroline had improved their spelling to some extent but they remained deficient in the use of phonological strategies.

Orthographic Representation

Michael and Caroline were again presented with a test of recognising correct spelling versus their own spelling errors (see Appendix 8-12). Michael had perfect recognition of one and two syllable words but was still at chance on three syllable words (50%). He accepted his own error as correct on three occasions (REFRESHMENT/readfashmet, CATALOGUE/catlong, CONTENTED/contenter) and a phonetic spelling on two occasions (CIGARETTE/siguret, UMBRELLA/umbeller). Caroline was perfect on one and three syllable words but accepted two of her own errors on two syllable words (TRUMPET/trump, TULIP/trumlip).

Although both childen had improved, they were still accepting errors as correct indicating that they were not able to monitor their spelling performance particularly on longer words. They showed a persisting dissociation between recognition and production skills which is not typical of normal development (Bradley and Bryant 1979, Frith and Frith 1980).

Regularity

Michael and Caroline were asked to spell the regular and irregular words that they had read correctly at T2 (see Appendix 8-13). Michael spelled 23% of the regular words and 50% of the irregular words correctly. In contrast, Caroline spelt more regular words (63.2%) than irregular words (40%) correctly. This regularity effect in Caroline's performance suggested that unlike

Michael, she was able to use and take advantage of phoneme-grapheme conversions.

Thus, these findings support the notion that even at T2 Michael was able to use very little alphabetic skill. He was more reliant on word-specific information than was Caroline who showed a normal regularity effect.

Lexicality

The spelling of words and nonwords was repeated at T2. This time Michael and Caroline were able to attempt all of the items. The data are presented in Table 8.16. Michael's spelling of real words had not improved between T1 and T2 (cf Table 7.7). He scored 13.3% at T2 compared to 16.7% at T1. This made his performance roughly equivalent to a Spelling Age of 6 years 7 months. In contrast, Caroline had improved her spelling of real words from 38.5% to 63.3% giving her a Spelling Age equivalent of 10 years 1 month. It was still the case that neither child could spell nonwords. Michael's one correct spelling (wesp) may have occurred by chance and Caroline again scored zero in spite of her improved real word spelling ability.

Qualitative Analysis

To examine qualitative changes in their spelling strategies, the data was examined further for initial and final error transcription and syllable structure (see Table 8.17). Michael had difficulties on real and nonwords while Caroline's main problem was with nonwords indicating that she was accessing her representation of real words for spelling more efficiently than

Michael.

Table 8.16 - Michael and Caroline's spellings of words and nonwords from Investigation 2 at T2 (+ = correct).

Real Words	Michael	Caroline	Nonwords	Michael	Caroline
nest	+	+	nust	nat	nesit
spider	+	+	spoder	spode	spode
wasp	wars	weep	wesp	+	swipt
ducks	drus	+	dacks	deas	duciks
biscuits	bisecet	biscults	baskoits	bast	baskat
snowman	+	+	snimon	sned	sumiy
scarecrow	scerwar	scracrow	scercray	scercower	scrowcrak
scarf	seerfary	+	scarth	scerful	scraps
slipper	spely	+	slepper	sitp	slopper
caravan	cavan	carvan	cirivin	carvain	kavon
television	televistian	+	tolovusion	televintion	tolevision
dragon	drager	+	drigon	drugeds	grodon
treasure	trase	treseasure	trisure	teued	troeaser
castle	castter	caslter	custle	catter	kaslte
fireengine	firenegel	firengian	farangine	firenigtg	forengian
bucket	bug	+	bickut	biup	bitup
spade	spad	+	spode	spoud	scop
crab	crab	crub	creb	carde	craup
star	stair	+	stee	steel	skir
kite	kit	+	koit	cout	clat
burglar	bulg	brubge	barglee	bulle	brelev
rocket	Rock	+	recket	relt	recokn
guitar	grilter	guilte	gator	gart	gadin
rollerskate	Rolls	rolly skate	rallyscote	relleral	wrast
motorbike	morthbicye	+	mitiboke	imbout	bibota
basket	bastit	+	beskat	bastcat	bscuk
pencil	penil pecnil	+	pinsel	pieint	pencil
chips	chirp	+	chups	chush	chislp
chocolate	choctlik	+	chicilote	shillops	ckulop
orange	orangr	+	erange	ellamsh	eran

Table 8.17 - Michael and Caroline's transcription of initial consonants, final consonants and syllable number in words and nonwords at T2 compared to a Spelling Age control of mean 8:4 (range 7:8 to 9:0) (% errors).

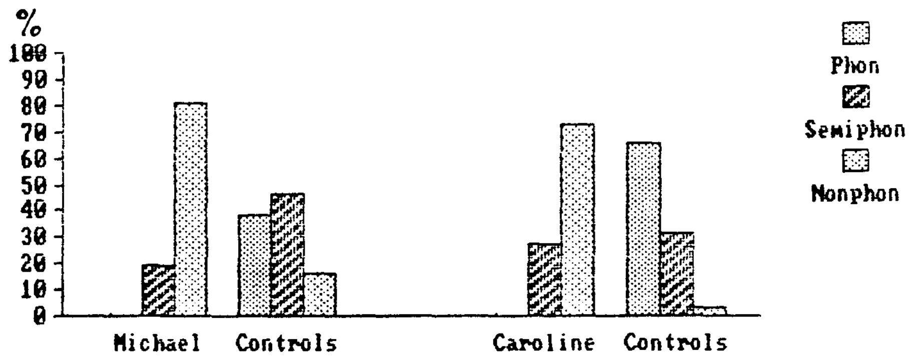
	Michael	Caroline	Controls
Initial Consonant			
Real word	0	0	0.83
Nonword	6.9	16.67	0
Final Consonant			
Real word	57.69	18.18	0.83
Nonword	68.97	63.33	3.33
Syllable Number			
Real word	19.23	9.09	1.11
Nonword	48.28	16.67	2.94

To establish if Michael and Caroline had moved into a different phase of spelling development at T2, their errors were classified into phonetic, semiphonetic and nonphonetic (see Figure 8.4). The trend in the pattern of their errors was identical to that seen at T1 (cf Figure 7.3): no phonetic errors, few semiphonetic and a majority of nonphonetic spellings. Even in normal beginner spellers, nonphonetic errors were not the most dominant and phonetic spelling was emerging. Michael and Caroline have therefore increased their spelling age on standardised tests, albeit little, without improving alphabetic spelling skills.

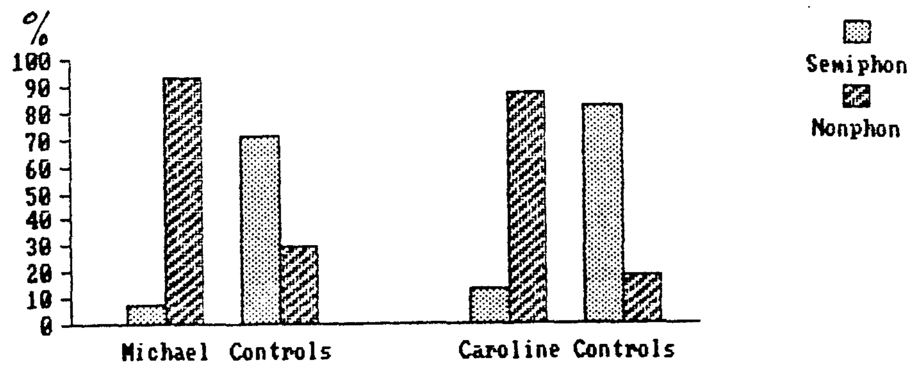
Qualitatively, only one of Michael's nonphonetic renderings for a real word was unclassifiable (SCARF/seerfary) but on nonwords the largest error subgroup (33.33%) defied analysis (MITIBOKE/imbout, CHICILOTE/shillops). Sequencing errors

Figure 8.4 - Percentage of Michael and Caroline's Phonetic, Semiphonetic and NonPhonetic spellings in real and nonwords at T2 compared to spelling age controls.

Real Words



Nonwords



dominated (28.57%) his word spelling (SLIPPER/spely, BURGLAR/bulg) but these were few (7.41) in his nonword spelling. Sound deletion was common in both word (19.04%) and nonword (22.22%) spelling (NUST/nat) but syllable deletion was more common in word (19.05%) than nonword (7.41%) spelling (CARAVAN/cavan, ROCKET/rock). Sound substitutions were also common in both word (19.05%) and nonwords (14.82%), for example TREASURE/trase, REKET/relt.

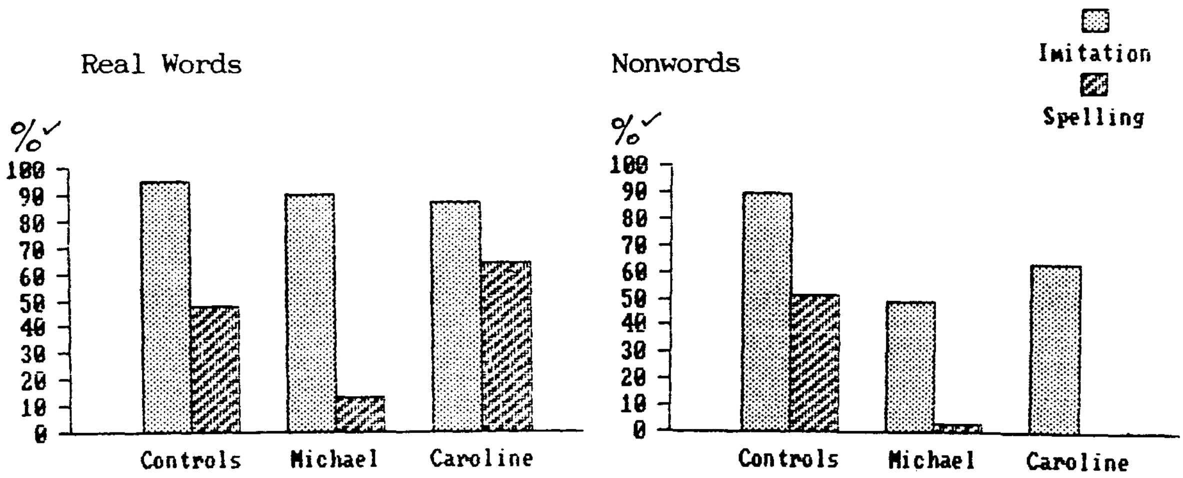
At T2, Caroline only made one "word-component" spelling error (SKERCRAY/scrowcrack). Only one word (BURGLAR/brubge) and three nonwords were unclassifiable (SNIMON/sumiy, BARGLY/brelev, MITIBOKE/bibota). The majority of her errors on words had intrusive sounds (TREASURE/treseasure, BISCUIT/biscults, SCARECROW/scracrow). Nonword spelling errors comprised sequencing difficulties (DRIGON/grodon), intrusive sounds (KOIT/klat), or a combination of these (WESP/swipt, CHUPS/chislp). Syllable and sound deletion (KIRIVIN/kavon, BASKOITS/baskat) as well as sound substitution was noted (BIKUT/bitup, GATOR/gadin).

Thus, the total absence of phonetic spelling in the errors collected from Michael and Caroline and the persisting tendency to make nonphonetic errors indicated a serious phonological disability. However, their level of spelling performance (the number of words they could spell) had increased in absolute terms. This suggests that Michael and Caroline were following an atypical course of development and not progressing through the normal phases of spelling development based on the development of alphabetic skills. They could either access word-specific spellings or not. When they could not, they were unable to use phonological strategies for spelling and therefore their attempts were different from younger normally developing children.

Speech and Spelling

The imitation and spelling responses produced to the targets mentioned above were analysed as at T1 (see Appendix 8-14). Michael imitated the real words better than at T1 but showed no improvement when spelling these. There was minimal improvement in his imitation of nonwords and he was only able to spell one nonword. Caroline improved both her imitation and spelling of real words. However, her improved nonword imitation did nothing to improve her spelling of nonwords (see Figure 8.5).

Figure 8.5 - Histograms showing Michael and Caroline's imitation and spelling of words and nonwords at T2 compared to Spelling Age controls (% correct).



Thus, improvement in articulatory performance particularly in the case of Michael was not reflected in improved spelling performance. There is no evidence to support a one-to-one relationship between speech and spelling errors in speech disordered children.

DISCUSSION OF RESULTS AT T2

Between T1 and T2 there had been an improvement in the speech of both Michael and Caroline. Michael was now quite intelligible although Caroline continued to display variability in her speech output. This may have accounted for her greater difficulty with auditory processing tasks, in particular, auditory lexical decision, rhyme production and blending. Michael did better on these tasks although neither his rhyme production nor blending was normal. Importantly, Michael and Caroline still depended on word-specific knowledge in order to produce words correctly. Their persisting multiple error pattern on words that they could not pronounce suggested a specific difficulty in assembling the motor programme for articulation.

Both children showed improvements in reading and spelling by standardized tests. However, they still had specific reading and spelling problems. Qualitatively, Michael used primarily direct visual reading strategies and his nonword reading remained impaired. Interestingly, Caroline had made more progress than Michael in both word and nonword reading. It could be argued from these data that both children had made some progress to the alphabetic phase of development. However, both continued to make unsuccessful sound attempts and this was particularly true of Caroline's nonword reading. An alternative explanation therefore is that the children accomplished what they did, not by the successful application of grapheme-phoneme rules, but by the use of lexical analogies (Glushko 1979). According to this argument, Caroline was more accurate than Michael because she could draw upon a larger number of representations within the visual-input lexicon. Reading by analogy however, is still partially dependent on sound processing skills (Ehri 1985) and in particular sound segmentation. Given Michael and Caroline's defects in this area, this strategy cannot be fully successful for them.

Turning to spelling, improvements in word-spelling were not matched by an increase in the ability to spell nonwords.

Moreover, a preponderance of nonphonetic spelling errors confirmed that the children had serious difficulty with phoneme segmentation and phoneme-grapheme transcription. In all likelihood, when they produced correct spellings this was by accessing word-specific spelling information within the graphemic-output lexicon. This mirrors their articulatory performance discussed above. When Michael and Caroline cannot say or spell a word, they do not have the phonological skill to assemble it for speech or spelling.

Thus, Michael and Caroline remained unable to use alphabetic reading and spelling strategies at T2. In this regard, they resembled phonological dyslexics although when compared to such children, their phonological impairments were more serious. Michael and Caroline had proved to be resistant to a phonic teaching regime; even though they had learned isolated grapheme-phoneme conversion rules, they were unable to apply these in reading and spelling because of the persisting speech, segmentation and blending difficulties. It can be argued that Michael and Caroline's pervasive phonological difficulties, compounded by articulatory inconsistency, were preventing the normal development of reading and spelling skills. As a result of these difficulties they have become "trapped" within the logographic phase of literacy development.

CHAPTER 9

RELATIONSHIP BETWEEN SPOKEN AND WRITTEN LANGUAGE DEVELOPMENT AND DISORDER

Two cases of children with Developmental Verbal Dyspraxia and Phonological Dyslexia have been presented within a developmental framework. These children were shown to have pervasive phonological difficulties affecting their speech, segmentation, reading and spelling processes. When first tested, their speech was unintelligible and they were subject to a range of deficits on auditory processing tasks: they had difficulties discriminating sequences of phonemes, categorising sounds and rhyming. They also had significant difficulty discriminating between words and nonwords in lexical decision. In the light of these deficits, it was not surprising that Michael and Caroline experienced reading and spelling problems. Despite intensive help with phonemes, they remained uncertain about letter-sound correspondences and they were unable to use these to read or spell unfamiliar words. According to Frith (1985), they were arrested within the logographic phase of literacy development.

It can be argued that the children's failure to make the transition to the alphabetic phase for spelling was, at least in part, a result of their speech problems. Certainly, there were some words which the children could spell automatically at both T1 and T2. However, their attempts to spell words which they did not know were nonphonetic. They were unable to make the necessary step of segmenting these prior to phoneme-grapheme translation

(Frith 1980). Moreover, their spelling attempts contained intrusive sounds, perseverations and substitutions as did their speech. Although there was not a one-to-one correspondence between speech and spelling errors, the same underlying deficits affected speech and spelling.

In the face of their difficulties, the children were adopting different strategies as a result of the interplay between their strengths and weaknesses (Snowling 1987, Seymour 1987). Michael persevered in using the strategy of "spelling-by-sound" even though this was ineffective for him. In contrast, Caroline was attempting to spell words using a strategy which avoided phoneme segmentation. This strategy has been described as "spelling-by-word-components". It was particularly noticeable when she attempted three syllable words. Essentially, Caroline appeared to be segmenting words into syllables and then translating these into spellings by reference to whole words, the spellings of which she knew, for example CIGARETTE/silonwet, REFRESHMENT/withfirstmint. A similar strategy was used by T.W., one of the dyslexics described by Snowling, Stackhouse and Rack (1986). However, in general, Michael and Caroline's spelling difficulties were much more serious than those of the phonological dyslexics who did not have speech problems.

Michael and Caroline's reading was also more impaired than that of the dyslexics with which they were compared. When presented with words and nonwords, they made a higher percentage of unsuccessful sound attempts and fewer visual errors. In fact, Michael and Caroline had several difficulties which militated against their successful use of alphabetic skills. Like other dyslexics, they were uncertain of grapheme-phoneme correspondences but, in addition, they had significant problems with blending skills. Moreover, when they did succeed in synthesizing a "pronunciation" from the individual letter sounds of a printed word, it was unlikely that they could decide whether or not it was a plausible rendering of the word because of problems in auditory lexical decision. In short, when they sounded out a novel word, it was not clear to them whether or not it could be correct. Although dyslexics without speech problems have difficulties with auditory lexical decision tasks too, their ability to discriminate words from nonwords is in line with reading skill (Snowling, Goulandris, Bowlby and Howell 1986). Therefore, this aspect of the decoding process does not pose such a problem for the non-speech disordered dyslexic children.

At follow-up some four years later, Michael and Caroline had changed rather little. Although, Michael's speech was more intelligible, Caroline had persisting articulatory incoordination which interfered with her intelligibility. There had been slight gains in their reading and spelling skill although their profile of difficulty remained the same. Neither Michael nor Caroline could be said to have made the transition into the alphabetic phase of literacy development. Caroline had, however, made more progress than Michael. By T2, she could read some nonwords although her spelling remained nonphonetic. Michael was unequivocally still functioning within the logographic phase; his spelling was nonphonetic and he was unable to read nonwords.

So, given that neither Michael nor Caroline can be said to have developed alphabetic competence, what accounts for their minimal gains between T1 and T2? It would seem that the knowledge the children have accumulated has been on a word by word basis. In speech, they have automatic production of well practiced and articulatorily simple words but are unable to assemble the motor programmes for novel material or more complex articulations. In reading, they have added words, one by one, to a visual input logogen system and in spelling they have accumulated word-specific orthographic information within a graphemic output logogen system. The rate at which they have been able to do this has been slow, probably much slower than that of other phonological dyslexics who receive remedial help. Although it is difficult to be certain about this point given the lack of experimental controls, some possible reasons are suggested.

First, it may be the case that some phonological dyslexics move into the alphabetic phase through gradual maturation of phonological skills (Snowling 1987). Such progress is ruled out for Michael and Caroline whose phonological development shows a pattern of "disorder" rather than delay.

Second, it could be that phonological dyslexics learn to read and spell by using compensatory strategies. Snowling (1987) discusses two possible areas of support which they may draw upon. The first relates to the use of context and semantic resources during reading. However, the success of this strategy will depend on the child's language abilities. Unfortunately, this avenue is restricted for Michael and Caroline because they perform poorly on other language-related tasks: they have persisting grammatical, conceptual and memory deficits.

The second compensatory strategy involves reading and spelling by analogy with familiar words. This makes sense for children with phonological dyslexia since it does not demand well developed sound segmentation skills. However, it does require segmentation of initial sounds and subsequent synthesis of new pronunciations. Whereas dyslexic children without serious speech problems may be able to utilise this strategy, Michael and Caroline's success was limited by their inconsistent speech output. Moreover, their difficulties with lexical decision would not allow them to discriminate between plausible and implausible candidates.

What about the children's own compensatory strategies? Their performance throughout suggested that although both children had difficulties at the input, segmentation and output levels, their deficits were weighted differently. Michael was particularly poor at detection and lexical tasks suggesting problems with input phonology. In contrast, Caroline had particular difficulties when a task required verbal production suggesting problems with output phonology which in turn had lexical consequences. Both children had serious sound segmentation difficulties. The differences between the children became more clear at T2. The implications are that Michael's input problems are a more serious barrier to literacy development than Caroline's output difficulties at the level of articulatory coordination. By T2, although Michael was more able than Caroline to use an articulatory code to support his literacy development, he had made less progress with reading and spelling skills. The number of unsuccessful sound attempts he made when reading and the number of perseverative errors he made when spelling had reduced. However, he still had a pervasive phonological deficit which may be related to a specific attentional deficit. It could be the case that Caroline had progressed more than Michael in spelling because of her strategy of "spelling-by-word-components". However, there was no experimental control for this and it may be that Caroline was merely more motivated than he to succeed.

Although Caroline had progressed more than Michael overall, it still remains the case that neither child could utilise the compensatory strategies which are normally available to phonological dyslexics. Specifically, their speech output difficulties set up a persisting cycle of deficit with segmentation, blending and lexical consequences. Functionally and qualitatively, Michael and Caroline could be said to be "trapped" within the logographic phase of reading and spelling development. What implications do these cases have for our understanding of normal and abnormal development of speech, reading and spelling skills? Taking speech first. The findings of this study provide a challenge for traditional views of Developmental Verbal Dyspraxia as being purely an output difficulty at the motor speech level. By adopting a developmental perspective it was possible not only to differentiate between delayed versus different articulatory development but also to examine the consequences of a long term speech disorder on other areas of development.

A most important finding from the present study was that Michael and Caroline had developed word-specific articulations.

This suggests that articulatory skill per se cannot account for their difficulties. Rather, a problem at a higher level of assembling the motor programme for articulation was indicated. However, Caroline in particular had another difficulty - coordinating the vocal tract in order to produce words. This was not a difficulty with specific sounds but a more general articulatory problem. Furthermore, both children, particularly at T1, were subject to the same immature speech errors as the normal controls. Their speech problem was therefore in part a delay in articulatory maturity. This is in keeping with a recent report by Milloy (1986) who describes a condition of "Immature Articulatory Praxis" as distinct from a dyspraxia of speech. By T2 however, it was possible to identify the persisting speech errors which would lead to the diagnosis of Developmental Verbal Dyspraxia. These were errors related to syllable structure planning rather than individual sounds. Table 9.1 summarises these findings.

Table 9.1 - A comparison of normal controls and speech disordered children on articulatory skills at T2 (+ present, - absent, = no difference between the groups).

Articulatory Level	Normal Children	Speech Disordered Children
Anatomical Structure:	+	+
Physiological Maturity:	-	+
Phoneme Substitutions:	=	=
Syllable Structure:	+	-
Timing Movements:	+	-

From Table 9.1 it can be seen that in order to develop normal speech, children first need an intact anatomical structure. Second, the articulatory maturity experienced around the age of 7 years is necessary for achieving articulatory precision of such sounds as /r/ and clusters (/spr, skl/). Without this, many of the simplifying processes such as fronting and stopping will persist. At the higher level of planning the utterance, the child needs to be able to assemble the appropriate syllable structure motor programmes and then coordinate the vocal tract to produce the target. A child with a speech difficulty can breakdown at any of these levels. For example, in the case of a child with a cleft palate, s/he lacks the intact structure and physiology but will be able to programme utterances - the result being an unintelligible but appropriately planned syllable structure and prosodic pattern. The child with developmental dysarthria breaks down at the levels of physiological maturity and timing, while the child with developmental verbal dyspraxia has difficulties programming and timing articulations. In addition to clarifying the nature of the speech errors, the study has revealed that the condition of developmental verbal dyspraxia also comprises deficits in input phonology and sound processing skills. Difficulties when discriminating and segmenting sound sequences were identified. These first manifest in speech when the child is unable to assemble new motor speech programmes easily and later in reading and spelling when the child has problems with alphabetic skill. The persisting output difficulties exacerbate the problem. Articulatory rehearsal cannot be used to support weak segmentation skill particularly when dealing with longer words, and the inconsistent and incoordinated output prevents the sound blending necessary for executing the motor programme when speaking, reading and spelling. This is particularly apparent when tackling novel material and therefore restricts the learning of new words. Finally, the incoordinated and inconsistent articulation results in a lexical disorder since the child often accesses words wrongly when attempting to read or blend sounds into words.

Developmental Verbal Dyspraxia is therefore more than an isolated speech disorder. Rather, it is the result of a motor programming difficulty which interferes with speech, reading and spelling development. The speech characteristics of this difficulty are known as "verbal or articulatory dyspraxia" and the literacy characteristics are known as "phonological dyslexia". Children may have a subtle disorder of speech in their dyslexic profile or a more serious disorder which persists as is the case with Michael and Caroline. However, perhaps one of the most important findings in the study is the lexical aspect of the speech disorder.

The speech and spelling data suggested that Michael and Caroline were relying on word-specific knowledge. This suggests that some lexical entries are clearly specified and can be accessed "automatically". Other lexical entries are more "fuzzy" and the child is unsure of the sound sequence because of poor input phonology and sound segmentation skills. When tackling new words such as the nonword material presented in this study, Michael and Caroline's segmentation skills were not sufficient to support the structuring of a new articulatory or phonetic spelling programme. This is further complicated by problems with the execution of this programme. This was particularly evident in Caroline's case where vocal tract incoordination resulted in more "groping" for targets. This resulted in a secondary lexical disorder being set up as the wrong words were accessed as seen in the sound blending task. Therefore, segmentation and blending skills are critical for the structuring of motor programmes. Without proficient sound segmentation skill a child cannot detect differences between words, order lexical entries or assemble the correct components of an utterance for speech and spelling. Dyspraxia might therefore be viewed as a sound processing difficulty which is exacerbated in varying degrees by a mistiming of the vocal tract.

In summary, it is argued that the condition "Developmental Verbal Dyspraxia" arises when a child has simultaneous auditory processing and articulatory difficulties which are not due to structural abnormality or obvious neurological damage. Children who predominantly have the former are more likely to be labelled as having "Developmental Dysphasia" while those whose main problem is at the output stage are described as having a "Phonological Disability". In this way, speech disorders arise from a breakdown at one or more levels of the information processing system. The precise nature of the disorder will depend on the "weightings" of deficits at these levels of breakdown. Diagnoses based on the medical model implying that discrete clinical entities exist need to be reviewed in the light of this work. Further investigations of the levels of breakdown within the speech disorderd population need to be carried out within a developmental information processing framework.

Second, the role of segmentation in literacy development can now be reexamined. The prerequisite controversy surrounding segmentation and reading development was discussed in Chapter 1. It is argued that indeed some segmentation even at the phoneme level can take place prior to the onset of reading. This is because, up to a point, the child can segment syllables and sounds on the basis of auditory and articulatory feedback. However, it is orthographic experience which allows for the development of more explicit segmentation skill. This view is summarised in Figure 9.1.

Figure 9.1 - The Development of Segmentation Skills.

Child Develops:	ACOUSTIC ANALYSIS →		ARTICULATORY FEEDBACK →	ORTHOGRAPHIC EXPERIENCE
	↓		↓	↓
Sound Analysis Achieved:	syllable segmentation		simple phoneme segmentation	cluster segmentation phoneme manipulation
		rhyme		
Level of Awareness:	zero —>	tacit —>		explicit

Skilled segmentation is the cumulative result of each of the stages shown in Fig 9.1. The child can detect acoustic bursts of energy, that is syllables, without any reference to text. Indeed, this is how he first organises and develops prosodic phonology and lexical skills (Lieberman 1972, Waterson 1981). Innate skills of acoustic analysis are then coupled with phonological and articulatory skills developed primarily for speech. These in turn enhance auditory discrimination abilities. Through sound play, language games, and finally literacy experience, the child's segmentation skills become explicit enabling more complex sound segmentation tasks to be carried out. Articulatory cueing develops the tacit level of awareness while orthographic experience accelerates the development of explicit awareness. This orthographic experience provides the child with segmentation tools - he is able to see the sound boundary markers which are not acoustically clear, for example the nasal in nasal clusters. This explicit level of awareness is necessary for the child to complete the more complex sound segmentation tasks such as spoonerisms. There is therefore a progressive reciprocal relationship, rather than one of cause and effect, between segmentation and learning to read.

Given this relationship between auditory, articulation and segmentation skills one immediately sees the problem for children like Michael and Caroline. A child with input phonology difficulties may use his articulatory skills for support. However, this is not possible when articulatory output is either limited or inconsistent. Although it may be possible to learn segmentation of familiar words through orthographic experience, segmentation of novel or long material will still be problematic. Such was the case for Michael and Caroline.

Finally, the data from this study add to the accumulating evidence that phonological skill is important for reading development (Mann 1986, Snowling 1987). However, they go further in alerting us to the range of different phonological abilitis which contribute to reading and spelling. Models of reading deficit which postulate difficulties within either direct or phonological route to the lexicon are clearly inadequate for explaining developmental reading problems. Use of the phonological route alone requires a number of subskills which are elucidated by consideration of the problems experienced by Michael and Caroline. Both children have had difficulties in learning letter-sound correspondences. Notwithstanding these, they have inordinate difficulty with sound blending, presumably because of speech articulation difficulties. Moreover, their ability to use phonological decoding processes was compromised because of lexical deficits which prevented them from deciding between plausible and implausible encodings of printed words. The alternative strategy of reading by lexical analogy must have been similarly compromised because of difficulties with sound synthesis and lexical access.

Turning to spelling, Michael and Caroline's difficulties shed light upon the development of both direct and phonological strategies. Neither child could segment effectively at the level of the phoneme and therefore any attempt to spell using phoneme-grapheme rules was doomed to failure. However, the acquisition of specific word spellings, presumably without recourse to phonology, offered an alternative means of spelling, at least to Caroline. Furthermore, by segmenting words by syllable, and matching these to syllable-spellings within the graphemic output logogen system, she could approximate words which otherwise she would have been unable to spell in any recognisable form.

In the light of these findings it is now possible to elaborate Frith's (1985) model of literacy development with reference to other language based skills (see Figure 9.2).

THE ROLE OF SPEECH AND LANGUAGE SKILLS IN LITERACY DEVELOPMENT

With reference to the model in Figure 9.2, the points at which a child with a speech and language disorder may encounter literacy problems will be examined.

The starting point in this model is the child's symbolic development and his ability to become aware of print representing meaning. This metalinguistic skill feeds into the preliterate phase. Here is the first point at which a child with a speech and language problem may encounter difficulties. For example, the child with a speech and language delay may reach this stage later than normally expected and so begin school at a disadvantage (Francis 1982). If the speech and language delay is associated with mental handicap then progress will be slow up until cognitive potential is reached. In the case of environmental speech and language delay however, there is no reason why a child should not catch up with his peers after appropriate intervention and move through the phases of reading and spelling development even if initially slower than normally expected.

Figure 9.2 - Normal Development of Reading and Spelling Strategies.

STAGE	READING	METALINGUISTIC	SPELLING
		Symbolic + Speech/Language Development	
PRELITERATE:	Awareness of print "Pretend" reading ↓		Awareness of writing "Pretend" spelling ↓
LOGOGRAPHIC:	1) Familiar words eg advertisements ↓ 2) Visual Errors eg organ/orange		1) Familiar words eg own name ↓ 2) NonPhonetic Errors eg star/senene
		+ Letter Knowledge + Articulation + Segmentation + Blending	
ALPHABETIC:	1) Tackles new words ↓ 2) Develops PGC	<———>	1) Semiphonetic eg arm/RM ↓ 2) Phonetic eg boat/BOT
	↓	+ Morphophonology	
ORTHOGRAPHIC:	Morphographs eg addiTION	———>	1) Nonphonetic eg kitchen/kittion ↓ 2) Morphemic convention eg have/having ↓ 3) Orthomorphophonology eg elastic/elasticity
DIRECT ANALOGY ↓ ↓	↓		↓

As long as there are no visual perceptual deficits accompanying the speech and language handicap, even the most severe speech problem should not prevent a child from entering the logographic phase of reading and spelling development since this does not require sound skills. The problem only arises when the child with a specific speech disorder of a phonological/dyspraxic nature tries to breakthrough to the alphabetic phase. Frith (1985) has suggested that the pacemaker for this breakthrough is spelling. An alternative view presented here is that breakthrough to the alphabetic phase occurs when the child can bring together his developing articulation and segmentation skills to develop letter-sound knowledge. Spelling allows these skills to be put into practice and provides feedback for the child. As he strives to write more "messages" he gains literacy experience. Spelling is a manifestation of and catalyst in the alphabetic process rather than the instigator of it.

A further departure from Frith's original model is on the relationship between reading and spelling at the beginning of the alphabetic phase. Rather than alphabetic skills being fedback into reading from spelling (see Figure 1.2), it is suggested that the combined articulatory, segmentation and letter knowledge is used to enhance reading and spelling experience independently but simultaneously. The dissociation between reading and spelling in normal children occurs because reading and spelling provides different kinds of feedback to the child. Visual print allows the child to develop his recognition skills and to see how words are segmented and represented - this is particularly important for segments which are not acoustically or articulatorily clear such as clusters or vowels. In contrast, writing pushes the child to experiment with representing sounds in words that he has not yet "learned" through orthographic experience. Thus, invented spellings which are normally of a semiphonetic nature arise (Read 1971, Bissex 1980) as a result of the independence of reading and spelling at the onset of the alphabetic phase. In normal development however, reading and spelling are soon reconciled. As the child's reading experience increases he is able to use this orthographic knowledge to supplement his spelling attempts which then become more phonetic in nature. In Michael and Caroline's case, however, there was a persisting dissociation between reading and spelling performance and there was no evidence of phonetic spelling attempts.

Just as the alphabetic phase drew on the child's articulatory and phonological knowledge developed for spoken language, the orthographic phase relies on the child's morphological language development. Root words plus affixes are identified and associated with the printed form. Explicit teaching of orthographic conventions is particularly important at this stage and increased orthographic experience is needed before the child will be able to use conventional morphological spelling rules. Thus, in this phase, experience is transferred from the reading to the spelling situation. Unfortunately, the child with a speech and language disorder will again be disadvantaged in this phase of literacy development. First, because of weak alphabetic skills on which to build the orthographic phase and second, because of the language disorder itself which may be at a morphophonological level and interfere with the child's identification of word chunks.

However, all children can develop some "automatic" spellings. This has been portrayed by the Direct Route on the model presented in Figure 9.2. Both Michael and Caroline had developed word-specific reading and spelling skills. This, however, does not allow novel material to be processed. An alternative to this is an analogy strategy. Although part of normal development, it is particularly useful as a compensatory strategy for children with difficulties at the alphabetic phase as it has less recourse to phonology. As can be seen on the model the analogy strategy gradually builds up in strength. Although it can normally begin at the logographic phase (Goswami 1986), the child does not have a well developed enough orthographic lexicon within which words can be compared. Furthermore, the use of this strategy is not completely devoid of sound skill (Ehri 1985). The child needs to be able to segment and blend in order to assemble the new target from the comparison word. This strategy is therefore functioning at its best once the child can use alphabetic skill and has reached the orthographic phase by which time he has a broader experience of word and sound chunks. Children with specific speech and language disorders who are unable to breakthrough to the alphabetic phase can therefore use this strategy while in the logographic phase but its efficiency will be limited. This seemed to be the experience of Michael and Caroline.

Although the model presented here is far from complete, it has allowed a clearer identification of children's difficulties when reading and spelling. It has also attempted to make explicit why the degree of reading and spelling difficulties observed in any given child may be associated with the severity and pervasiveness of underlying phonological deficits.

CLINICAL AND EDUCATIONAL IMPLICATIONS

What implications does this study have for the assessment and management of children such as Michael and Caroline? First, the experimental procedures used in this study may be adopted into routine assessments of older children with persisting speech disorders. Articulatory assessments alone will not be sufficient to understand the nature of a child's difficulties. It is particularly important to include tests of input phonology, sound processing and segmentation skill. The use of nonword material is essential to identify lexical, sequencing and motor programming difficulties.

Second, when designing remediation programmes, clearly children like Michael and Caroline need more than the articulatory drill work advocated by supporters of the motor theory of dyspraxia (Connery 1982). The articulatory work needs to be linked with auditory processing and together these need to be explicitly related to the development of letter knowledge and orthography (Bradley and Bryant 1983, Stackhouse 1985).

Third, the findings have implications for the teaching of literacy skills. Early work on a range of segmentation and alphabetic skills is indicated. This work however needs to be presented via a multisensory approach whereby weak auditory-verbal skills can be supported by stronger visual-kinaesthetic skills. Such an approach has been advocated by Hulme (1981) and Bradley (1981). Through a series of experiments on normal and retarded readers, Hulme has shown that tracing letter shapes improves memory for letters. Bradley's highly structured teaching programme based on Gillingham and Stillman's "Simultaneous Oral Spelling" shows the need for rigour and repetition when teaching dyslexic children. Another approach to couple visual cueing and articulatory/alphabetic training has been designed by Edith Norrie (1973) who advocated the use of colour coding to categorise sounds/letters when spelling. The use of colour coded graphemes to denote manner of articulation and diacritics to denote place of articulation has proved useful when working with dyslexic children with more serious speech problems (Stackhouse 1985).

Although such sound-based work is recommended to promote reading and spelling development in both normal and speech disordered/dyslexic children, there may come a point with the secondary school age child where phonics training needs to be abandoned in favour of visual memory training of words and word chunks. With reference to Michael and Caroline, the development of word specific knowledge is to be encouraged from an early stage in children with serious and persisting speech difficulties.

Finally, recognising that reading and spelling difficulties are a manifestation of an underlying language difficulty has implications for the professionals involved (Stackhouse 1988). Children with dyslexic and speech difficulties would benefit from a programme designed and administered jointly by their speech therapist and teacher rather than, as has happened in the past, intelligibility being treated in isolation from the literacy problems.

In conclusion, by adopting a developmental information processing framework the present study has gone some way in clarifying the nature of the speech, reading and spelling problems encountered by Michael and Caroline. The tackling of different areas of development longitudinally through an in-depth case study approach proved to be beneficial in understanding the nature and effects of the persisting speech disorder known as Developmental Verbal Dyspraxia. The comparison with other phonological dyslexics supports the view that the degree of reading and spelling deficit observed in any given child is associated with the severity and pervasiveness of the underlying phonological deficit. Further studies of children with a range of articulatory and phonological disabilities are needed to elucidate which phonological processes (for example input versus output) are most influential on reading and spelling development. Critically, however this approach needs to be applied to the neglected area of examining content and efficacy of intervention programmes.

REFERENCES

Aitcheson, J. and Straf, M. (1982). Lexical storage and retrieval: A developing skill. In Cutler, A. (Ed) Slips of the Tongue and Language production. The Hague:Mouton.

Alegria, J., Pignot, E. and Morais, J. (1982). Phonetic analysis of speech and memory codes in beginning readers. Memory and Cognition, 10, 451-456.

Anthony,A., Bogle, D., Ingram, T.T.S. and McIsaac, M.W. (1971). Edinburgh Articulation Test. Churchill Livingstone.

Aram, D.M. and Horwitz, S.J. (1983). Sequential and non-speech praxic abilities in developmental verbal dyspraxia. Developmental Medicine and Child Neurology, 25, 197-206.

Aram, D. and Nation, J. (1980). Pre-school language disorders and subsequent language and academic difficulties. Journal of Communication Disorders, 13, 159-198.

Aten, J. (1979) The Denver Auditory Phoneme Sequencing Test. Houston: College-Hill Press.

Baken, R.J. (1983). Getting ready to talk. The infant's acquisition of motor capability for speech. In Kirk, U. (Ed), Neuropsychology of Language, Reading and Spelling. Educational Psychology Series. Academic Press.

Bamford, J. and Saunders, F. (1985). Hearing Impairment, Auditory Perception and Language Disability. Arnold.

Baron, J. and Strawson, C. (1976). Use of orthographic and word specific knowledge in reading words aloud. Journal of Experimental Psychology: Human Perception and Performance, 2, 386-393.

Barton, D., Miller, R. and Macken, M.A. (1980). Do children treat clusters as one unit or two? Stanford University Department of Linguistics, Papers and Reports on Child Language Development. Stanford University. 18. 105-137.

Bauer, R.H. and Emhert, J. (1984). Information processing in reading disabled and nondisabled readers. Journal of Experimental Child Psychology, 37,271-81.

Bishop, D.V.M. (1982). T.R.O.G. Test of Reception of Grammar. Abingdon, Oxon.:Thomas Leach Ltd.

Bishop, D.V.M. (1985). Spelling ability in congenital dysarthria: evidence against articulatory coding in translating between phonemes and graphemes. Cognitive Neuropsychology,2, 229-51

Bishop, D.V.M. and Edmundson, A. (1986). Is otitis media a major cause of specific developmental language disorders? The British Journal of Disorders of Communication, 21,3,321-38.

Bissex, G.L. (1980). GNYS at Work: a child learns to write and read. Cambridge, MA: Harvard University Press.

Boder, E. (1973). Developmental dyslexia: a diagnostic approach based on three atypical reading-spelling patterns. Developmental Medicine and Child Neurology, 15, 663-87.

Boder, E. and Jarrico, S. (1982). The Boder test of reading-spelling patterns. New York: Grune and Stratton.

Bradley, L. (1980). Assessing Reading Difficulties. London: Macmillan Educational.

Bradley, L. (1981). The organisation of motor patterns for spelling: an effective remedial strategy for backward readers. Develop. Med. and Child Neurol. 23, 83-91.

Bradley, L. and Bryant, P.E. (1978). Difficulties in auditory organisation as a possible cause of reading backwardness. Nature, 271, 746-47.

Bradley, L. and Bryant, P. (1979). Independence of reading and spelling in backward and normal readers. Developmental Medicine and Child Neurology, 21, 504-514.

Bradley, L. and Bryant, P.E. (1983) Categorising sounds and learning to read: a causal connexion. Nature, 301, 419.

Bradley, L. and Bryant, P.E. (1985). Rhyme and Reason in Reading and Spelling. Ann Arbor: University of Michigan Press.

Brady, S., Shankweiler, D. and Mann, V. (1983). Speech perception and memory coding in relation to reading ability. Journal of Experimental Psychology, 35, 345-67.

Brandt, J. and Rosen, J.J. (1980). Auditory phonemic perception in dyslexia: Categorical identification and discrimination of stop consonants. Brain and Language, 9, 324-337.

Bridgeman, E. and Snowling, M. (1988). The perception of phoneme sequence: a comparison of dyspraxic and normal children. British Journal of Disorders of Communication, 23, 3. Dec.

Broca, P. (1865). Sur la faculte du language articule. Bull. Soc. Anthrop. (Paris), 6. 337-393. (In Edwards 1984).

Brown, R. (1973). A First Language. Cambridge, Mass.: Harvard University Press.

Brown, R. and McNeill, D. (1966) The tip of the tongue phenomenon. Journal of Verbal Learning and Verbal Behaviour, 5, 325-337.

Bruce, D.J. (1964). An analysis of word sounds by young children. British Journal of Educational Psychology, 34, 158-70.

Bryant, P. (1985). The question of prevention. In Snowling, M. (Ed), Children's Written Language Difficulties: Assessment and Management. N.F.E.R.

Bryant, P. and Bradley, L. (1980). Why children sometimes write words which they cannot read. In Frith, U. (Ed), Cognitive Processes in Spelling. Academic Press.

Bryant, P. and Bradley, L. (1985). Children's Reading Problems. Psychology and Education. Basil Blackwell.

Bryant, P. and Impey, L. (1986). The similarities between normal readers and developmental and acquired dyslexics. Cognition, 24, 121-137.

Byrne B. and Shea, P. (1979) Semantic and phonetic memory codes in beginning readers. Memory and Cognition, 7, 333-38.

Calfee, R.C., Chapman, R.S. and Venezky, R.L. (1972). How a child needs to think to learn to read. In, Gregg, L. (Ed), Cognition in Learning and Memory. New York : Wiley.

Calfee, R.C., Lindamood, P. and Lindamood, C. (1973). Acoustic phonetic skills and reading - kindergarten through twelfth grade. Journal of Educational Psychology. 64. 293-298.

Calnan, M. and Richardson, K. (1976). Speech problems in a national survey. Child: Care, Health and Development 2 (4), 181-202.

Campbell, R. (1983). Writing nonwords to dictation. Brain and Language, Vol. 19, 153-179.

Campbell, R. and Butterworth, B. (1985). Phonological dyslexia and dysgraphia in a highly literate subject; a developmental case with associated deficits of phonemic awareness and processing. Quarterly Journal of Experimental Psychology, 37A, 435-75.

Carver, C. (1970). Word Recognition Test. Hodder and Stoughton.

Cermak, S. (1985). Developmental Dyspraxia. In, Ray, E.A. (Ed), Advances in Psychology, 23, Neuropsychological Studies of Apraxia and Related Disorders. North-Holland.

Chall, J.S. (1967). Learning To Read: The Great Debate. New York: McGraw Hill.

Chiat, S. (1983). Why "Mikey's" right and "my key's" wrong: The significance of stress and word boundaries in a child's output system. Cognition, 14, 275-300.

Chukovsky, K. (1963). From Two to Five. Berkely and Los Angeles: University of California Press.

Coltheart, M. (1980). Analysing Acquired Disorders of Reading. Unpublished clinical tests. Birkbeck College, London.

Coltheart, M., Masterson, J., Byng, S., Prior, M. and Riddoch, J. (1983). Surface dyslexia. Quarterly Journal of Experimental Psychology, 35A, 469-96.

Connery, V. (1982). Therapy techniques for articulatory dyspraxia in children. Bulletin, 365. College of Speech Therapists.

Conrad, R. (1964). Acoustic confusions in immediate memory. British Journal of Psychology. 5. 75-84.

Conrad, R. (1979). The Deaf School Child. London: Harper and Row.

Content, A., Kolinsky, R., Morais, J., and Bertelson, P. (1986). Phonetic segmentation in prereaders: effect of corrective information. Journal of Experimental Psychology. 42, 49-72.

Cook, L. (1981). Misspelling analysis in dyslexia: observation of developmental strategy shifts. Bulletin of the Orton Society, 31, 123-134.

Crary, M.A. (1984). A neurolinguistic perspective on developmental verbal dyspraxia. Communicative Disorders, IX, 3, 33-49.

Crary, M.A., Landess, S. and Towne, R. (1984). Phonological error patterns in developmental verbal dyspraxia. Journal of Clinical Neuropsychology, 6, 2, 157-70.

Crary, M.A. and Towne, R. (1984). The asynergistic nature of developmental verbal dyspraxia. Australian Journal of Human Communication, 12, 2.

Darley, F., Aronson, A and Brown J.R. (1975). Motor Speech Disorders. W.B. Saunders Company.

Davie, R., Butler, N. and Goldstein, H. (1972). From Birth to Seven. London: Longman.

Deputy, P. (1984). The need for description in the study of developmental verbal dyspraxia. Australian Journal of Human Communication Disorders, 12, 2.

De Montford Supple, M. (1980). Reading as one aspect of language. In Jones, M. (Ed), Language Disability in Children. M.T.P.

Denckla, M.B. and Rudel, R.G. (1976) Rapid automatised naming: dyslexia differentiated from other learning disabilities. Neuropsychologia, 14, 471-79.

Dodd, B. (1980). The spelling abilities of profoundly deaf children. In U. Frith (Ed). Cognitive Processes in Spelling. London and New York: Academic Press.

Dodd, B. and Cockerill, H. (1985). Phonological coding deficit: A comparison of spelling errors made by deaf, speech disordered and normal children. In J.E. Clark (Ed). Beitrage Zur Phonetik und Linguistik - The Cultivated Australian. Helmut Buske Verlag Hamburg.

Dodd, B. and Hermelin, B. (1977). Phonological coding by the prelinguistically deaf. Perception and Psychophysics. 21, 5, 413-417.

Dunn, L.M., Dunn, L.M., Whetton, C. and Pintilie, D. (1982). British Picture Vocabulary Scales. NFER-Nelson.

Durrell, D.D. (1980). Commentary:Letter name values in reading and spelling. Reading Research Quarterly, 16, 159-163.

Durrell, D.D. and Murphy, H.A. (1953). The auditory discrimination factor in reading readiness and reading disability. Education 73, 556-560.

Edwards, M. (1984). Disorders of Articulation. Springer-Verlag, Wien, New York.

Eguchi, S. and Hirsh, I.S. (1969). Development of speech sounds in children. Acta Otolaryngologica Suppl. 257, 4-53.

Ehri, L.C. (1983). Critique of five studies related to letter name knowledge and learning to read. In L. Gentile, M. Kamil, and J. Blanchard (Eds). Reading Research Revisited. Columbus, Ohio: C.E. Merrill.

Ehri, L.C. (1985). Sources of difficulty in learning to spell and read. In M.L. Wolraich and D. Routh (Eds), Advances in Developmental and Behavioural Paediatrics. Greenwich, Conn: Jai Press Inc.

Ehri, L.C. and Roberts, K. (1979). Do beginners learn printed words better in context or isolation? Child Development, 50, 675-85.

Ehri, L.C. and Wilce, L.S. (1979). The mnemonic value of orthography among beginning readers. Journal of Educational Psychology, 71, 26-40.

Ehri, L.C. and Wilce, L.S. (1980). The influence of orthography on readers' conceptualisation of the phonemic structure of words. Applied Psycholinguistics. 1.4. 371-386.

Eisenson, J. (1972). Aphasia in Children. New York: Harper and Row.

Ekelman, B.L. and Aram, D.M. (1983). Syntactic findings in developmental verbal apraxia. Journal of Communication Disorders, 16, 237-50.

Elbers, L. (1985). A tip-of-the-tongue experience at age two? Journal of Child Language, 12, 2, 353-365.

Elkonin, D.B. (1973). U.S.S.R. In Downing, J. (Ed), Comparative Reading. New York: Academic Press.

Ellis, A.W. (1985). The cognitive neuropsychology of developmental (and acquired) dyslexia: a critical survey. Cognitive Neuropsychology, 2, 169-205.

Ellis, N. (1981). Visual and name coding in dyslexic children. Psychological Research, 43,201-18.

Fay, D.A. and Cutler, A. (1977) Malapropisms and the structure of the mental lexicon. Ling. Inq. 8, 505-520.

Ferguson, C.A. and Macken, M. (1980). Phonological development in children - play and cognition. PRCLD, 18.

Ferry, P.C., Hall, S.M. and Hicks, J.L. (1975). "Dilapidated" speech: developmental verbal dyspraxia. Developmental Medicine and Child Neurology, 17, 749-56.

Fischer, F.W., Shankweiler, D, Liberman, I.Y. (1985). Spelling proficiency and sensitivity to word structure. Journal of Memory and Language, 24, 423-41.

Fox, B. and Routh, D.K. (1975). Analyzing spoken language into words, syllables and phonemes: A developmental study. Journal of Psycholinguistic Research. 4.331-342.

Fox, B. and Routh, D.K. (1976). Phonemic analysis and synthesis as word-attack skills. Journal of Educational Psychology, 68, 70-74.

Francis, H. (1982). Learning to Read - Literate behaviour and orthographic knowledge. Unwin Education Books.

Frisch, G. and Handler, L. (1974). A neuropsychological investigation of "functional disorders of speech articulation". Journal of Speech and Hearing Research, 17, 432-45.

Frith, U. (1979). Reading by eye and writing by ear. In Kolers, P.A., Wrolstad, M. and Bouma, H. (Eds), Processing of Visible Language, I. N.Y.: Plenum Press.

Frith, U. (1980). Unexpected spelling problems. In Frith, U. (Ed), Cognitive Processes in Spelling. Academic Press.

Frith, U. (1981). Experimental approaches to developmental dyslexia:an introduction. Psychological research, 43, 97-109.

Frith, U. (1982). Specific spelling problems. Paper presented at NATO Advanced Study Institute, Dyslexia: A Global Issue.

Frith, U. (1985). Beneath the surface of developmental dyslexia. In Patterson, K.E., Marshall, J.C. and Coltheart, M. (Eds), Surface Dyslexia. London: Routledge and Kegan Paul.

Frith, U. and Frith, C.D. (1980). Relationships between reading and spelling. In Kavanagh, J.F. and Venezky, R.L. (Eds), Orthography, Reading and Dyslexia. Baltimore: University Park Press.

Furth, H.G. (1966). A comparison of reading test norms of deaf and hearing children. American Annals of the Deaf 111, 461-2.

Gentry, J.R. (1982). An analysis of developmental spelling in GNYS AT WRK. The Reading Teacher, 36, 192-200.

Gibson, E.J. and Levin, H. (1975). The Psychology of Reading. The MIT Press Cambridge, Massachusetts and London, England.

Gillingham, A. and Stillman, B.W. (1956). Remedial Training for Children with Specific Disability in Reading, Spelling and Penmanship. 5th Edition, Cambridge, Mass.: Educators Publishing Service Inc.

Gleitman, L.R. and Rozin, P. (1977). The structure and acquisition of reading, I: Relations between orthographies and the structure of language. In Reber, A.S. and Scarborough, D.L. (Eds), Toward a Psychology of Reading. Hillsdale. N.J.: Erlbaum.

Glushko, R.J. (1979). The organisation and activation of orthographic knowledge in reading aloud. Journal of Experimental Psychology: Human Perception and Performance, 5, 674-91.

Godfrey, J.J., Syrdal-Laskey, A.K., Millay, K.K., and Knox, C.M. (1981). Performance of dyslexic children on speech perception tests. Journal of Experimental Child Psychology, 32, 401-42.

Goldstein, D.M. (1976). Cognitive-linguistic functioning and learning to read in pre-schoolers. Journal of Educational Psychology, 68, 680-88.

Golinkoff, R.M. (1978). Critique: Phonemic awareness skills and reading achievement. In Murray, F.B. and Pikulski, J.J. (Eds), The Acquisition of Reading: Cognitive, Linguistic and perceptual prerequisites. Baltimore, Md.: University Park Press.

Gordon, N. and McKinlay, I. (1980). Helping Clumsy Children. Churchill Livingstone.

Goswami, U. (1986). Children's use of analogy in learning to read: a developmental study. Journal of Experimental Child Psychology, 42,73-83.

Grunwell, P. (1982). Clinical Phonology. Croom Helm, London.

Gubbay, S.S. (1978). The management of developmental apraxia. Developmental Medicine and Child Neurology, 20, 643-46.

Guyette, T.W. and Diedrich, W.M. (1981). A critical review of apraxia of speech. In, Lass, N.J. (Ed), Speech and Language Advances in Basic Research and Practice. Vol 6. London-New York: Academic Press.

Hanson, V.L., Liberman, I.Y., and Shankweiler, D. (1984). Linguistic coding by deaf children in relation to beginning reading success. Journal of Experimental Child Psychology, 37, 378-393.

Harris, M. and Coltheart, M. (1986). Language Processing in Children and Adults. London: Routledge and Kegan Paul.

Harste, J.C., Burke, C.L. and Woodward, V.A. (1982). Children's language and world: Initial encounters with print. In Langer, J. and Smith-Burke, M. (Eds), Bridging the Gap: Readers meets Author. Newark, Del.: International Reading Association.

Helfgott, J. (1976). Phonemic segmentation and blending skills of kindergarten children: Implications for beginning reading acquisition. Contemporary Educational Psychology, 1. 157-69.

Henderson, L. (1982). Orthography and Word Recognition in Reading. Academic Press.

Hewlett, N. (1985). Phonological versus phonetic disorders: some suggested modifications to the current use of the distinction. The British Journal of Disorders of Communication, 20, 2, 155-64.

Horn, T.D. (1969). Spelling. In Ebels, R.L. (Ed), Encyclopedia of Educational Research (4th edition). N.Y.: Macmillan.

Hulme, C. (1981). Reading Retardation and Multi-Sensory Teaching. Routledge and Kegan Paul.

Ingram, D. (1976). Phonological Disability In Children. Arnold.

Ingram, T.T.S., Mason, A.W. and Blackburn, I. (1970). A retrospective study of 82 children with reading disability. Developmental Medicine and Child Neurology, 12, 271-81.

Ivimey, G.P. and Lachterman, D.H. (1980). The written language of young English deaf children. Language and Speech 23, 351-75.

Johnson, R.J. (1969). The effect of training in letter names on success in beginning reading for children of differing abilities. Doctoral dissertation, University of Minnesota.

Johnston, R.S. (1983). Developmental deep dyslexia? Cortex, 19, 133-39.

Jorm, A.F. (1978). Reading processes in dyslexia. Collected Original Resources in Education 2. Fiche 9F12.

Kamhi, A.G. and Catts, H.W. (1986). Toward an understanding of developmental language and reading disorders. Journal of Speech and Hearing Disorders, 51, 337-347.

Kamhi, A.G., Friemoth, L. and Nelson, L.K. (1985). Word syllable and sound awareness in language disordered children. Journal of Speech and Hearing Disorders, 50, 207-12.

Kamhi, A.G., Lee, R.F. and Nelson, L.K. (1985). Word, syllable and sound awareness in language disordered children. Journal of Speech and Hearing Disorders, 50, 207-212.

Katz, J. (1983). Phonemic synthesis. In Lasky, E.Z. and Katz, J. (Eds), Central Auditory Processing Disorders. University Park Press, Baltimore.

Katz, R.B. (1986). Phonological deficiencies in children with reading disability: evidence from an object naming test. Cognition, 22, 225-57.

Kirk, S.A., McCarthy, J.J. and Kirk, W.D. (1968). Illinois Test of Psycholinguistic Abilities. Urbana, Ill: University of Illinois Press.

Kirk, U. (1983). Introduction: Toward an understanding of the neuropsychology of language, reading and spelling. In Kirk, U. (Ed), The Neuropsychology of Language, Reading and Spelling. New York: Academic Press.

La Berge, D. and Samuels, S.J. (1974). Toward a theory of automatic information processing in reading. Cognitive Psychology, 6, 293-323.

Lasky, E.Z. and Katz, J. (1983). Central Auditory Processing Disorders. University Park Press, Baltimore.

Laver, J. (1970). The production of speech. In, Lyons, J. (Ed), New Horizons of Linguistics. Penguin.

Lenel, J.C. and Cantor, J.H. (1981). Rhyme recognition and phonemic perception in young children. Journal of Psycholinguistic Research, 10, 1.

Lewkowicz, N.K. (1980). Phonemic awareness training: what to teach and how to teach it. Journal of Educational Psychology, 72, 5, 686-700.

Lewkowicz, N.K. and Low, L.Y. (1979). Effects of visual aids and word structure on phonemic segmentation. Contemporary Educational Psychology, 4, 238-252.

Liberman, I.Y. and Mann, V.A. (1980). Should reading instruction and remediation vary with the sex of the child? Paper presented at the Symposium on the Significance of Sex Difference in Dyslexia, Boston.

Liberman, I.Y., Shankweiler, D., Fischer, F.W. and Carter, B. (1974). Reading and the awareness of linguistic segments. Journal of Experimental Child Psychology, 18. 201-212.

Liberman, I.Y., Shankweiler, D., Liberman, A.M., Fowler, C, and Fischer, F.W. (1977). Phonetic segmentation and recoding in the beginner reader. In Reber, A.S. and Scarborough, D.L. (Eds), Toward a Psychology of Reading. Hillsdale. N.J.:Erlbaum.

Lieberman, P. (1972). Speech Acoustics and Perception. Bobbs-Merrill Studies in Communicative Disorders.

Lieberman, P., Meskill, R.H., Chatillon, M. Schupack, H. (1985). Phonetic speech perception deficits in dyslexia. Journal of Speech and Hearing Disorders, 28, 480-86.

Lindamood, C.H. and Lindamood, P.C. (1969). Auditory Discrimination In Depth. Boston, Mass.: Teaching Resources.

Locke, J. L. (1980). The inference of speech perception in the phonologically disordered child. Parts 1 and 2. Journal of Speech and Hearing Disorders. 45.

Lundberg, I., Olofsson, A. and Wall, S. (1981). Reading and spelling skills in the first school years predicted from phonemic awareness skills in kindergarten. Scandinavian Journal of Psychology, 21, 159-173.

Macaluso-Haynes, S. (1978). Developmental apraxia of speech: symptoms and treatment. In Johns, D.F. (Ed), Clinical Management of Neurogenic Communicative Disorders. Boston: Little Brown and Company.

MacNeilage, P.F. (1980). The control of speech production. In, Yeni-Komshian, G.H., Kavanagh, J.F. and Ferguson, C.A. (Eds), Perspectives in Neurolinguistics, Neuropsychology and Psycholinguistics. Academic Press.

Magnusson, E., Naucler, K. and Soderpalm, E. (1984). Form or substance? The linguistic awareness of preschool children and school children investigated by means of a rhyming test. Working Papers 27. Lund University, Department of Linguistics.

Mann, V.A. (1986). Phonological awareness: The role of reading experience. Cognition, 24 (1986) 65-92.

Marcel, A. (1980). Phonological awareness and phonological representation: Investigation of a specific spelling problem. In Frith, U. (Ed), Cognitive Processes in Spelling. Academic Press.

Mark, L.S., Shankweiler, D., Liberman, I.Y. and Fowler, C.A. (1977). Phonetic recoding and reading difficulty in beginning readers. Memory and Cognition. 5. 623-9.

Marsh, G. and Desberg, P. (1983). Development of strategies in the acquisition of symbolic skills. In Rogers, D.R. and Sloboda, J.A. (Eds), The Acquisition of Symbolic Skills. NY: Plenum.

Marsh, G., Friedman, M., Welch, V. and Desberg, P. (1980). The development of strategies in spelling. In Frith, U. (Ed), Cognitive Processes in Spelling. Academic Press.

Martin, A.D. (1974). Some objections to the term apraxia of speech. Journal of Speech and Hearing Disorders. 39. 53-64.

Mason, J. (1980). When do children begin to read: An exploration of four-year-old children's letter and word reading competencies. Reading Research Quarterly, 15, 203-27.

Maul, B.D.K. (1983). Learning word spellings: How do good readers who are good spellers differ from good readers who are poor spellers? Unpublished master's thesis, University of California, (In Ehri 1985).

McCarthy, R. and Warrington, E.K. (1983). A two-route model of speech production: Evidence from aphasia. Brain, 107, 463-85.

McLaughlin, J.F. and Kriegsman, E. (1980). Developmental dyspraxia in a family with X-linked mental retardation (Renpenning Syndrome). Developmental Medicine and Child Neurology, 22, 1, 84-92.

McNicol, D. (1972). A Primer of Signal Detection Theory. Sydney:Allen and Unwin.

Miles, T. (1982) Dyslexia: The Pattern of Difficulties. St. Albans: Granada.

Milloy, N. (1986). The discovery of a population. Speech Therapy in Practice. Dec.

Montgomery, D. (1981). Do dyslexics have difficulty accessing articulatory information? Psychological Research 43:235-243 (Developmental Dyslexia Issue).

Morais, J., Bertelson, P., Cary, L. and Alegria, J. (1986). Literacy training and speech segmentation. Cognition, 24, 45-64.

Morais, J., Crary, L., Alegria, J. and Bertelson, P. (1979). Does awareness of speech as a sequence of phones arise spontaneously? Cognition 7, 323-31.

Morley, M. (1965). The Development and Disorders of Speech in Childhood. 2nd Edn, London:Churchill Livingstone.

Morton, J. (1987). An information processing account of reading acquisition. Paper presented at Symposium "From Neurons To Reading", Florence, Italy.

Murdoch, B.E., Porter, S., Younger, R and Ozzane, A. (1984). Behaviours identified by South Australian clinicians as differentially diagnostic of developmental articulatory dyspraxia. Australian Journal of Human Communication, 12.2.

Newton, M. J. and Thomson, M. E. (1976). The Aston Index: A Screening Procedure for Written Language Difficulties. Wisbech:Learning Development Aids

Norrie, E. (1973). The Edith Norrie Letter Case. Helen Arkell Dyslexia Centre.

Parsons, C.L. (1984). A comparison of phonological processes used by developmentally verbal dyspraxic children and non-dyspraxic phonologically impaired children. Australian Journal of Human Communication Disorders, 12, 2, 93-107.

Pattison, H. (1983). Literacy skills in hearing impaired children. Unpublished Ph.D. thesis, University of Reading.

Perfetti, C.A. and Goldman, S.R. (1976). Discourse memory and reading comprehension skill. Journal of Verbal Learning and Verbal Behaviour 14, 33-42.

Perin, D. (1983). Phonemic segmentation and spelling. British Journal of Psychology, 74, 129-144.

Pring, L. and Snowling, M. (1986) Developmental changes in word recognition: an information processing account. Quarterly Journal of Experimental Psychology, 38A, 395-418.

Prichard, C.L., Tekieli, M.E. and Kozup, J.M. (1979). Developmental apraxia: diagnostic considerations. Journal of Communication Disorders 12, 337-48.

Quigley, S.P. and Kretschmer, R.E. (1982). The Education of Deaf Children. Baltimore: University Park Press.

Rack, J. (1985). Orthographic and phonetic encoding in normal and dyslexic readers. British Journal of Psychology, 76, 325-40.

Rack, J. and Snowling, M. (1985). Verbal deficits in dyslexia: a review. In Snowling, M. (Ed), Children's Written Language Difficulties. NFER-Nelson.

Read, C. (1971). Preschool children's knowledge of English phonology. Harvard Educational Review, 41, 1-34.

Read, C. (1975). Lessons to be learned from the preschool orthographer. In, Lenneberg, E.H. and Lenneberg, E. (Eds), Foundations of Language Development, Vol 2. Academic Press.

Read, C., Yun-Fei, Z., Hong-Yin, N. and Bao-Qing, D. (1986). The ability to manipulate speech sounds depends on knowing alphabetic writing. Cognition, 24, 31-44.

Reynell, J. (1969). Reynell Developmental Language Scales. NFER-Nelson.

Roberts, T. (1983). Reading and spelling performance of 8 year old children. First Language. 4, 3.12.

Robinson, P., Beresford, R. and Dodd, B. (1982). Spelling errors made by phonologically disordered children. Spelling Progress Bulletin, 22, 19-20.

Rosenbek, J.C. and Wertz, T. (1972). A review of fifty cases of developmental apraxia of speech. Language, Speech and Hearing Services in Schools. 3. 23-33.

Rosner, J. and Simon, D.P. (1971). The auditory analysis test: An initial report. Journal of Learning Disabilities, 4, 384-392.

Roy, E. (1978). Apraxia: a new look at an old syndrome. Journal of Human Movement Studies 4: 191-210.

Rozin, P., Bressman, B. and Taft, M. (1974). Do children understand the basic relationship between speech and writing? The mow motorcycle test. Journal of Reading Behaviour 6. 327-334.

Rutter, M. and Yule, W. (1975). The concept of specific reading retardation. Journal of Child Psychology and Psychiatry. 16. 181-97.

Savin, H.B. (1972). What the child knows about speech when he starts to learn to read. In Kavanagh, J.F. and Mattingley, I.G. (Eds), Language by Ear and by Eye. Cambridge, Mass. the MIT Press.

Schallert, D.L. (1982). The significance of knowledge: A synthesis of research related to schema theory. In Otto, W. and White, S. (Eds), Reading Expository Material. New York: Academic Press.

Schonell, F.J. (1976). Graded word reading and spelling tests.In Newton, M. and Thomson M. The Aston Index. Wisbech, Cambs: Learning Development Aids.

Schwartz, S. (1983). Spelling disability: A developmental linguistic analysis of pattern abstraction. Applied Psycholinguistics, 4, 303-16.

Seymour, P.H.K. (1987). Individual cognitive analysis of competent and impaired reading. British Journal of Psychology, 78, 483-506.

Seymour, P.H.K. and Elder, L. (1986). Beginning reading without phonology. Cognitive Neuropsychology, 1, 43-82.

Seymour, P.H.K. and McGregor, C.J. (1984). Developmental dyslexia: a cognitive experimental analysis of phonological, morphemic and visual impairments. Cognitive Neuropsychology, 1, 43-82.

Shankweiler, D. and Crain, S. (1986). Language mechanisms and reading disorder: A modular approach. Cognition, 24, 139-68.

Siegal, L.S. (1985). Deep dyslexia in childhood? Brain and Language, 26, 16-27.

Silva, P. A. (1987). Epidemiology, longitudinal course and some associated factors; an update. In Yule, W. and Rutter, M. (Eds) Language Development and Disorders. Mac Keith Press.

Skjelfjord, V. (1976). Teaching children to segment spoken words as an aid in learning to read. Journal of Learning Disabilities, 9, 297-306.

Slobin, D.I. (1978). Studies of Child Language Development. New York: Holt, Rinehart and Winston.

Snowling, M. (1980). The development of grapheme-phoneme correspondence in normal and dyslexic readers. Journal of Experimental Child Psychology, 29, 294-305.

Snowling, M.J. (1981). Phonemic deficits in developmental dyslexia. Psychological Research, 43. 219-234.

Snowling, M. (1982). The spelling of nasal clusters by dyslexic and normal children. Spelling Progress Bulletin, 22, 13-18.

Snowling, M.J. (1983). The comparison of acquired and developmental disorders of reading. Cognition, 14, 105-18.

Snowling, M.J. (1985). Children's Written Language Difficulties. Windsor: NFER-Nelson.

Snowling, M. (1987). Dyslexia. A Cognitive Developmental Perspective. Blackwell.

Snowling, M., Goulandris, N., Bowlby, M. and Howell, P. (1986). Segmentation and speech perception in relation to reading skill: a developmental analysis. Journal of Experimental Child Psychology, 41, 489-507.

Snowling, M. and Hulme, C. (in prep). A longitudinal case study of developmental phonological dyslexia: Arrest at a logographic stage of literacy development. Cognitive Neuropsychology.

Snowling, M.J. and Perin, D. (1983). The development of phoneme segmentation skill in young children. In, Rogers, D.A. and Sloboda, J.A. (Eds), Acquisition of Symbolic Skills. New York: Plenum Press.

Snowling, M.J. and Stackhouse, J. (1983). Spelling performance of children with developmental verbal dyspraxia. Developmental Medicine and Child Neurology, 25, 430-437.

Snowling, M.J., Stackhouse, J. and Rack, J.P. (1986). Phonological dyslexia and dysgraphia: a developmental analysis. Cognitive Neuropsychology, 3, 309-39.

Snowling, M., van Wagtendonk, B. and Stafford, C. (1988). Journal of Research in Reading, September.

Sommers, R.K. (1983). Articulation Disorders. Prentice-hall Inc., Englewood Cliffs, New Jersey 07632.

Spring, C. and Capps, C. (1976). Encoding speed, rehearsal and probed recall of dyslexic boys. Journal of Educational Psychology, 66, 780-86.

Stackhouse, J. (1982). An investigation of reading and spelling performance in speech disordered children. British Journal of Disorders of Communication,17,53-60.

Stackhouse, J. (1985). Segmentation, speech and spelling difficulties. In Snowling, M.J. (Ed), Children's Written Language Difficulties. NFER-Nelson.

Stackhouse, J. (1988). Relationship between spoken and written language disorders. In, Children With Language Difficulties: Implications in an Educational Setting. Multilingual Matters, Nov.

Stackhouse, J. and Snowling, M. (1983). Segmentation and spelling in children with speech disorders. In Edwards, M. (Ed), Proceedings of XIX Congress of the International Association of Logopaedics and Phoniatrics. Edinburgh: College of Speech Therapists.

Stanovich, K.E., Cunningham, A.E. and Cramer, B.B. (1984). Assessing phonological awareness in kindergarten children: issues of task comparability. Journal of Experimental Child Psychology, 38, 175-90.

Stark, R. and Tallal, P. (1981). Selection of children with specific language deficits. Journal of Speech and Hearing Disorders, 46, 114-22.

Stuart, K.M. (1986). Phonological Awareness, Letter-Sound Knowledge, and Learning to Read. Unpublished Ph.D. thesis, London University.

Sweeney, J.E. and Rourke, B.P. (1978). Neuropsychological significance of phonetically accurate and phonetically inaccurate spelling errors in younger and older retarded spellers. Brain and Language, 6, 212-25.

Tallal, P. (1980). Auditory temporal perception, phonics and reading disabilities in children. Brain and Language 9, 182-98.

Tallal, P. and Piercy, M. (1973). Developmental aphasia: Impaired rate of nonverbal processing as a function of sensory modality. Neuropsychologia.11.389-398.

Tallal, P. and Piercy, M. (1980). Defects of auditory perception in children with developmental dysphasia. In Wyke, M.A. (Ed), Developmental Dysphasia. Academic Press.

Tallal, P., Stark, R.E. and Mellits, D. (1985). The relationship between auditory temporal analysis and receptive language development: Evidence from studies of developmental language disorder. Neuropsychologia, 23. 4. 527-34.

Temple, C. (1986). Developmental Dysgraphias. The Quarterly Journal of Experimental Psychology, 38A, 77-110.

Temple, C. (in press). Red is read, but eye is blue: A case study of developmental dyslexia and follow up report. Brain and Language.

Temple, C. and Marshall, J.C. (1983). A case study of developmental phonological dyslexia. British Journal of Psychology, 74, 517-33.

Thomson, M. (1981). An analysis of spelling errors in dyslexic children. First Language ii, 141-50.

Torgeson, J. and Goldman, T. (1977). Verbal rehearsal and short term memory in reading disabled children. Child Development, 48, 56-60.

Treiman, R. (1985). Onsets and rimes as units of spoken syllables: evidence from children. Journal of Experimental Child Psychology, 39, 161-81.

Treiman, R. and Chafetz, J. (1987). Are there onset- and rime-like units in printed words? In, Coltheart, M. (Ed),Attention and Performance XII, The Psychology of Reading. Lawrence Erlbaum.

Vellutino, F. (1979). Dyslexia: Theory and Research. Cambridge. Mass: The MIT Press.

Vellutino, F.R., Harding, C.J., Phillips, F. and Steger, J.A. (1975). Differential transfer in poor and normal readers. Journal of Genetic Psychology, 126, 3-18.

Wallach, M.A. and Wallach, L. (1976). Teaching All Children To Read. Chicago: University of Chicago Press.

Walton, J.S., Ellis, E. and Court, S.D.M. (1962). Clumsy children: developmental apraxia and agnosia. Brain, 85, III.

Waterson, N. (1981). A tentative developmental model of phonological representation. In Myers, T., Laver, J. and Anderson, J. (Eds), The Cognitive Representation of Speech.

Webster, A. and McConnell, C. (1987). Children with Speech and Language Difficulties. Series:Special needs in ordinary schools. Cassell Educational Ltd.

Wechsler, D. (1967). Wechsler Preschool and Primary Scale of Intelligence. New York: Psychological Corporation.

Wepman, J.M. (1958). Auditory Discrimination Test. Chicago University of Chicago Press.

Whitworth, A. and Zubrick, A. (1983). Emergence of the concepts "word" and "sound" in 4-6 year old children, observed through response to verbal stimuli. Australian Journal of Human Communication Disorders. 11, 1, June, 25-40.

Williams, J.P. (1980). Teaching decoding with an emphasis on phoneme analysis and phoneme blending. Journal of Educational Psychology, 72, 1, 1-13.

Williams, R., Ingham, R.J. and Rosenthal, J. (1981). A further analysis for developmental apraxia of speech in children with defective articulation. Journal of Speech and Hearing Research, 24, 496-505.

Williams, R. Packman, A., Ingham, R. and Rosenthal, J. (1980). Clinician agreement on behaviours that identify developmental articulatory dyspraxia. Australian Journal of Human Communication Disorders, 8,1, 16-26.

Wyke, M.A. (1980). Developmental Dysphasia. London: Academic Press.

Yoss, K.A. and Darley, F.L. (1974). Developmental apraxia of speech in children with defective articulation. Journal of Speech and Hearing Research, 17, 399-416.

Zhurova, L.E. (1963). The development of analysis of words into their sounds by preschool children. Soviet Psychology and Psychiatry, 1963/64, 2, 17-27.

APPENDIX 4-1: RHYME DETECTION TEST

SET A Target	Choice 1	Choice 2	SET B Target	Choice 1	Choice 2
peg	leg	pig	leg	peg	feet
cat	coat	bat	cat	dog	bat
sock	clock	shoe	sock	clock	sack
goat	gate	boat	goat	sheep	boat
light	lights	kite	kite	coat	light
shell	bell	sand	bell	shell	ball
heart	hat	dart	heart	star	dart
ship	lip	yacht	ship	lip	shop
ball	wall	bell	ball	wall	goal
cat	fish	mat	cat	kite	mat
purse	nurse	bag	purse	nurse	peas
key	cow	tea	tea	drink	key
pen	hen	pan	hen	pen	egg
chair	table	bear	bear	boy	chair
saw	sea	door	saw	wood	door
spoon	knife	moon	moon	man	spoon
tap	cap	top	tap	cap	bath
box	fox	books	fox	box	cub
plate	dish	gate	gate	goat	plate
nail	whale	hammer	whale	nail	wall
Practice Items:-					
tie	pie	paw	tie	pie	shirt
log	tree	dog	dog	dig	log
mouse	house	rabbit	house	mouse	horse
door	deer	four	four	two	door

APPENDIX 4-2: ANOVA SUMMARY TABLE

RHYME DETECTION PERFORMANCE IN THREE [illegible], [illegible] READERS

One between (Reading Age) and two within (Modality and Distractor) mixed design

Source	SSqs	df	MSqs	F	p
Bet Ss (RA)	35.606	2	17.803	5.22	0.0144*
Error RAxS	71.617	21	3.410		
Within Ss (Mod)	1.537	1	1.537	0.815	0.3768
RA x Mod	3.026	2	1.513	0.802	0.4616
Mod x Error RAxS	39.604	21	1.886		
Within Ss (Dist)	11.340	1	11.340	8.464	0.0084*
RA x Dist	2.880	2	1.440	1.075	0.3594
Dist x Error RAxS	28.137	21	1.340		
Mod x Dist	0.411	1	0.411	0.426	0.5209
RA x Mod x Dist	0.482	2	0.241	0.25	0.7813
Mod x Dist x ErrRAxS	20.271	21	0.965		

APPENDIX 4-3: SUBJECTS' RHYME PRODUCTION RESPONSES

(SN = Subject Number, M/F = Male/Female, DK = Don't Know,
CA = Chronological Age, VA = Vocabulary Age)

Target	S1M (CA 4:8, VA 7:2)	S2M (CA 4:8, VA 6:8)
hat	cap	you wear a hat
key	goat	boot
comb	DK	brushing your hair
bin	boing I know what goes in it	dustbin
shell	bell	shell and the seaside
draw	bin	draw a picture
map	mat	DK
log	dog	sitting on it
bear	chair	angry
sew	DK	sewing
sun	DK	a little boy
wool	knitting	cotton wool
eye	nose	I like
bed	bear	sleep in it
four	fine	number four
ring	DK	put it on your finger
fish	DK	swimming
can	beer	jump, can play ball
heart	star	kissing
iron	DK	ironing something, some clothes

	S3F (CA 5:1, VA 5:4)	S4M (CA 4:10, VA 4:5)
hat	mat [illegible]	pat sat [illegible]
key	pea dee me tea see	pig king ring
comb	mome sone dome	Rome DK
bin	[illegible]	[illegible]
shell	[illegible]	[illegible]
draw	paw gore more saw	DK
map	pap fap paf caf	Mathew bap
log	pog mog sog nog	bog
bear	pear nare care sare wear	bed
sew	moe koe poe	soda stream
sun	pum come nun dum	Sonya
wool	pull full wall mall	pull
eye	my kie high	I do
bed	med said led ked dead	bear
four	bore more core door paw	or
ring	ping fing ming wing ding	ping
fish	mish pish dish kish wish	pish
can	ban fan man pan dan	pan
heart	bart sart cart mart tart part	bart
iron	pion zion kion mion sion nion	bion

Target	S5M(CA 5:4, VA 3:7)	S6M (CA 5:8, VA 3:2)
hat	hout	mat cat fat
key	cat	pea, ke for keys, kicking
comb	camera	mome
bin	dustbin	kin ben then big
shell	DK	bell
draw	jaw	more
map	dap bat	cap
log	gog dog leg	dog hotdog
bear	bingo	care nare
sew	soap	sewing mowing, sew poe
sun	sat	gun more
wool	walk	bull
eye	die	I spy
bed	dead daddy	bear bed ked
four	fish frog	more
ring	rabbit rash	ming ping ning
fish	dish DK	mish dish
can	fat	man
heart	hat	bart
iron	octopus, because its a "O"	ironman Brian

	S7M (CA 5:7, VA 4:5)	S8F (CA 5:9, VA 6:8)
hat	at eat	mat tat lat
key	ee	tea me lea pea
comb	DK	home tome wone
bin	in	Lynne tin in
shell	sugar	hell mell tell
draw	drip	war tore hore more
map	at ap	lap tap
log	og	tog frog hog
bear	DK	wear tear hair
sew	sewing	mow toe low
sun	un	pun chun won tun
wool	woola	tull pull hull
eye	am	tie high my
bed	big	Ted wed led
four	fan	tore war law more
ring	rain	ting wing
fish	fast	dish tish wish
can	DK	wan lan flan
heart	hoot	tart waht part
iron	horse's shoe	tion lion wion bion

APPENDIX 4-3
(Contd)

Target	S9M (CA 5:11, VA 6:8)	S10F (CA 6:1, VA 3:7)
hat	DK	pat lat cat
key	kick	pea lee
comb	cut	pome lome bome
bin	bird	Lynne king, big don't rhyme
shell	shore	pell lell
draw	running	paw call ball lorl
map	DK	lat cat, don't rhyme, can't think
log	pog	pog dog
bear	balloon	lair care
sew	soap	soap
sun	sum	lawn DK
wool	pulling	Paul call
eye	hiding	lie
bed	bull	head led ked
four	five	nor call door
ring	row	ping ling king
fish	five	pish lish kish
can	no	an pan lan
heart	flying	lart bart cart
iron	silver	pion lion kion

	S11M (CA 6:4, VA 7:2)	S12F (CA 6:6, VA 4:10)
hat	dat yat mat	ham ate yate
key	glee dee pea yee	keif
comb	car yome	code ko cow
bin	din yin kin pin	big pig dig lig
shell	tell yell pell	she sheet sheep
draw	gore your door core	what you write with, door Dawn
map	[illegible] [illegible] yat	mouse mom
log	dog pog	lon on yon
bear	dare yare pear	Ben bed beg
sew	low yoe koe glow	soap sea seaside sunbed
sun	dun yun kun yummy	seaside sunbed
wool	dull yull pull glull	wall woad wull
eye	kie kite pie die	eyeball eyelashes like
bed	ped yed cled	bear beg Betty
four	foot your core fourteen	fall fish fun
ring	ging ying king ping	rig rad robin
fish	pish yish vish vicious	fin figure fid
can	yan nan yud	Keith Kim like
heart	yart part	horse house
iron	yie pun, klun yiron	eye ironing board I'en

APPENDIX 4-4: RHYME PRODUCTION - CLASSIFICATION OF "OTHER" ERROR TYPES

1. Mixed Rhyme and Alliteration

   a)Rhyme correct and alliteration to target
     eg S5:LOG/gog dog leg
   b)Alliteration to target and rhyme to alliteration
     eg S4:KEY/king ping
   c)Alliteration to target and correct rhyming responses
     eg S11:COMB/car yome
   d)Rhyme correct and alliteration to rhyme response
     eg S5:BED/dead daddy
   e)Rhyme correct, alliteration to target, rhyme to alliteration
     response and alliteration to target.
     eg S6:BIN/kin ben then big
   f)Alliteration to target and semantic associations to response
     eg S12: SEW/soap sea seaside sunbed
   g)Definition, rhyme correct and alliteration to rhyme
     eg S12: DRAW/draw, what you write with, door, Dawn

2. Rhyme and Derivation

   a)Derivational eg S2:BIN/dustbin
   b)Derivation and rhyme correct eg S6:IRON/ironman Brian
   c)Derivation and rhyme to the response eg S6:SEW/sewing mowing
   d)Rhyme correct and derivation to response eg S6:LOG/dog hotdog

3. Rhyme and Feature Change

   a)Rhyme correct plus final nasal confusion
     eg S8: [illegible] S9:BIN/[illegible] king
   b)Rhyme correct plus final plosive confusion
     eg S9: DRAW/paw call ball
   c)[illegible] consonant confusion
     eg S11: MAT/dat gat yat
   d)Final Consonant of target triggers initial consonant of
     response eg S9:CAN/no
   e)Short/long vowel confusion plus rhyme to response
     eg S9:WOOL/Paul call

4. Syntagmatic

   a)Syntax eg S2: CAN/jump, can play ball, S4: EYE/I do
   b)Definitions eg S2: HAT/you wear a hat, BED/sleep in it
   c)Derivation and Syntax eg S11: EYE/eyeball eyelashes like

5. Miscellaneous

   a)Random word association eg S1: DRAW/bin, S2: KEY/boot
   b)Idiosyncratic reasoning
     eg S5: IRON/octopus, because its a "O"
   c)Repetition of the target with emphasis eg S7: WOOL/woola

APPENDIX 4-5: RHYME PRODUCTION - QUALITATIVE DISCUSSION OF INDIVIDUAL SUBJECTS

Details of Subjects (in years and months):-

Subject	Chronological Age	Vocabulary Age	Reading Age	Spelling Age
1	4-8	7-2	-	-
2	4-11	6-11	6-5	5-4
3	5-1	5-7	6-7	5-8
4	5-1	4-8	-	-
5	5-4	3-10	-	-
6	5-11	3-5	6-7	5-7
7	5-11	4-8	7-3	6-1
8	6-1	6-11	7-3	6-11
9	6-3	6-11	6-5	5-4
10	6-4	3-10	7-0	6-2
11	6-7	7-5	6-10	5-8
12	6-9	5-1	6-11	6-4

SUBJECT 1

S1 attended a playgroup attached to the school. He had not been exposed to any formal reading and spelling training and was a non reader/speller. His vocabuary was exceptionally good. He is beginning to develop rhyming skills but is unstable in his use of strategies. Semantic associations were high, ([illegible]%), but alliterative responses were also made, (20%), indicating some sound awareness. Other responses consisted of one random dinner/thin. 20% of his responses were "don't know". Although high, this might indicate an awareness that he did not know the RHYME and refused to give a response rather than guess.

SUBJECT 2

S2 attended the infants class and was making very satisfactory progress with his reading and spelling development. In spite of this he was a nonrhymer. Not only was he unable to produce any correct rhyming responses, he did not produce any sound based errors. By far the largest proportion of his errors were semantic, (40%). The largest proportion of his "other" errors, (60%), were definitions, (ring/put it on your finger). A further 20% of these were derivational, (wool/cotton wool), 13.33% were syntagmatic, (eye/I like), and 6.66% were random, (key/boot). This child demonstrates no sound awareness and yet is making satisfactory progress in school.

SUBJECT 3

In contrast to S2, who is only two months younger, S3 is a most proficient rhymer, (93.02% correct). She had no semantic or simple alliterative errors. The majority of her "other" responses were due to feature change, (75%), and the remainder were short/long vowel confusions. She was the most fluent of the group in her number of responses.

SUBJECT 4

A nonreader/speller who nevertheless produced 50% correct rhyming responses. 26.93% of his errors were alliterations and there were no semantic associations. His "other" responses comprised mixed alliteration and rhyme, (20%), derivational, (40%), syntagmatic, (20%), and random (20%). He has developed more rhyming skill than his fellow nonreader/speller, S1.

SUBJECT 5

Also a non reader, with a poor vocabulary age. Some rhyming ability is present, (26.92%), but the largest number of responses are alliterative, (50%), with few semantic errors, (3.84). One third of his "other" responses were mixed rhyme and alliteration, and another third were attribuatble to feature change. He appears on the brink of more stable rhyme responses and seems to be weighing up vowels versus consonants.

SUBJECT 6

S6 has the poorest vocabulary in the group, yet is well above chronological age in reading and only minimally delayed in spelling. He has a comfortable rhyming performance, (64.1%) with no semantic associations and only a small number of alliterations, (10.25%). All of his "other" responses included rhyme.

SUBJECT 7

S6 and S7 are at the same chronological age but S7 has more advanced performance ages, being a particularly good reader. S6, however, is the better rhymer. Only 27.27% of S7's responses were correct. This makes him comparable with S5, a non reader/speller. Furthermore, all of his correct responses indicated that he could segment onset/rime but not maniopulate phonemes, (hat/at, bin/in). 31.81% of his responses were alliterations and only 4.54% were semantic. His other responses comprised, derivations,(20%), syntagmatic, (20%), repetition, (20%), feature change, (20%), and random, (20%). His errors indicate that his rhyming skills are not as advanced as S5's.

SUBJECT 8

S8 scored above average on the tests, with a reading age over a year in advance. She was almost 100% correct on rhyme production, (98.41), her only errors being due to feature change, (m/n confusion). Although not the most fluent in the group she does have the highest accuracy score.

SUBJECT 9

S9 has the largest discrepancy between chronological and spelling ages but has a good vocabulary and reading age. He performed poorly on the rhyme test, (5%), producing a large number of alliterations, (50%), and some semantic associations, (10%). Unlike S5 who has the same nummber of alliterative response, S9 produces more nonsound based "other" errors: derivations, (40%), random, (20%). The remaining 40% of these "other" errors were words beginning with the final consonant of the target, (can/no). He is in the early stages of rhyme development and lacks fluency.

SUBJECT 10

S10 has extremely poor vocabulary performance but her reading is above age appropriate and her spelling is not significantly delayed. She has a high rhyming score, (81.25%), with no semantic errors or refusals, and only minimal alliterations. 66.66% of her "other" errors are due to feature change, and the remainder are short/long vowel confusions. She has a similar profile to S3, also female, and is in the "fine tuning" stage of rhyme development.

SUBJECT 11

S11 is comparable with S9 in terms of poor spellinmg ability with above age appropriate reading and vocabulary, but differs by obtaining a high rhyme score, (84.05%). He is extremely fluent and has no semantic or alliterative errors. "Other" errors indicate sound awareness and evidence of rhyme development. They included mixed rhyme/alliteration, (25%), mixed rhyme/derivation, (37.5%), feature change, (25%), and one unusual/sounding out response, (iron/yie-pon ko- yiron).

SUBJECT 12

S12 has above average reading development, minimally retarded spelling and poor vocabulary. Although the oldest member of the group, S12 scored no correct rhyming responses. This puts her on par with S2, one of the youngest members of the group. Qualitatively, however their profiles are quite different. S12 has high alliterative responses, (64.91% vs 0%), and low semantic errors, (3.5% vs 40%). She was also more fluent in her responses and attempted every item. "Other" responses comprised rhyming words to her own errors but not to the target, (66.66%), the remainder being syntagmatic. Unlike S2, S12 does have some rhyming ability but lacks control over it. She is READY to learn more stable rhyming skills.

APPENDIX 4-6: IMITATION AND SPELLING STIMULI

Thirty words and matched nonwords:-

nest	/nʌst
spider	spəʊdə
wasp	wɛsp
ducks	dæks
biscuits	ˈbæskɔɪts
snowman	ˈsnimɒn
scarecrow	ˈskɜkreɪ
scarf	skaθ
slipper	ˈslɛpə
caravan	ˈkɪrɪvɪn
television	ˌtɒlɒˈvʌʒn̩
dragon	drɪgn̩
treasure	trɪˈʒa
castle	kʌsl̩
fire engine	ˈfa ˈændʒn̩
bucket	ˈbɪkʌt
spade	spəʊd
crab	krɛb
star	sti
kite	kɔɪt
burglar	ˈbagli
rocket	ˈrɛkət
guitar	gæˈtɔ
rollerskates	ˌræliˈskəʊts
motorbike	ˈmɪtɪˈbəʊk
basket	ˈbɛskæt
pencil	ˈpɪnsəl
chips	tʃʌps
chocolate	ˈtʃɪkɪləʊt
orange	ɛrændʒ/

APPENDIX 4-7: SUBJECTS' WORD SPELLING AND IMITATION RESPONSES

(SN = Subject Number, M/F = Male/Female, + = Correct
N:N = Chronological Age, SpA = Spelling Age)

	S1M 6:1	**S2F 7:8**	**S3F 6:6**	**S4M 6:7**	**S5F 6:9**
	SpA 5:11	**SpA 6:0**	**SpA 6:1**	**SpA 6:2**	**SpA 6:7**
SPELLING					
nest	nes	+	+	ntesd	nesd
spider	sia	spid	speth	spodey	sBidar
wasp	wos	wapst	wostp	wops	wosb
ducks	doay	dunks	bukes	dues	bocs
biscuits	bis	biskis	discy	bisoits	biskis
snowman	sulid	sowman	snreman	scweman	+
scarecrow	s	sreko	sestey	sheycow	skercro
scarf	svey	saf	scov	shof	skof
slipper	sl p	srip	sliga	slipy	sleibr
caravan	cavaey	krafn	cavert	cavan	carfan
television	Teveai	tefisn	telves	telvisn	teleyvisen
dragon	gaie	dragn	drav	bagn	Jragen
treasure	cesay	tras	tresa	teey	tresa
castle	casly	casul	casu	casul	casul
fire engine	fosce	fiegnan	fiejin	fiyegn	fieyrengin
bucket	ibut	bucit	bucit	bookit	bukit
spade	sane	sbad	sqayes	spad	sbad
crab	cup	crap	crad	cad	+
star	sanene	sro	sto	sor	sber
kite	coien	kit	cit	katte	cit
burglar	bane	bugl	blgla	bgl	beul
rocket	rochenesli	rokit	rocit	[illegible]	rocir
guitar	ctolen	gitr	gito	gtr	rgtor
rollerskates	rlsens	rolasat	rolsgsndy	rolashas	rowisats
motorbike	[illegible]	metalik	mot Bie	[illegible]	motterbi[illegible]
basket	nence	base	Ba th	bashit	Bascit
pencil	penne	pecul	qesu	polles	bensul
chips	ciple	cips	thisyeser	cis	clbs
chocolate	canp	colk	thol	colot	coklt
orange	onnennenen	orng	oronneren	oring	orinJ

IMITATION
(Errors only)

scarecrow	[ˈstɛəkʊəʊ				ˈskɛəkʊəʊ
slipper				ɬɪpə	
caravan			kæʊəvæn		
dragon			ˈdʊægn		ˈdʒʊægn
treasure		ˈtrɛzə	ˈtʊɛʒə	twɛʒə	ˈtʋɛʃə
basket			ˈbæskɪtˀ(+)]		

SPELLING

	S6M 6:9 SpA 6:7	S7F 5:9 SpA 6:8	S8M 7:7 SpA 6:8	S9F 8:10 SpA 6:8	S10F 8:8 SpA 7:0
nest	+	+	nesd	next	+
spider	shidr	side	spida	sitet	sipter
wasp	wosq	wosd	wosp	water	wap
ducks	ducke	+	duks	drar	+
biscuits	bisit	biscs	bics	bixret	biusets
snowman	sonw-man	soman	+	sontmen	+
scarecrow	seck kouo	scecroman	secro	sate	scaedgrow
scarf	sckf	scrf	scof	stera	sacef
slipper	slae	sliq	slepa	ceatn	sipper
caravan	cavan	cavan	crardven	canran	cavavan
television	Televen	Tjelvisn	Telvecn	teniıcxn	telehpone
dragon	Gran	dagn	gran	darretr	danger
treasure	treru	dresh	treva	charewr	sevantse
castle	kasl	casul	casl	carer	clasat
fire engine	frie en	fireiin	fiea n	fire carn	fire vang
bucket	buci	buckit	bucit	buarac	butsat
spade	sad	stad	spad	sarers	satag
crab	crad	cab	+	canaer	cab
star	+	sare	sdol	satr	start
kite	kit	crt	kit	careier	ket
burglar	bcla	bglg	blag	beareisar	butgote
rocket	Rocit	rocit	roct	raiat	+
guitar	bitr	gitr	gto	giars	goteal
rolerskates	rooas	rolsas	rolsct	riasri	rocksauets
motorbike	motrdic	mot drc	mosbc	morar	mauebakek
basket	bast	bastit	basct	bartie	batgit
pencil	Fesu	Pes	pisl	pieabe	penites
chips	cips	chip	chip	chaesr	chisp
chocolate	cokt	chocl	cholt	chasers	choctaet
orange	orig	oriJr	oreg	oearasrie	oange

IMITATION
(Errors only)

	S6M	S7F	S8M	S9F	S10F
biscuits				['bɪstɪʔ,'bɪstɪs'bɪskɪps (+)	
scarecrow	'skɛəkʊəʊ				
caravan			'kævəvæn		
dragon	'dʒʊæɡn				
treasure	'tʃɛʃə	'tʃɛʒə	'tʊɛzʒə	'tʃɛzə	
burglar					'bedɡlə
basket				'bæstɪʔk	
orange		'ɒʊvɪndʒ]			

	S11F 7:2 SpA 7:0	S12F 7:1 SpA 7:2	S13M 7:8 SpA 7:8	S14M 7:3 Sp A 7:11	S15F 7:8 SpA 8:0
SPELLING					
nest	+	Neste	+	+	+
spider	spda	spidre	+	+	+
wasp	+	wospe	+	wospe	wosp
ducks	+	+	+	+	+
biscuits	bicks	biskits	biscits	BiciTse	Bickets
snowman	someman	+	+	+	+
scarecrow	skcron	scerKrow	scarcrow	scarcrow	scecrow
scarf	skof	scrfe	+	+	+
slipper	slip	slipre	sliper	sliper	sliper
caravan	crvan	+	cavaran	+	carvan
television	tvelvisn	Televishn	televisen	Televishon	televeson
dragon	drogn	dragan	dragen	+	+
treasure	trsher	tresha	treasher	Trieha	treser
castle	casuli	casal	casel	+	casle
fire engine	fire ngins	fire engin	fire Engen	+	Fiverengin
bucket	bukit	bucit	Buccet	buckit	Bucit
spade	sdad	spad	spab	+	spad
crab	+	+	+	crabe	crad
star	sdor	+	+	+	+
kite	kit	+	+	+	cit
burglar	blind	bagala	bargala	buglare	Burgla
rocket	rokct	rokit	roket	rokite	rocit
guitar	getr	gitre	citar	Gitor	kitar
rollerskates	rolaskas	rollasats	rolaskats	rollerscats	roller sasts
motorbike	motbick	motabike	moterbike	moterbike	moter bike
basket	bakesi	baskit	+	bascit	Bascet
pencil	pensul	pensul	+	pencill	+
chips	+	+	+	+	+
chocolate	chockt	chokcit	choclate	chocolite	choclet
orange	oring	oringe	+	oringe	orige

IMITATION
(errors only)

	S11F	S12F	S13M	S14M	S15F
snowman	[sŋdəʊmæn				
caravan			ˈkævvəvæn		
dragon				ˈdʒrægŋ	
treasure		ˈtʃʋɛʒə	ˈtʋʃɛʒə		ˈtʃrɛʒə
crab			kʋæb		
burglar	ˈbɜgtə		ˈbɜgəLə	ˈbɜgəLə	
rollerskates			ˈwəʊLəˈskeɪts		
pencil	ˈpɛnsɔə				
orange			ˈɒwɪndʒ]		

APPENDIX 4-7
(Contd)

	S16M 7:8 SpA 8:0	S17 7:8 SpA 8:5	S18F 6:1 SpA 8:11	S19 8:3 SpA 8:11
SPELLING				
nest	+	+	+	+
spider	+	+	+	+
wasp	wosp	wosp	wosb	wosp
ducks	duks	+	+	+
biscuits	bicgits	bicusts	+	biscuts
snowman	+	+	+	+
scarecrow	skeacrow	scarcrow	scer-crow	scar crow
scarf	+	+	+	scarfe
slipper	sliper	sipper	+	+
caravan	+	+	+	+
television	televison	+	televison	+
dragon	+	+	+	+
treasure	trecea	trasa	treser	tresure
castle	casle	casal	+	+
fire engine	fie engin	fria engin	fire-engin	fier engien
bucket	bucit	buckut	+	bucet
spade	spayd	spad	+	spaid
crab	+	crad	+	+
star	+	+	+	+
kite	kiyt	+	+	+
burglar	burgler	burgler	burgler	berculur
rocket	roket	+	+	+
guitar	gitar	gitar	giter	gitar
rollerskates	rolerskayts	roller skats	roller scats	rollar skats
motorbike	moter bike	moter bike	moter bike	motterbike
basket	+	+	+	baskit
pencil	+	+	+	+
chips	+	+	+	+
chocolate	choclat	chlolate	choclate	choclat
[illegible]	[illegible]	+	+	+

IMITATION
(errors only)

scarecrow [skɛəkʊəɹ]

APPENDIX 4-7
(Contd)

	S20M 8:9 SpA 9:0	S21M 8:8 SpA 10:4	S22 8:11 SpA 13:6
SPELLING			
nest	+	+	+
spider	+	+	+
wasp	+	+	+
ducks	Duck	+	+
biscuits	Biskuits	+	+
snowman	+	+	+
scarecrow	scarcrow	+	+
scarf	+	+	+
slipper	+	sliper	+
caravan	+	+	+
television	+	+	televisoin
dragon	+	+	+
treasure	tresure	tresure	+
castle	casle	+	+
fire engine	firengine	+	+
bucket	Buket	buket	+
spade	+	+	+
crab	+	+	+
star	+	+	+
kite	+	+	+
burglar	Bergaler	burgler	burgalar
rocket	rocet	+	+
guitar	+	+	gitar
rollerskates	rolarskates	rollar skates	+
motorbike	moterbike	motar bike	+
basket	+	+	bascket
[illegible]	+	+	+
chips	+	+	+
chocolate	choclate	choclate	choclate
[illegible]	+	+	+

IMITATION
(Errors only)

scarecrow		[ˈɜkɛəkʋəʊ	
treasure		ˈʧɛʒə	ˈʧrɛʒə
crab	k̫ʋæb		
rocket			ˈʋɒkɪt]

APPENDIX 4-7(contd):SUBJECTS' NONWORD SPELLING AND IMITATION RESPONSES

SPELLING

	S1F 6:1 SpA 5:11	S2F 7:8 SpA 6:0	S3F 6:6 SpA 6:1	S4M 6:7 SpA 6:2	S5F 6:9 SpA 6:7
/nʌst	nanen	+	nost	notd	nuster
'spɔːdə	ne unyei	spodr	sqod	sodey	suBun
wɛsp	wep	weps	wod	wsp	weB
dæks	dasy	Dask	das	daus	duks
'bæskɔɪts	snodon	baks	basc	bacos	Baskit
'snimɒn	snollou	simon	+	seyon	snawman
'skɜkreɪ	sinnqpenvg	srck	sotcem	socay	skekrow
skɑθ	sianenven	sarf	thof	soth	scolthe
'slɛpə	sianc ive	srepr	sled	sepey	sliBer
'kɪrɪvɪn	fey	crin	ciedvin	cevin	carvan
tɒlɒvʌʒn	dandnenengheh	torvn	tolvos	tovan	Telvisn
'drɪgn	gandnenaae	drign	drign	bign	cragn
'trɪʒə	ganenlal	trisr	thisdre	torr	creser
kʌst	cu lleuon	corsul	cus	cosl	casul
fɑ'ændʒn	fond eno	vadn	fareaju	foregin	fierenGin
'bɪkʌt	ban	bikit	becutyt	dickt	beycd
spɔːd	sond	sopod	sqod	spod	sbun
krɛb	cred	creb	cred	ced	crab
sti	sea	ser	sde	sey	sb
kɔɪt	cane	crut	cit	kot	coyt
'bɑgli	baneny	bolag	Bogle	dogleg	bag
'rɛkət	resaliec	rekt	rect	recd	recud
gaɪtɔ	[illegible]	[illegible]	[illegible]	guiell	[illegible]
'ræliskɔːts	rasalieie	ralsass	ralesgs	reaieysos	rag
'mɪtɪbɔːk	miteore	mitgat	mitego	mitdock	bot
'bɛskæt	[illegible]	beek	[illegible]	[illegible]	beslent
'pɪnsəl	ipinleje	pisul	distysy	pensaw	[illegible]
tʃʌps	caulieie	cups	thos	cos	cobs
'tʃɪkɪlɔːt	cuaneol	kilot	thitelot	cinlot	ciein
'ɛrændʒ/	eralc	eras	eras	erag	oring

IMITATION
(Errors only)

	S1F 6:1	S2F 7:8	S3F 6:6	S4M 6:7	S5F 6:9
/nʌst			[nːʌst		
wɛsp					wɛsps
'bæskɔɪts		'bæskɔ̃ɪn			
skɑθ				skɑf (+)	
'slɛpə					'slɪpə (+)
'kɪrɪvɪn			'kɪvɪvɪn	kɪrɪvɛn	
tɒlɒvʌʒn			tɛlə tɒlɒvʌʒn	tɒləvɪʒn tɛlivʌʒn	
'trɪʒə	'tʃɪʒə	'tʃrɪʒə			
'rɛkət				'rɛkəd	
'ræliskɔːts					'ræliskɔːt
'mɪtɪbɔːk	'mɪtɪ'mɔːk		'mɪtɪbɔːt		
'pɪnsəl	'pɛnsɪl	'pɛnsɪl	'pɛnsl		
tʃʌps	tʃɒps		tʃɒps		
'tʃɪkɪlɔːt/				'tʃɪkɪnɔːt]	

	S6M 6:9 SpA 6:7	S7F 5:9 SpA 6:8	S8M 7:7 SpA 6:8	S9F 8:10 SpA 6:8	S10F 8:8 SpA 7:0
SPELLING					
/nʌst	nut	+	nosd	nearsie	nud
'spəʊdə	sBoba	sod	sold	sarsise	saveda
wɛsp	wep	+	wesd	wase	weet
dæks	Duc	das	+	daseid	daveg
'bæskɔɪts	dasis	basc	dasi	baiern	backcan
'snɪmɒn	snon	sema	smon	stierire	samemud
'skɜkreɪ	srkra	stan	sclrw	staircn	seadasan
skaθ	sote	sprf	scfer	staincans	sacaf
'slɛpə	slepr	slep	slew	sacs	sapper
'kɪrɪvɪn	ciavin	cirv	creva	chasir	cavan
tɒlɒ'vʌʒn	Telvein	tolvisn	tolvesn	tbwesirie	talepone
'drɪgn	grign	doivr	grgn	dateit	daveg
'trɪʒə	Treer	tisn	Tesa	turait	sventer
kʌsl	+	casl	cusl	cruy	kanclesle
fəændʒn	Fegin	frand dan	fogin	fureite	fandcan
'bɪkʌt	+	Bict	bict	bixcan	bitcut
spəʊd	sob	sod	spd	bcngier	saot
krɛb	+	cred	cred	caiebar	catbed
stɪ	sey	siy	sedes	seraxb	steve
kɔɪt	kit	cut	kintt	caeris	cionge
'bɒglɪ	brgl	Brgle	bole	Jyoiser	barcand
'rɛkət	rect	+	rect	raisxr	rebetg
gætɔ	gat	gatul	gautut	hartei	gatetalk
'rælɪskəʊts	ralest	ralisos	ralscot	ratreicaot	rages
mɪtɪbəʊk	mieb	+	mitboat	eariacbacd	makegot
'bɛskæt	besat	Besacot	bex	beica	batgata
'pɪnsəl	Pisl	Pisul	pelulste	pihaie	piengl
tʃʌps	cops	cups	chop	chaisr	chops
'tʃɪkɪləʊt	cicilt	chicle	chleclot	cahairs	chikengot
'ɛrændʒ/	Ergrs	erar	erog	crhaJisc	egetang

IMITATION

	S6M	S7F	S8M	S9F	S10F
/'bæskɔɪts				['bæstɔɪks bæstɔɪz	'bæskɔɪnʒ 'bæskɔɪ[e]s
'snɪmɒn			'snɪmɒmn		'snɪmɔ[n]
'skɜkreɪ			'skɜkʊeɪ		
skaθ		skaf (+)	skaf		
'slɛpə				'slɪpə	
'kɪrɪvɪn					
ˌtɒlɒ'vʌʒn	ˌtɒlɒ'vɪʒn	ˌtɒlɒ'vɪʒn	tɛlɪ'vɪʒn ˌtɒlɒ'vɪʒn	tɒlɒ'vɪʒn	ˌtɛlə'vʌʒn
'trɪʒə	'tʊɛʒə 'tʃɪʒə			'trɪzə	'trɛʒə
'bɛskæt			'bɛskɜt 'bɛskæɪ	'bɛstə;bɛskət 'bɛstək	
'pɪnsəl			'pensɪ		
tʃʌps			tʃɒps	tʃɒps	tʃɒps
'ɛrændʒ/			'ɛrɪndʒ	ə'rændʒ]	

	S11F 7:2 SpA 7:0	S12F 7:1 SpA 7:2	S13M 7:8 SpA 7:8	S14M 7:3 SpA 7:11	S15F 7:8 SpA 8:0

SPELLING

/nʌst	nast	+	+	+	+
'spəɹdə	sdda	+	+	+	+
wɛsp	+	+	+	wespe	+
dæks	dack	+	bax	+	Dac
'bæskɔɪts	bakus	basuts	+	BackScots	Basuts
'snɪmɒn	snon	+	+	snimmarn	sneman
'skɜkreɪ	skarau	scrcway	+	scarcraye	+
skɑθ	skaf	skthe	+	scarte	sarth
'slɛpə	slep	+	+	+	+
'kɪrɪvɪn	krivin	+	civerin	kirovin	cervin
tɒlɒvʌʒn	tovesn	tollovashn	tolvosen	Tolorvoohon	televoson
drɪgn	+	grigan	+	+	Dregon
'trɪʒɑ	trish	grishon	trisar	Trichor	trear
'kʌsl̩	+	cosol	cosel	cusuule	casle
'fɑ'ændʒn	froagun	fra angan	+	fAre anGan	Fierengen
'bɪkʌt	+	becot	Bicart	Bicot	buit
spəɹd	sodsed	spod	+	+	+
krɛb	+	+	+	+	greb
stɪ	sdese	+	+	+	+
kɔɪt	+	cuet	kit	kiet	+
'bɒgli	brke	brgale	+	Bogle	Brgley
'rɛkət	rekter	+	recart	recute	+
gæ'tɔ	gaurer	gatol	+	Gater	cot
'ræliskəɹts	rale sase	ralesots	+	+	ralycoats
'mɪtɪ'bəɹk	mtbok	+	+	meteeboak	migbok
bɛskæt	begsers	bescot	bescot	bestscate	Biout
pɪnsəl	pisul	+	pinele	pincilaeel	+
tʃʌps	chier	chops	chops	chopes	chops
'tʃɪkɪləɹt	chike	chicelot	+	shikelot	+
'ɛrændʒ/	erag	erang	+	eranGnae	erag

IMITATION

	S11	S12	S13	S14	S15
/'snɪmɒn			['smɪnɒn	'slɪmɒn	
skɑθ		skɑf	skɑf		
'kɪrɪvɪn			'kɪvɪvɪn		
tɒlɒvʌʒn					tɛlɒvʌʃn tɒlɒvɪʃn
'trɪʒɑ		tʃrɪʒɑ		tʃrɪʒɑ	
'fɑ'ændʒn					fɑ ɛndʒɪn
'rɛkət	'rɛkɔt		'vjɛkɔt		
'mɪtɪ'bəɹk				mɪkɪbəɹt	
bɛskæt			bɛskɔt		
tʃʌps/		tʃɒps		tʃɒps]	

APPENDIX 4-7
(Contd)

	S16M 7:8 SpA 8:0	S17F 7:8 SpA 8:5	S18F 6:1 SpA 8:11	S19F 8:3 SpA 8:11
SPELLING				
/nʌst	nast	+	+	+
ˈspaʊdə	+	+	+	+
wɛsp	+	+	+	+
daks	+	+	+	+
ˈbæskɔɪts	basguyts	bascus	baskuts	baskwrites
ˈsnimɒn	+	semon	+	+
ˈskɜkreɪ	+	scarcay	scerc cray	+
ˈskaθ	scalf	+	+	+
ˈslɛpə	sleapa	slaper	+	+
ˈkɪrɪvɪn	+	cirvin	+	+
tɒlɒˈvʌʒn	tarvaion	tolerwisoin	tolavusone	tolovison
ˈdrɪgn	dregon	+	+	+
ˈtrɪʒa	trisar	+	+	+
ˈkʌsl	+	+	+	+
ˈfaˈændʒn	+	far agon	fare angen	+
ˈbɪkʌt	+	+	+	+
spaʊd	spout	+	+	+
krɛb	+	cred	+	+
sti	+	+	+	+
kɔɪt	+	cute	kute	kute
ˈbɒgli	+	bargel	+	+
ˈrɛkət	+	+	+	+
ˈgætɔ	gatur	+	gat-all	gatur
ˈræliˈskaʊts	+	raller skots	+	+
ˈmɪtɪˈbaʊk	+	mitir boke	+	+
ˈbeskæt	besscout	besket	+	+
ˈpɪnsəl	pinsell	+	picle	picel
tʃʌps	+	cups	+	chops
ˈtʃɪkɪlaʊt	+	cicey lote	chielote	+
ɛræændʒ/	+	+	+	+

IMITATION				
/wɛsp	[wɛhp (+)			ˈslimɒn (+)
ˈsnimɒn				
skaθ	skaf			
ˈkɪrɪvɪn	ˈkɪʊɪvɪn			
tɒlɒˈvʌʒn			tɒlɒˈvɪʒn	
kɔɪt			kaɪt	
ˈbɛskæt	bɛskaʊt			
tʃʌps/			tʃɒps	tʃɒps]

	S20M 8:9 SpA 9:0	S21M 8:8 SpA 10:4	S22M 8:11 SpA 13:6
SPELLING			
/nʌst	+	+	+
ˈspəɹədə	+	+	+
wɛsp	+	+	+
dæks	+	+	+
ˈbæskɔɪts	baskiats	baskites	+
ˈsnɪmon	+	snewmon	+
ˈskɜkreɪ	+	+	+
skɑθ	+	+	+
ˈslɛpə	+	+	+
ˈkɪrɪvɪn	kiravin	+	+
ˌtɒlɒˈvʌʒn	tollervoison	+	+
ˈɑrɪgn	+	+	+
ˈtrɪʒɑ	trisuar	+	trishare
ˈkʌsl	+	cosel	+
ˈfɑˈærɑdʒn	faragein	+	+
ˈbɪkʌt	Bicart	+	bickart
ˈspəɹɑd	+	+	+
krɛb	+	+	+
stɪ	+	+	+
kɔɪt	kiut	kit	+
ˈbɒgli	+	+	+
ˈrɛkət	recart	+	+
gæˈtɔ	+	+	+
ˈræliskəʊts	+	+	raleay scote
mɪtɪbəʊk	+	+	+
ˈbɛskæt	[illegible]	[illegible]	+
ˈpɪnsəl	[illegible]	+	+
tʃʌps	+	+	+
ˈdʒɪkɪləʊt	+	+	+
ˈɛrændʒ/	+	+	+
IMITATION			
/kɪrɪvɪn	[ˈkɪʋɪvɪn		
ˈtrɪʒɑ			ˈtʃɪʒɑ
kɔɪt	kwɔɪt		
ˈbɛskæt/	ˈbɛskət]		

APPENDIX 4-8: ANOVA SUMMARY TABLES

APPENDIX 4-8a: IMITATION OF REAL AND NONWORDS BY BEGINNER SPELLERS AND GOOD SPELLERS

One Between Subject Factor (Spelling Age) and One Within Subject Factor (Word Type: Real and Nonwords)

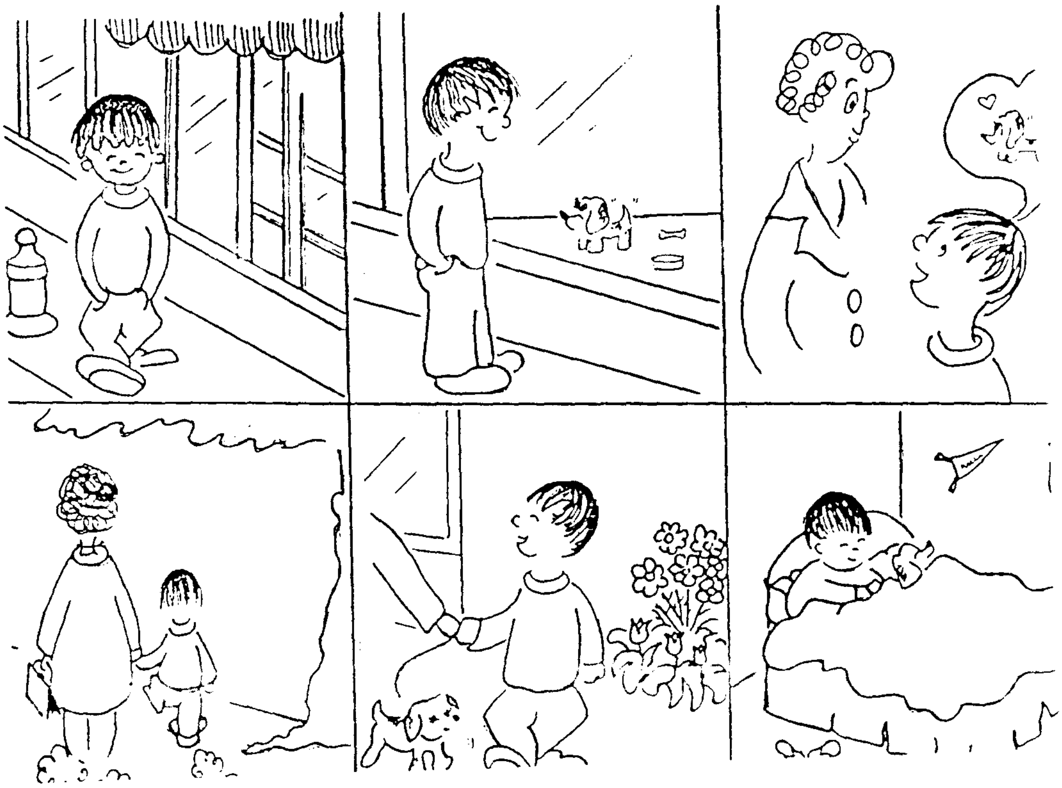
Source	SSqs	df	MSqs	F	p
Bet Ss	971.009	19			
Sp Age	111.153	1	111.153	2.327	0.14454
Error	859.856	18	47.770		
Within Ss	810.956	20			
Word Type	401.069	1	401.069	17.857	0.00051*
SpA x Wd Tpe	5.603	1	5.603	0.249	0.62351
Error	404.284	18	22.460		
Total	1781.965	39			

APPENDIX 4-8b: SPELLING OF REAL AND NONWORDS BY BEGINNER SPELLERS AND GOOD SPELLERS

One Between Subject Factor (Spelling Age) and One Within Subject Factor (Word Type: Real and Nonwords)

Source	SSqs	df	MSqs	F	p
Bet Ss	21076.653	19			
Sp Age	16667.167	1	16667.167	68.037	0.0000*
Error	4409.486	18	244.971		
Within Ss	716.800	20			
Wd Type	46.981	1	46.981	1.280	0.27278
Sp A x Wd Tpe	9.068	1	9.068	0.247	0.62520
Error	660.752	18	36.708		
Total	21793.453	39			

APPENDIX 5-1: CARTOON



APPENDIX 5-2: COMPLETE LIST OF TEST ITEMS

REAL WORDS	NONWORDS
snowman	/ˈsnɪmɒn
scarf	skɑθ
bag	bʌg
slipper	ˈslɛpə
scarecrow	ˈskɜkreɪ
ducks	dæks
nest	nʌst
poppy	ˈpɛpi
wasp	wɛsp
spider	ˈspəʊdə
web	wɪb
dragon	ˈdrɪgn
lighthouse	ˈləʊthaɪs
castle	ˈkʌsl̩
caravan	ˈkɪrɪvɪn
tent	tænt
chips	tʃʌps
biscuits	bæskɔɪts
girl	gil
doll	dæl
desk	dæsk
basket	ˈbɛskæt
chocolate	ˈtʃɪkɪləʊt
[illegible]	ˈɪbɪkəs
pencil	ˈpɪnsəl
star	sti
[illegible]	beɪ
bucket	ˈbɪkʌt
spade	spəʊd
treasure	trɪʒə
crab	krɛb
boat	beɪt
orange	ˈærɪnʒ
stamp	stɛmp
television	tɒlɒvʌʒn
burglar	ˈbɑgli
guitar	gætɔ
kite	kɔɪt
rollerskates	ˈræləɪskəʊts
rocket	rɛkət
motorbike	ˈmɪtɪˈbəʊk
smoke	smaɪk
fire engine	fa ændʒn/

APPENDIX 5-3: BREAKDOWN OF TEST ITEMS

ONE SYLLABLE WORDS

kite boat bag web boy girl doll

TWO SYLLABLE WORDS

poppy bucket rocket lighthouse guitar pencil basket

ONE SYLLABLE WORDS WITH CLUSTERS

nest wasp desk chips tent ducks
smoke crab spade scarf star stamp

TWO SYLLABLE WORDS WITH CLUSTERS

castle orange ducks biscuits
spider slipper dragon snowman treasure burglar scarecrow

THREE SYLLABLE WORDS

chocolate motorbike television abacus rollerskates
fire engine caravan

APPENDIX 5-4: REDUCED LISTS OF ITEMS USED IN THE ANALYSIS

WORDS	NONWORDS	WORDS	NONWORDS
nest	/nʌst	bucket	/bɪkʌt
spider	ˈspəɪʊdə	spade	spəɪʊd
wasp	wɛsp	crab	krɛb
ducks	dæks	star	sti
biscuits	ˈbæskɔɪts	kite	kɔɪt
snowman	snimon	burglar	ˈbagli
scarecrow	ˈskɜkreɪ	rocket	ˈrɛkət
scarf	skaθ	guitar	gæˈtɔ
slipper	ˈslɛpə	rollerskates	ˈræliskəʊts
caravan	ˈkɪrɪvɪn	motorbike	ˌmɪtɪˈbəɪk
television	ˌtɒlɒˈvʌʒn	basket	bɛskæt
dragon	drɪgn	pencil	ˈpɪnsəl
treasure	ˈtrɪʒə	chips	tʃʌps
castle	ˈkʌsl̩	chocolate	ˈtʃɪkɪləʊt
fire engine	fa ændʒən/	orange	ˈɛrændʒ/

APPENDIX 5-5: STORIES

A. Nest. Spider. Wasp. Biscuits. Ducks.

Who do you think lives in this NEST?
Is it the SPIDER - all black and hairy? No.
Is it the WASP? No.
I'll give you a clue.
It's something that likes to eat your BISCUITS.
It's the DUCKS!

B. Snowman. Scarf. Slipper. Caravan. Scarecrow.

In the winter the children made a big SNOWMAN.
Here is a SCARF, and here is a SLIPPER for him.
But now it's summer we don't have snowmen anymore do we?
Who can we give the things to?
I know, by the side of the old CARAVAN is a SCARECROW.
Let's give them to him.

C. Television. Dragon. Treasure. Castle. Fire engine.

Last night I watched a programme on the TELEVISION.
It was about a DRAGON.
He breathed fire to frighten people away and to stop them looking for the TREASURE hidden in the CASTLE.
One day he breathed so much fire the FIRE ENGINE had to come to put it out!

D. Bucket. Spade. Crab. Star. Kite.

Have you been to the seaside? Are you going this holiday?
You'll need to take a BUCKET and SPADE to build a sandcastle.
If you're lucky you might find a CRAB or a special fish shaped like a STAR.
If it's windy you could fly a KITE on the beach.

E. Burglar. Rocket. Rollerskates. Guitar. Motorbike.

One day a BURGLAR tried to take a little boy's toys. He climbed into the house and took his ROCKET, his ROLLERSKATES and his GUITAR. Luckily somebody heard him and shouted "Stop". A policeman came rushing round the corner on his MOTORBIKE and caught the burglar. The little boy got all his toys back.

F. Pencil. Chocolate. Chips. Orange. Basket.

Mummy is going shopping. She got her PENCIL and wrote a shopping list. Daddy wanted CHOCOLATE. The little boy wanted CHIPS. The little girl wanted an ORANGE.
Mummy put all the things into her BASKET to bring them home.

APPENDIX 5-6: SPEECH DATA SAMPLE

Subject: 1F. CA 3:03. AA 3:0<3.5. VA 2:06

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[✓	✓	nɛsk	/nʌst	[✓
	Spider	✓	✓	✓	ˈspaʊdə	✓
	Wasp	✓	wɒs̥p	✓	wɛsp	ʋɛsp
	Ducks	✓	✓	✓	dæks	dʌks
	Biscuits	ˈbɪs̥kɪts	bɪθkɪts	✓	ˈbæskɔɪts	bæskɔɪə
B.	Snowman	✓	✓	✓	ˈsnɪmɒn	ˈsnᶧɪmɒn
	Scarecrow	skɛə k kɛəkəʊ	skə ə ˈkəʊ	∅	ˈskəkreɪ	ˈskɜʀeɪ
	Scarf	✓	✓	✓	skɑθ	ˢkɑf
	Slipper	s̥ˡɪpə	θɪpə	sɪpə	ˈslɛpə	lɪpə lɛpə
	Caravan	væ væn	ˈkæːvæn	∅	ˈkɪrɪvɪn	ˈkɪwɪvɪn ˈkɪːvɪn
C.	Television	ˌtɛlɪˈbɪʒn̩	ˌtɛjɪˈbɪʒn̩	∅	ˌtɒlɒvʌʒn	tɒlɒvɪʒn̩ tɒlɒvɪn
	Dragon	ˈdʋægn̩	dægn̩	∅	drɪgn	dgrɪgn̩
	Treasure	DK	ˈtɛθʒə	∅	ˈbrɪʒə	✓
	Castle	DK	✓	∅	ˈkʌs̥l	kʌsʊ
	Fire engine	faɪːdʒɪn	ˈfaɪrˈɛndɪn	∅	ˈfaɪˈændʒən	ˈfaɪ ˈhændn̩
D.	Bucket	✓	✓	✓	ˈbɪkʌt	✓
	Spade	✓	ˢpeɪd	∅	spaʊd	speɪd
	Crab	kʋæb	kʋæᵇ	∅	krɛb	kɛb
	Star	✓	✓	∅	stɪ	ˀtɪ
	Kite	✓	✓	∅	kɔɪt	✓
E.	Burglar	ˈbɜgə	✓	∅	ˈbɒglɪ	✓
	Rocket	wɒkɪt	wɒkɪt	∅	ˈrɛkət	ʋɛkət
	Guitar	gɪtə ə dɪtɑrə	dgɪtɑ tɪtɑ	∅	gæɪtə	æˈkə
	Rollerskates	wəʊlːskeɪt	wəʊləskeɪᵗˢ	∅	ˈrɒlɪskəʊts	ˈrɑjɪskəʊts
	Motorbike	✓	✓	∅	ˈmɪtɪbaʊk	ˈmɪkɪbaʊk
F.	Basket	bæθkɪt	✓	∅	ˈbɛskæt	ˈbɛskæʔ
	Pencil	✓	✓	ˈpɪnsəʊ	ˈpɪnsəl	ˈpɛnsɪl
	Chips	tʲɪps	✓	tɪps	tʲɪps	tɒps
	Chocolate	tɒkləʔ	tˢɒklə	ˈtɒklə	ˈtʲɪkɪləʊt	ˈtʲɪkɪləʊ
	Orange	ɒwɪndz	ɒwɪndʒ	ɒwɪnd]	ˈɛrændʒ/	ˈɛhɛrændz]

APPENDIX 5-6: SPEECH DATA SAMPLE

Subject: 2 F. CA 4:01. AA 5·25<5·5. VA. 3:02

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[✓	nɛ⁺t, ✓	✓	/nʌst	[✓
	Spider	✓	✓	✓	'spəʊdə	✓
	Wasp	fwɒsp	wɒʰp, ✓	∅	wɛsp	✓
	Ducks	✓	✓	✓	dæks	✓
	Biscuits	bə'bɪskɪts	✓	✓	'bæskɔɪts	'bæskwɪts
B.	Snowman	✓	✓	✓	'snɪmon	'snlɪmon
	Scarecrow	'skɛəkvəʊ	✓	'skɛəkvəʊ	'skɜkreɪ	'skɜᵗkreɪ
	Scarf	✓	✓	✓	skaθ	skaf
	Slipper	✓	ɬɪpə	∅	'slɛpə	'slɛpət
	Caravan	keɪv 'kævəvan	✓	'kævəvæn	'kɪrɪvɪn	'kuwɪdɪn, kɪvɪvɪn
C.	Television	tɛlɪvɪʒn	'vɪʒn	'vɪʒn	ˌtɒlóvʌʒn	ˌtɛlívʌʒn ɬolovɪʒn
	Dragon	'vrægn	✓	✓	drɪgn	✓
	Treasure	'bwɛʒə	'brɛʒə, bwɛʒə	✓	'brɪʒa	'brɪʒæ
	Castle	'kæsʊ	'kæsʊ	'kæsʊ	'kʌsl	✓
	Fire engine	✓	✓	✓	'fɑ'ændʒn	'fa'ɛndʒɪn
D.	Bucket	✓	✓	✓	'bɪkʌt	✓
	Spade	✓	✓	✓	spəʊd	spəʊnd
	Crab	kræb	kræb	✓	krɛb	kræb
	Star	✓	✓	✓	stɪ	stɪ
	Kite	skɒɪt	✓	✓	kɔɪt	✓
E.	Burglar	'bɜgɪlə	'bɜgɪlə	✓	'bagli	✓
	Rocket	wɒkɪt	'vɒkɪt	'vɒkɪt	'rɛkət	✓
	Guitar	✓	✓	✓	gæ'tɔ	✓
	Rollerskates	rəʊvə skeɪt	rəʊlə skeɪt	vəʊlə skeɪt	'rælɪskɔʊts	✓
	Motorbike	✓	✓	✓	mɪtɪbəʊk	'mɪkɪbəʊk, mɪtkɪbəʊk
F.	Basket	✓	✓	✓	bɛskæt	✓
	Pencil	pɛnsəʊ	pɛns	✓	pɪnsəl	✓
	Chips	✓	✓	tʃɪps	tʃʌps	✓
	Chocolate	tʃɒklə	✓	✓	tʃɪkɪləʊt	✓
	Orange	'bɒɪndʒ	'bʊɪndʒ	'dʊɪndʒ]	ɛrændʒ/	✓]

APPENDIX 5-6: SPEECH DATA SAMPLE

Subject: 3F. CA 4:03. AA. 4:0<4:25. VA 4:10

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[nɛs	✓	næs	/nʌst	[✓
	Spider	✓	'pspaɪdə	✓	'spaʊdə	✓
	Wasp	wɒs	wɒs	wɒsz	wɛsp	✓
	Ducks	✓	✓	✓	dæks	✓
	Biscuits	bəbɪstɪts	bɪstɪts	bɪstɪts	'bæskɔɪts	✓
B.	Snowman	✓	✓	✓	'snɪmɒn	'si.ɒn
	Scarecrow	'skɛəkwəʊ	'skɛəkwəʊ	'skəəkəʊ	'skɜkreɪ	✓
	Scarf	✓	✓	✓	skaθ	skaf
	Slipper	✓	ɬɪpə	✓	slɛpə	✓
	Caravan	'kævəvæn	'kærə.væn	ø	kɪrɪvɪn	'kɪvɪ.ɪn, 'kɪvɪnə
C.	Television	'tɛli	'tɛlɪ'ɪʃn	'tɛlɪʒn	'tɒlɒvʌʒn	tɛljɪɪʒn
	Dragon	✓	✓	✓	drɪgn	✓
	Treasure	'twɛzə	'twɛzə	twɛzə	'trɪʒə	bɪzə brɪzə
	Castle	'kæsʊ	✓	kæsɔ	'kʌsl	✓
	Fire engine	✓	✓	✓	'faɪ'ændʒn	✓
D.	Bucket	✓	✓	✓	'bɪkʌt	vɪkʌt wɪkʌt
	Spade	✓	✓	✓	spaʊd	✓
	Crab	✓	✓	kwæb	krɛb	kræ
	Star	sta̤	✓	✓	sti	✓
	Kite	✓	✓	✓	kɔɪt	✓
E.	Burglar	✓	bɜgələ	✓	'bagli	✓
	Rocket	wɒkɪt	vɒkɪt	ø	'rɛkət	✓
	Guitar	ə'ta	ta	ø	gæ'tɔ	✓
	Rollerskates	bwɛʊləskɛɪts	'wəʊləskeɪt	ø	'ræliskəʊts	'vælɪskəʊts
	Motorbike	'bəʊtə'baɪk	✓	'məʊpə'baɪk	mɪtɪbaʊk	✓
F.	Basket	'bæstɪt	'bæstɪz, bæstɪt	'bæstɪz	'bɛskæt	'bæsɪzæt
	Pencil	pɛnsɪl	✓	✓	'pɪnsəl	pɛnsəl
	Chips	✓	✓	tɪps	tʃʌps	tʃɒps
	Chocolate	✓	✓	✓	tʃɪkɪlaʊt	'tʃɪkɪlaʊk
	Orange	ɒwɪndʒ	ɒrwɪndʒ	ɒwɪndʒ]	'ɛræandʒ/	'ɛræandʒ]

APPENDIX 5-6: SPEECH DATA SAMPLE

Subject: 4F. CA4:05. AA.4·0<4·25. VA.3:07

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[mɛst	mɛst	meθt˺	/nʌst	[mʌst
	Spider	ˈθpaɪdə	ˈθpaɪdə	θpaɪdə	ˈspaʊdə	s̪paʊdə
	Wasp	✓	✓	wɒθsp	wɛsp	wɛs̪p
	Ducks	dʌkθ	dʌksθ	dʌksθ	dæks	dæθk
	Biscuits	✓	ˈbɪθkɪts̪	ˈbɪθkɪtθ	ˈbæskɔɪts	ˈbæs̪kɔɪts̪
B.	Snowman	ˈθnəʊmæn	ˈθnəʊmæn	ˈθnəʊmæn	ˈsnɪmɒn	✓
	Scarecrow	ˈθkrɛəkwəʊ	θkwɛəkwəʊ	ˈθkɛəkəʊ	ˈskɜkreɪ	ˈskɜkweɪ
	Scarf	θkaf	θkaf	θkaf	skaθ	✓
	Slipper	ˈθlɪpə	θlɪpə	ˈθlɪpə	ˈslɛpə	✓
	Caravan	ˈkæwəvæn	ˈkævəvæn	ˈkwævəvæn	ˈkɪrɪvɪn	ˈkɪɔɪvɪn
C.	Television	✓	ˈtʃɛlɪvɪʒn	ˈtʃɛlɪvɪʒn	tɒlɒvʌʒn	ˌtɒfəvʌʒn
	Dragon	ˈdʒægn	dʒægn	ˈdʒwægn	drɪgn	✓
	Treasure	twɛʒə trɛθə	✓	ˈtwɛʒəz	trɪʒə	✓
	Castle	ˈkæθl	ˈkæθl	ˈkæθl	ˈkʌsl	kʌθl
	Fire engine	✓	✓	✓	ˈfaˈændʒn	✓
D.	Bucket	✓	✓	✓	ˈbɪkʌt	✓
	Spade	s̪peɪd	✓	s̪peɪd	spaʊd	θpaʊd
	Crab	kwæb	kwæb	kwæb	krɛb	kræb
	Star	✓	s̪ta	s̪ta	sti	θti
	Kite	✓	✓	✓	kɔɪt	✓
E.	Burglar	✓	✓	✓	ˈbɒgli	✓
	Rocket	wɒkɪt	ˈwɒkɪt	wɒkɪt	rɛkət	ˈwɛkət
	Guitar	kəˈta	kəˈta	✓	gæˈtə	kæˈtə
	Rollerskates	ˈrəʊləs̪keɪts̪	ˈrəʊləs̪keɪts̪	ˈrəʊləs̪keɪts̪	ˈræliskɔʊts	wæliθkəʊts̪
	Motorbike	✓	✓	✓	ˈmɪtɪbaʊk	ˈmɪkɪbaʊk, mɪt̪ɪbaʊk
F.	Basket	ˈbæs̪kɪt	ˈbæs̪kɪt	ˈbæθkɪt	ˈbɛskæt	ˈbɛθkɒt
	Pencil	ˈpɛnθɪl	ˈpɛnθɪl	ˈpɛnθɪl	ˈpɪnsəl	pɛnθəl
	Chips	tʃɪps̪	tʃɪps̪	✓	tʃʌps	✓
	Chocolate	✓	✓	ˈtʃɒkləz	ˈtʃɪkɪləʊt	✓
	Orange	ˈɒwɪndʒ	ˈɒwɪndʒ	ˈɒwɪndʒ]	ˈɛrændʒ/	ˈɛwændz]

APPENDIX 5-6: SPEECH DATA SAMPLE

Subject: S5F. CA 4:07. AA 3.75<4.0. VA 5:09

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[ts nεθt	nεθ:	nεˢt	/nʌst	[✓
	Spider	'θpaɪdə	'θpaɪdə	✓	'spəʊdə	✓
	Wasp	wɒθp	wɒθp	wɒsθ	wεsp	wεθp
	Ducks	dʌkθ	dʌʔkθ	dʌkθ	dæks	✓
	Biscuits	'bɪθkɪtθ	'bɪθkɪtθ	'bɪθkɪtθs	'bæskɔɪts	'bæʔskɔɪt
B.	Snowman	'θnəʊmæn	θnəʊmæn	'sənəʊmæn	'snɪmɒn	'θnɪmɒn
	Scarecrow	θkɜəkwəʊ	'θkεəkwəʊ	'skə ə 'krəʊ	'skɜkreɪ	'θkɜkreɪ
	Scarf	θkaf	θkaf	skεə ᶿkaf	skaθ	θkaf
	Slipper	'θlɪpə	'θlɪpə	ʃlɪpə	'slεpə	'θlεpə
	Caravan	kæwəvæn	✓	✓	'kɪrɪvɪn	✓
C.	Television	✓	✓	✓	'tɒlɒvʌʒn	tεlɪvɪʒn
	Dragon	dʒægn	✓	✓	'drɪgn	✓
	Treasure	✓	'ʧεðə, 'trεðʒə	ʧrεʒə	'brɪʒə	✓
	Castle	'kæθʊ	'kæθu	'kæθɪl	kʌsl	✓
	Fire engine	✓	✓	✓	fa'εndʒn	✓
D.	Bucket	✓	✓	✓	bɪkʌt	✓
	Spade	θpeɪd	θpeɪd	θpeɪd	spəʊd	θpəʊd
	Crab	✓	✓	✓	krεb	kəʊεb
	Star	θta	θta	səta	sti	θtin
	Kite	✓	✓	✓	kɔɪt	✓
E.	Burglar	✓	bɜgəlæ	✓	bɒgli	✓
	Rocket	✓	✓	rɒkɪʔ	'rεkət	✓
	Guitar	✓	✓	✓	gæ'tɔ	gæ'təʊ
	Rollerskates	rəʊləθkeɪtθ	rəʊləskeɪt	'rəʊləθkeɪts	'ræliskəʊts	'ræli'θkəʊts
	Motorbike	✓	✓	✓	'mɪtɪbəɪk	✓
F.	Basket	'bæθkɪt	'bæθkɪt	bæsθkɪt	bεskæt	bεθtæ
	Pencil	'pεnθɪl	pεnθɪl	pεnsɪl	pɪnsəl	pεnsəl
	Chips	ʧɪpθ	ʧɪpθ	✓	ʧʌps	✓
	Chocolate	✓	✓	✓	'ʧɪkɪləʊt	✓
	Orange	✓	✓	✓]	ε'rændʒ /	✓]

APPENDIX 5-6: SPEECH DATA SAMPLE

Subject: SbM. CA 3:05. AA 3·75<4·0. VA 2:10

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[✓	✓	✓	/nʌst	[✓
	Spider	✓	✓	'spaɪjə	'spaʊdə	✓
	Wasp	✓	wɒɪs	✓	wɛsp	wɪsp
	Ducks	✓	✓	✓	dæks	✓
	Biscuits	bɪkɪts, ✓	✓	✓	'bæskɔɪts	✓
B.	Snowman	✓	✓	✓	'snɪmɒn	✓
	Scarecrow	'kɛəs skəˈtəkəʊ	'skʊɛəkʊəʊ	skɜəkʊəʊ	'skɜkreɪ	'skwɛəkʊeɪ
	Scarf	✓	✓	✓	skɑθ	skɑf, kɑf
	Slipper	✓	ɬɪpə	✓	'slɛpə	✓
	Caravan	✓	'kæəvəvæn	✓	'kɪrɪvɪn	kɪvɪvɪn
C.	Television	tɛlɪvɪʒn	'tɛlɪvɪʒn	tɛlɪvɪzn	tɒlɒvnʒn	kɒˀɒvʌʒn, kɒəvʌʒn
	Dragon	'zwæəgn	dʊæəgən	'dʊæəgn	'drɪgn	✓
	Treasure	'twɛʒə	'swɛʒə, twɛʒə	twɛʒə	'brɪʒə	'tᵏrɪʒə
	Castle	✓	kæəsʊ	✓	kʌsl	kɛsɬ
	Fire engine	'faɪə 'ɛndᶻɪn	'tfaɪ 'ɛndᶻɪn	'faɪ 'ɛndɪn	'faɪændʒən	'fəs ændʒɬ
D.	Bucket	'bʌkɪʔ	'bʌkɪʔ	'bʌkɪʔ	bɪkʌt	'bɪkɒkt bɪkɒd
	Spade	✓	✓	ᵛpeɪd	spaʊd	✓
	Crab	kʊæəb	kʊæəb	kʊæəb	kreb	kweb
	Star	✓	✓	✓	stɪ	✓
	Kite	✓	✓	✓	kɔɪt	✓
E.	Burglar	bɪ 'bɜgə	'blɜgələ	bɪ'blɜgə	bɒgli	'bwɒgli
	Rocket	'wɒkɪt	'wɒkɪt	wɒkɪt	'rɛkət	'wɛkət
	Guitar	gɪtᵏɪɑ	gɪtɪɑ	ɪtɪɑ	gæɪtə	✓
	Rollerskates	wəʊlə 'skeɪt	wəʊlɪn skeɪts	wəʊlə skeɪ	'rælɪskɔʊts	'wælɪskəʊts
	Motorbike	✓	✓	✓	'mɪtɪbəʊk	✓
F.	Basket	✓	✓	✓	'bɛskæt	✓
	Pencil	✓	'pɛntsɪʊ	✓	'pɪnsəl	'pɛnsəl
	Chips	ɕɪps	sɪps	ʃɪps	tʃʌps	'tsʌps
	Chocolate	'gɒzlət	'gɒklət	'gɒʔlət	'tʃɪkɪləʊt	s'tɪkɪləʊk
	Orange	'ɒʊɪndz	ɒʊɪndz	'ɒwɪndz]	'ɛrændʒ/	'ɛwændz]

APPENDIX 5-6: SPEECH DATA SAMPLE

Subject: S7M. CA 3:11. AA. 4:7S<5.0. VA 3:07

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[✓	✓	✓	/nʌst	[✓
	Spider	✓	✓	✓	'spəʊdə	✓
	Wasp	✓	✓	✓	wɛsp	✓
	Ducks	✓	✓	✓	dæks	✓
	Biscuits	✓	✓	✓	'bæskɔɪts	✓
B.	Snowman	✓	✓	✓	snɪmon	'slimaɪ 'snɪmɔɪlə'snɪmɔrə
	Scarecrow	'skrɛə'krəʊ	✓	✓	'skɜkreɪ	'skɜkreɪn
	Scarf	✓	✓	✓	skaθ	skaf
	Slipper	✓	ʧɪpə	✓	'slɛpə	'slɪpə
	Caravan	✓	✓	✓	'kɪrɪvɪn	✓
C.	Television	✓	✓	✓	'tɒlɒvʌʒn	tɒlɪvʌv tɒlɒvəʃɪʃn tɒlɒvʌʒini tɒlɒvʌʒɪn
	Dragon	✓	✓	✓	drɪgn	✓
	Treasure	✓	ʧw 'trɛzə	trɛzəz	trɪʒə	✓
	Castle	✓	✓	✓	kʌsl	kæsl kasl
	Fire engine	✓	'faɪ'ɛndɪn	✓	'fa'ændʒn	✓
D.	Bucket	bʌkɪʔ	✓	✓	'bɪkʌt	✓
	Spade	✓	✓	✓	spəʊd	✓
	Crab	✓	✓	✓	kreb	✓
	Star	✓	✓	✓	sti	✓
	Kite	✓	✓	✓	kɔɪt	✓
E.	Burglar	✓	✓	✓	'bɒgli	✓
	Rocket	✓	✓	✓	'rɛkɔt	✓
	Guitar	ʔɪtə	ɪʔtə	ɪʔtə	gæ'tɔ	gæ'tɔl
	Rollerskates	✓	✓	✓	'rælɪskɔʊts	'ræbɪ 'rælɪskəʊt
	Motorbike	✓	✓	✓	mɪtɪbəʊk	mɪtɪbəʊk
F.	Basket	✓	✓	'bæsʔɪʔ	beskæt	✓
	Pencil	✓	✓	✓	pɪnsəl	✓
	Chips	✓	✓	✓	ʧʌps	✓
	Chocolate	✓	✓	✓	'ʧɪkɪləʊt	✓
	Orange	✓	✓	✓]	'ɛrændʒ/	✓]

APPENDIX 5-6: SPEECH DATA SAMPLE

Subject: S8m. CA 4:01. AA 3.5<3.75. VA 3:07

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[nɛs	✓	✓	/nʌst	[nɛst nɛkt
	Spider	✓	✓	✓	spaɪʊdə	✓
	Wasp	✓	✓	✓	wɛsp	✓
	Ducks	✓	✓	✓	dæks	✓
	Biscuits	✓	✓	✓	ˈbæskɔɪts	✓
B.	Snowman	snɔmæn	✓	ˈslnəʊmæn	ˈsnɪmɒn	✓
	Scarecrow	skɛəkʌp skɛəkəʊ	skɛəkʌp skɛəkəʊp	ˈskɛəkʌp	ˈskɜkreɪ	ˈskwɜkreɪ
	Scarf	✓	✓	✓	skaθ	skaf
	Slipper	✓	✓	✓	ˈslɛpə	ˈtɛpə
	Caravan	ˈkæzəbæd kædəd	ˈkævəbæn	ˈkæzəbæd	ˈkɪrɪvɪn	ˈkɪvɪvɪn
C.	Television	tɛləʒn	ˈtɛlɪvɪʒn	ˈtɛlɪˈʌʒn	tɒlɒvʌʒn	ˌtɒwəˈvʌʒn
	Dragon	dægn	ˈdægn	ˈdægn	drɪgn	ˈdwɪgn
	Treasure	ˈtɛzə	ˈtwɛzə	ˈtwɛʒə	trɪʒə	ˈtwɪʒə
	Castle	ˈkasʊ	ˈkæsʊ	ˈkæsʊ	ˈkʌsl	ˈkʌsʊ
	Fire engine	faɪˈɛndʒɪn	faɪˈɛndˢɪn	faɪˈɛndʒn	ˈfaˈændʒn	ˈfaˈændn
D.	Bucket	✓	ˈsbʌkɪʔ	✓	bɪkʌt	✓
	Spade	✓	✓	✓	spaɪʊd	✓
	Crab	kʋæb	kæb	kæb	krɛb	kwɛb
	Star	stɔ	✓	✓	stɪ	✓
	Kite	✓	✓	✓	kɔɪt	✓
E.	Burglar	ˈbɜgələ	ˈbɜʔlə	ˈbɜgələ	bɒgli	✓
	Rocket	ˈwɒkɪʔ	ˈwɒkɪʔ	ʋɒkɪᵗ	ˈrɛkət	ˈwɛkət
	Guitar	✓	✓	✓	gæˈtɔ	✓
	Rollerskates	ˈwəʊləˈskeɪt	ˈʋəʊləˈskeɪts	ˈʋəʊləˈskeɪts	ˈræliskəʊts	ˈʋæliskəʊts
	Motorbike	✓	✓	ˈməʊtˢəbaɪk	mɪtɪbaʊk	✓
F.	Basket	ˈbæskɪt	✓	✓	ˈbɛskæt	✓
	Pencil	✓	✓	✓	pɪnsəl	✓
	Chips	tɪps	✓	tɪps	tʌps	tsʌps
	Chocolate	ˈtɒləʔ	ˌtɒkɒlɒklət tɒklət	ˈtsɒklət	ˈtɪkɪləʊt	tɪkɪləʊk
	Orange	ˈɒzɪnd	ˈɒfwɪndz	ˈɒwɪndz]	ˈɛræŋdʒ/	ˈɛʋændz ˈɒʋændʒ]

APPENDIX 5-6: SPEECH DATA SAMPLE

Subject: 59m. CA 4:07. AA 4·7 < 5·0 . VA 4:0

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[nɪt	nɪst	nɪst	/nʌst	[✓
	Spider	✓	✓	✓	ˈspaɪdə	✓
	Wasp	✓	✓	wɒpˀ	wɛsp	✓
	Ducks	✓	✓	✓	dæks	dæsk
	Biscuits	✓	✓	✓	ˈbæskɔɪts	✓
B.	Snowman	✓	✓	✓	ˈsnɪmɒn	ˈsnɪmɒnd
	Scarecrow	ˈskɛəkrəʊp	skɛəkrəʊpˀ	ˈskɛəkrəʊpˀ	ˈskɜkreɪ	✓
	Scarf	✓	✓	✓	skaθ	skaf
	Slipper	✓	✓	✓	ˈslɛpə	✓
	Caravan	✓	ˈkævəvræn	ˈkærəˈbæŋ	ˈkɪrɪvɪn	ˈkɪvɪrɪn
C.	Television	✓	✓	✓	ˈtɒlɒvʌʒn	ˈtɒlɒvɪʃn
	Dragon	✓	✓	dʒræɡn	drɪɡn	ˈdræɡn ˈdʒrɪɡn
	Treasure	✓	ˈtʃrɛzæ ˈtʃrɛʒə	ˈtʃrɛʃə	ˈbrɪʒə	ˈtʃrɪʒə
	Castle	✓	✓	✓	kʌsl	ˈkʌsʊ
	Fire engine	✓	✓	✓	fɑ ˈændʒn	✓
D.	Bucket	✓	✓	✓	ˈbɪkʌt	✓
	Spade	✓	✓	✓	spaɪd	✓
	Crab	✓	✓	✓	krɛb	kræb
	Star	✓	✓	✓	stɪ	✓
	Kite	✓	✓	✓	kɔɪt	✓
E.	Burglar	ˈbɜɡələ	✓	ˈbɜɡələ	ˈbɑɡlɪ	ˈbɑʔlɪ
	Rocket	ʋɒkɪt	✓	ˈʋɒkɪt	ˈrɛkət	ˈʋækət
	Guitar	ˈjəʊkɪˈtɑ	ɪʔtɑ	ɪˈtɑ ✓	ɡæˈtɔ	✓
	Rollerskates	✓	✓	✓	ˈrɑlɪskəʊts	✓
	Motorbike	✓	✓	✓	ˈmɪtɪbaɪk	ˈmɪtɪbaɪt
F.	Basket	✓	✓	✓	ˈbɛskæt	ˈbæskɪt
	Pencil	ˈpɪnsɪʊ	pɪˈsɑ	ˈpɪnsɪʊ	pɪnsəl	✓
	Chips	✓	✓	✓	ˈtʃʌps	✓
	Chocolate	✓	✓	✓	ˈtʃɪkɪləʊt	✓
	Orange	ˈɒʋɪndʒ	✓	✓]	ˈɛrændʒ/	ˈærɪændʒ, ˈɛrændʒ ˈærɒndʒ]

APPENDIX 5-6: SPEECH DATA SAMPLE

Subject: SIOM.CA 4:08 .AA 5.5. VA:7:02

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[✓	✓	✓	/nʌst	[✓
	Spider	✓	✓	✓	ˈspaɪdə	✓
	Wasp	✓	✓	✓	wɛsp	✓
	Ducks	✓	✓	✓	dæks	✓
	Biscuits	✓	✓	✓	ˈbæskɔɪts	✓
B.	Snowman	✓	✓	✓	ˈsnɪmɒn	ˈsŋɪmɒn
	Scarecrow	✓	✓	✓	ˈsɪkɜkreɪ	✓
	Scarf	✓	✓	✓	ˌskaθ	skaf
	Slipper	✓	✓	✓	ˌslɛpə	✓
	Caravan	✓	✓	✓	ˈkɪrɪvɪn	kaʊəvɪn
C.	Television	✓	✓	ˈtɛjɪvɪʒn	ˈtɒlɒvʌʒn	ˈt̪kɒlɒvʌʒn
	Dragon	✓	✓	✓	drɪgn	✓
	Treasure	ˈtwɛʒə	ˈɟɛʒə twɛʒə	ˈtwᵛɛʒə	trɪʒə	ˈtrɪzə
	Castle	✓	✓	✓	ˈkʌsl	✓
	Fire engine	✓	✓	✓	ˈfaɪ ˈændʒn	✓
D.	Bucket	ˈbʌkɪʔ	✓	ˈbʌkɪtk	bɪkʌt	✓
	Spade	✓	✓	✓	spaɪd	✓
	Crab	✓	✓	✓	kræb	kræb
	Star	✓	✓	✓	stɪ	✓
	Kite	✓	✓	✓	kɔɪt	✓
E.	Burglar	✓	ˈbɜgəlɔ	ˈbɜgəlɔ	ˈbagli	✓
	Rocket	ˈvɒkɪʔ	✓	ˈrɒkɪ	ˈrɛkɔt	✓
	Guitar	kəˈtɑ	kəˈtɑ	gəˈtɑ	gæˈtɔ	✓
	Rollerskates	✓	✓	✓	ˈrælɪskaʊts	✓
	Motorbike	✓	✓	maʊʔə baɪk	mɪtɪbaʊk	vɪ vɪkɪbaʊk
F.	Basket	ˈbæskɪʔ	✓	✓	ˈbɛskæt	✓
	Pencil	✓	✓	✓	pɪnsəl	pɛnsɪl
	Chips	✓	✓	✓	ʧʌps	✓
	Chocolate	ʧɒkləʔ	✓	✓	ʧɪkɪlaʊt	✓
	Orange	✓	✓	✓]	ˈɛrændʒ/	✓]

APPENDIX 5-6: SPEECH DATA SAMPLE (T1)

Subject: Michael

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[nɛs	✓	nɛs	/nʌst	[✓
	Spider	✓	spmaɪdə	✓	'spɔʊdə	✓
	Wasp	wʷɒsᵖ	✓	wɒsᵖ	wɛsp	ʷɛst
	Ducks	✓	✓	✓	dæks	dʌks
	Biscuits	'bmɪskɪts	✓	✓	'bæskɔɪts	✓
B.	Snowman	✓	sməʊ snəʊmæn	'snəʊmæ̃ⁿ	'snɪmɒn	sndɪmɒn
	Scarecrow	'skʊɛə 'skʊɛərəʊ skwɛə rəʊ mæn sk·skɛə kgʊəʊ	skrɛə k əʊ skʊɛə k ʊ əʊs	'skʊɛəskʊəʊ	sk3kreɪ	'sk3 'kwɛəkrəʊ
	Scarf	skafᶻ	✓	stkaf skwafs	skaθ	skaf
	Slipper	~~t~~ stɪpə	səlɪpə	slɪpəᶻ	'slɛpə	slɪpə
	Caravan	'kævəvæn	kæ̃ʊ:væn	tkævæn	'kɪrɪvɪn	'kɪvɪm 'kɪvɪvɪn
C.	Television	'tɛ:vɪʒn	'tɛjɪvɪʃn	tɛʔvɪʃn	'tɒlɒvʌʒn	tɛlɪvɪnʒn
	Dragon	✓		dræɡn dʒæɡn	'drɪɡn	✓
	Treasure	dʒʌɡ dʒɛz dʒɛʃə	'trɛvə tʃɛvə twɛʃə 'tʃɛʃə	tʃɛvə	'trɪʒə	✓
	Castle	✓	✓	✓	'kʌsl	✓
	Fire engine	faɪ; faɪ ɛ̃ʒɪn	faɪ ɛ̃ʒɪn	faɪ ɪn faɪ ɛʒn	fəændʒn	faɪᵊ ɪnʒɪn
D.	Bucket	✓	✓	bʌʔkɪʔ	'bɪkʌt	bɪkʌʔp
	Spade	✓	✓	✓	spɔʊd	✓
	Crab	kxəwæb	klʊæᵇ	kʊᵊæb	krɛb	kʊɛb
	Star	✓	✓	✓	stɪ	✓
	Kite	keɪʔ	kaɪtk	keɪʔ	kɔɪt	✓
E.	Burglar	'bɜɡəlɐ	'bɜɡəlɐ	'bɜɡəlɐ	'bɒɡlɪ	'baʰjɪ
	Rocket	'ʋɔkɪʔ	'ʋɒkɪt'	wɒkɪʔ	'rɛkət	'rɛkəˢ 'rɛkəts
	Guitar	.təʔ'ʔɑ	tʃɪʔɑ	əʔtɑ	ɡæɪtɔ	ɡəˈtəɔ
	Rollerskates	'ʋ̃ɔ:skeɪʔ	rəʊᵗ:skeɪʔ	wəʊlᵖ:skeɪ	'rælɪskəʊts	'ʋælɪ'skəʊts
	Motorbike	'bməʊʔə'baɪʔ	'məʊ:tə'baɪt	mɔʔ:əbaɪ	'mɪtɪbəʊk	'mɪkɪ'bəʊᵏs
F.	Basket	✓	✓	✓	'bɛskæt	'bɛskæ
	Pencil	✓	✓	pɛnsɪʊ	'pɪnsəl	'pɛnsɪʊ
	Chips	✓	dʒɪps ✓	✓	tʃʌps	✓
	Chocolate	✓	✓	'tʃɒklɪts 'tʃɒklɪk	'tʃɪkɪləʊt	tʃɪkɪ̃ləʊʔ
	Orange	ɒwɪndʒ	✓	ɒwɪndʒ]	ɛrændʒ/	'ɛʊɪnʒ]

APPENDIX 5-6: SPEECH DATA SAMPLE (T1)

Subject: Caroline

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[nɛs	nɛs	nɛs	/nʌst	[nʌs
	Spider	'spaɪdə	spaɪʔə	spaʔjə	'spaʊdə	spɔdə
	Wasp	wɒɸ wɒs	wbɒs wɒs wɒʔɪ bɪ	wɒs wɒs wɒʔ	wɛsp	sw³fθ
	Ducks	✓	✓	✓	dæks	dʌks
	Biscuits	'bɪsɪʔ 'bɪsɪt 'bɪ'sɪ	'bɪ'tɪz	bɪsɪʔ	'bæskɔɪts	'bæs'kɔɪts
B.	Snowman	'snɑdəʊmæn	snəʊmæn	səʊmæn sⁿəʊmæn	'snɪmɒn	sm snɪmɒn
	Scarecrow	s s stɛəmæn 'stɛəkəʊ	skɛəkəʊ	s²'stɛəkʷəʊ	'skɜkreɪ	'skɜ'kreɪ
	Scarf	skɒas	s² s: sraf	s² sᵏ skaf staf	skaθ	skaf
	Slipper	sɪpə	'sɪpə	ʒjɪpə	'slɛpə	s' səlɛpə
	Caravan	'dʒælɪbəbæn 'kærɪbæn 'kærɪvæn 'kærɪ'væn	kˣærɛvæn kæləvæ	dærɛbæn kævəbæn	'kɪrɪyɪn	✓
C.	Television	tɛlɪ tɛlɪvɪʃn	'tɛlɪ'vɪʃn	tɛlɪ'vɪʒn	tolo'vʌʒn	✓
	Dragon	'dʌgn	dʷægn	dvægn	drɪgn	✓
	Treasure	st sɛʃɛə stɛvə dɛvə stɛə dʒɛlɪʃ dʒɛdə	'brɛdəz	'tɛlɪʃ	'brɪʒə	tərə 'brɪʒə
	Castle	✓	✓	✓	'kʌsl	s kæsl
	Fire engine	faɪə'ɛdʒ faɪə'ɛʒɪn 'faɪlə ɛnʒɪn	faɪɛ ɛndʒɪn	faɪɛ ɛʒn faɪɛ ɛdn	'fa'ændʒn	'fæ 'ændn
D.	Bucket	✓	✓	✓	'bɪkʌt	'bɪtɪk 'bɪkæt
	Spade	✓	speɪ speɪᵈ	speɪd speɪ	spaʊd	spaʊ
	Crab	kəvæb	✓	kˣvæb	krɛb	✓
	Star	✓	✓	✓	stɪ	✓
	Kite	✓	✓	✓	kɔɪt	✓
E.	Burglar	'bɜdlə	bɜgləˣ	'bʌglə	'bɒglɪ	'bagəlɪ
	Rocket	'vɒkɪʔ	'vɒkɪt	'wɒkɪʔ	'rɛkət	✓
	Guitar	'tɪ'ta tɪ'ta tɪ'da tɪ'do	'tɪ'kɪ 'dɪʔgra	tɪ'ta	gæ'tɔ	tɪtʰɔ 'dæ dɪtɔ
	Rollerskates	s skɛɪt vəʊlə skɛɪt	'vəʊlə stə 'stɛɪt	'vəʊlə stɛɪk	'ræləskɔɪts	'ræbɪstəʊ
	Motorbike	'məʊkəbaɪk	✓	pməʊʔ: baɪ ɸməʊ baɪ	'mɪtɪbaʊk	✓
F.	Basket	bə bæsɪʔ bæs 'bæskɪʔ	bækɪt bækɪtˢ	'bæsɪʔ	'bɛskæt	'bɛstæˡ
	Pencil	✓	pɛsɪʊ	✓	'pɪnsəl	✓
	Chips	✓	✓	tʃɪps tsɪps	tʃʌps	✓
	Chocolate	'tʃɒkəlɪʔ	tʃɒkəlɪʔ	tʃɒʔɪlɪʔ tʃɒʔləʔ	'tʃɪkɪlaʊt	tʃɪkɪlɒk
	Orange	'ɒvɪʒ	blɪʒ	'ɒɪʒ]	ɛrændʒ/	ɛj'ɪʒ]

APPENDIX 5-7: The type and number of speech errors that emerged from the word by word analysis of the data at T1. (* = only occurred in Michael and Caroline's data, ~ = only occurred in the control data).

	Type of Speech Error	Controls	Michael	Caroline
Clusters:	Reduction,	4.9	3	15
	Weak Reduction,	1.9	2	2
	* ʔ Replacement,	0	2	1
	Omission,	0.2	1	0
	Reversal,	0.1	0	1
	Assimilation.	1.1	4	4
Syllables:	Deletion,	0.9	7	1
	Addition.	0.5	0	2
Consonant:	Omission,	2.1	3	7
	Weak.	0.5	6	6
Voice:	+ Voice,	0.4	3	5
	- Voice.	1.2	6	6
Place:	Fronting,	5.5	5	8
	~ Backing,	0.4	0	0
	~ Interdental,	12.5	0	0
	+ Dental.	0.3	0	1
Manner:	Stopping,	0.9	0	3
	Denasal,	0.4	4	7
	+ Nasal	0.3	4	0
	- Friction,	1.9	3	6
	+ Friction,	1.5	3	1
	Weak Friction,	0.5	0	1
	* NonEnglish.	0	1	2
Glottal:	ʔ Replacement,	2.1	15	12
	+ ʔ	0.5	1	0
wrly:	Labialised,	10.7	16	13
	Glided,	0.5	2	2
	* Flapped,	0	0	5
	Lateralised,	0.3	1	1
	+ Lateral,	0.3	1	3
	Vowel.	1.7	7	7
Assimilations:	Regressive,	2	4	8
	Progressive.	1	3	1
Intrusions:	Anticipated,	1.4	4	2
	Perseverated,	0.2	1	1
	Unrelated.	1.1	1	2
Groping:		0.9	6	22
Metathesis:		0.1	0	5
Double Articulations:		1	9	3
Nasal Emission:		0.3	0	2
Distortions:		0.5	2	4
Vowels:	Substitution,	1.7	7	10
	Neutralised,	1.2	2	1
	+ Vowel,	1.5	5	5
	* Intrusive.	0	1	0

APPENDIX 5-8: The type and number of errors occurring in each category at T1.

Error Category	Number of Occurrence Controls	Michael	Caroline
I SYLLABLE STRUCTURE.			
Clusters:	8.2	12	23
Syllables:	1.4	7	3
Consonants:	2.6	9	13
	Sum=12.2	28	39
	sd= 3.63	2.52	10
II SUBSTITUTIONS.			
Stopping:	0.9	0	3
Fronting:	5.5	5	8
Backing:	0.4	0	0
Other:	24.6	20	25
	Sum=31.4	25	36
	sd=11.4	9.46	11.17
III ARTICULATORY INCOORDINATION.			
Nasalisation:	1.0	8	9
Frication:	3.9	7	10
Assimilation:	3	7	9
Double Articulation:	1	9	3
Distortion:	0.5	2	4
Voicing:	1.6	9	11
	Sum=11	42	46
	sd= 1.33	2.61	3.33
IV ARTICULATORY INCOORDINATION AFFECTING SYLLABLE STRUCTURE.			
Groping:	0.9	6	22
Metathesis:	0.1	0	5
Intrusions:	2.7	6	5
	Sum= 3.7	12	32
	sd= 1.33	3.46	9.81
V VOWELS			
Substitution:	1.7	7	10
Neutralised:	1.2	2	1
Intrusive:	1.5	6	5
	Sum=4.4	15	16
	sd=0.25	2.65	4.51

APPENDIX 5-9: Summary of differences in error types between the controls and speech disordered children at T1.

A. MINIMAL/NO DIFFERENCE BETWEEN GROUPS.
Weak cluster reduction. Cluster reversal. cluster omission. Syllable addition. Fronting. +Glottal. Stopping. +Dental. +Friction. Weak friction. Regressive assimilation. Perseveration. Intrusive consonants. Nasal emission. Vowel neutralisation. Gliding. +Lateral. Weak nasal. +Nasal.

B. SLIGHT DIFFERENCE.
Cluster assimilation. Syllable deletion. Labialisation. +Voicing. -Frication. Metathesis. -Nasal. Double articulations. Distortions. Intrusive vowel in clusters.

C. MODERATE DIFFERENCE.
Cluster reduction. Consonant deletion. Weak consonants. Vowel lateralisation. -Voice. Progressive assimilation.

D. LARGE DIFFERENCE.
+Glottal. Groping. Vowel substitutions.

E. ONLY IN CLINICAL CHILDREN.
Glottal replacement of clusters. Flapping. r/l. Non-English sounds. Intrusive vowels.

F. ONLY IN NORMAL CHILDREN.
Backing. Interdental articulation.

APPENDIX 5-10: NUMBER OF ERRORS PER WORD AT T1

(N = Normal Controls, M = Michael, C = Caroline)

Target	Naming			Imitation Words			Imitation Nonwords			Continuous Speech		
	N	M	C	N	M	C	N	M	C	N	M	C
nest	1	1	1	1	0	1	1	0	1	1.5	1	1
spider	1	0	1	1	1	1	1	0	1	1	0	3
wasp	1	2	3	1	0	5	1	2	4	1.5	1	4
ducks	1	0	0	1	0	0	1	0	0	1	0	0
biscuits	1.25	1	5	1.25	0	4	1.5	0	0	1.33	0	3
snowman	1	0	1	1	1	1	1.14	1	1	1	1	2
scarecrow	1.77	6	5	1.85	3	1	1.5	3	0	1.57	4	4
scarf	1	1	2	1	1	3	1.33	1	1	1	3	4
slipper	1.33	2	2	1.42	1	2	1	0	2	1	1	2
caravan	1.83	1	4	1.33	3	3	1.75	2	1	1.75	2	3
television	1.4	1	2	1.66	2	1	1.22	1	0	1.16	2	2
dragon	1	1	2	1	0	1	1	0	0	1.25	2	1
treasure	1.66	5	10	2	4	2	1.2	0	2	1.75	3	4
castle	1	1	1	1	0	1	1	1	1	1	1	1
fire engine	1	3	6	1.25	1	1	1.75	1	1	1	4	4
bucket	1	1	1	1.5	1	1	1.5	2	2	1	2	1
spade	1	0	0	1	0	2	1	0	1	1	0	1
crab	1.2	3	2	1	3	0	1.2	1	0	1	2	2
star	1	0	0	1	0	0	1	0	0	1	0	0
kite	1	1	0	0	1	0	0	0	0	0	1	0
burglar	1.2	1	1	1.16	1	1	1	3	1	1.5	1	1
rocket	1.25	3	2	1.16	2	1	1	1	0	1.16	2	2
guitar	1.57	4	8	1.42	2	4	1.66	2	4	1.75	2	2
rollerskates	2	3	4	1.57	2	4	1.5	2	3	1.6	2	3
motorbike	1	3	1	1	2	1	1.16	2	1	1	3	5
basket	1	1	4	1.33	1	3	1.5	1	2	1.75	1	2
pencil	1	2	1	1.4	1	2	0	0	0	1	2	1
chips	1	0	0	1	1	0	1	0	0	1.2	0	1
chocolate	1.6	2	3	1.25	1	1	2	2	2	1.75	1	2
orange	1.28	1	3	1.33	0	3	2	1	3	1.6	1	3

APPENDIX 6-1: COMPLEX NONWORD AUDITORY DISCRIMINATION TEST

Practice Items:-

/nʌst	nʌst	skaθ	staθ
gil	dil	kɔɪt	kɔɪt/

Test Items:-

Set A

/wɛsp	wɛps
'snɪmɒn	'snɪmɒn
wɪb	jɪb
'lɔʊthaɪs	'lɔʊthaɪf
dæks	dæks
'skɜkreɪ	'stɜtreɪ
gə'tɔ	tə'gɔ
pɪnsəl	pɪnsəl
'ɪbɪkəs	'ɪkɪbəs
'beskət	'beksət/

Set C

/bʌg	bʌg
'slɛpə	'slɛtə
'pɛpi	tɛpi
'kʌsl	'kʌsn
tænt	tɪnt
ɥʌps	ɥʌps
'bæskɔɪts	pæskɔɪts
dæl	dæl
dæsk	dæks
'ɥɪkɪlɔʊt	'ɥɪkɪlɔʊt/

Set B

/stɛmp	stɛmp
beɪt	peɪt
'rɛkət	rɛtək
smaɪk	smaɪk
'ræliskɔʊts	'læriskɔʊts
drɪgən	drɪgən
bɪkʌt	bɪtʌk
'kɪrɪvɪn	'kɪrɪvɪm
'ærɪndʒ	'ærɪʒ
'spɔʊdə	'spɔʊdə/

Set D

/ski	ski
beɪ	beɪ
spɔʊb	spɔʊd
'brɪʒa	'brɪða
krɛb	krɪb
'bagli	'badli
ɥʌsp	ɥʌps
'tɒldvʌʒn	'tɒldvʌʒn
spɔʊd	spɔʊd
mɪrɪbɔʊk	mɪkɪbɔʊt/

APPENDIX 6-2: ANOVA SUMMARY TABLE

Auditory discrimination of complex nonwords by normal children from the three chronological age groups (4, 5/6 and 7/8 years).

Source	SSqs	df	Msqs	F	p
Bet Gps (CA)	2677.435	2	1338.717	8.974	0.00062
Within Gps	5817.617	39	149.170		
Total	8495.052	41			

APPENDIX 6-3: LEXICAL DECISION TEST STIMULI

(after Coltheart 1980)

Words	Legal Nonwords	Illegal Nonwords	SET A	SET B
house	gouse	housl	fire	foom
school	schoom	sctool	fnoor	doney
fire	fime	firw	fodb	church
floor	floon	fnoor	cag	myn
food	foop	fodb	heao	cbild
water	nater	watlr	womgn	girl
face	fape	xace	food	hapd
head	heam	heao	floor	garl
eye	ede	eyw	car	bcy
book	boak	bodk	woman	ginl
car	cag	cgr	ede	doy
woman	moman	womgn	foop	street
girl	garl	ginl	moman	road
road	poad	ryad	bodk	money
boy	doy	bcy	cgr	ryad
street	streed	shteet	heam	room
money	doney	mpney	xace	rodm
hand	pand	hapd	fape	chold
church	charch	cfurch	eyw	toble
door	hoor	doqr	schoom	door
man	mun	myn	nater	cfurch
table	toble	tabwe	eye	poad
child	chold	cbild	book	pand
room	foom	rodm	house	shteet
			face	mpney
			fime	boy
			gouse	[illegible]
			head	man
			firw	table
			floon	mun
			school	doqr
			water	streed
			watlr	hand
			housl	charch
			sctool	tabwe
			boak	child

APPENDIX 6-4: ANOVA SUMMARY TABLE

Lexical decision by children from reading age groups 6:0 ,7:0 and 8:0 years (P(A) scores).

Source	SSqs	df	Msqs	F	p
Bet Ss	3800.037	26			
Reading Age	1453.481	2	726.741	7.433	0.00307
SwGrps	2346.556	24	97.773		
Within Ss	5056.500	27			
Modality	2360.167	1	2360.167	39.122	0.00000
RA x Mod	1248.444	2	624.222	10.347	0.00057
Mod x SwGps	1447.889	24	60.329		
Total	8856.537	53			

APPENDIX 6-5: MICHAEL AND CAROLINE'S RHYME PRODUCTION RESPONSES

Stimulus	Michael	Caroline
hat	cat, cut, hut, nut.	bat, bit, bite.
key	bee, ee, wasp, tea, ee, bee.	king, car.
comb	coat, coach.	brush, kelim, came, pen, men.
bin	bit, pin, pam, an.	bin, pan, sit, pin.
shell	shed, shoulder, books shed, books, something you put on the wall, book shelf.	shell, sea, shelly, saw, shell.
draw	drum, doll.	drawl (gesture of drawing)
map	train map, trap, hatch, mat, mop.	map, bat, pop, mop, top.
log	mog, hog (whispered), hog, mog (voiced).	cot, cog, leg.
bear	bear, beachball, beachback, beeboat.	bed, bag.
sew	soap.	Sue, sing, winner, sh, boy, low, solo, hello, no, doe.
sun	sun, lun, mun, clouds, sky.	sun, san, s, n, s.
wool	what is wool? jumper, skirt.	wool.
eye	(pointed to eye) glasses, I I am, I like.	eye, n.
bed	[illegible]. bread, time to bed, blackboard, purse.	red, bed, red.
four	fork, four, 1234, four birds, four teachers.	four, fawn.
ring	king, watch, earrings, king and queen.	ring, king, ring, king.
fish	fish, dish, ish, dash, dashy, mash, hash, lots of words.	fish, dish, dish.
can	open the can, like can of stars, cape, cake, cran, queen, cake, make, like.	can.
heart	Miss Heart, Heart to Heart, your heart (pointed to stomach).	hat, har, ha, ham.
iron	iron, you put on meat when you make gravy, something you put on your eye and it stings, iron, cannonballs.	iron, I.

APPENDIX 6-6: WRITTEN RHYME DETECTION TEST

Practice Items :-

win	pin	pen
drawer	move	more

Test Items:-

pan	fan	far
mop	map	pop
sew	new	no
cat	mat	car
hear	heart	cart
leg	pig	peg
week	beak	bear
boot	note	boat
hit	hat	fat
toff	laugh	cough
wig	big	bag
fear	pear	fair
rope	soap	ripe
tart	dart	dirt
yacht	coat	cot
bad	bed	red
fill	fall	ball
gun	fun	fin
paw	four	hour
hail	hair	sale

APPENDIX 7-1: LETTER IDENTIFICATION ERRORS

	MICHAEL	CAROLINE
Letter Names	Q - Don't Know W - Y	100% Correct
Letter Sounds	a -[eɪ ɑ ʌ æ e - ɪ f - ɛf g - dʒ i - dʒ l - dʒ aɪ q - ju r - ɑ x - ɛtʃ y - g waɪ jə]	e -[i i - ɩ n - ɛn o - əʊ q - kwu r - ɑ u - ju v - vi y - wə]
Correct:	b c d h j k m n o p s t u v w z	a b c d f g h j k l m p s t w x z
Blends	bl -[bələ gl - gələ cr - kɑ tr - tɑ fr - fələ cl - sk ✓ st - kst s:t gr - gl dr - dərə dw - βw tw - təwə pr - pl sp - sləp bl - bələ scr - səʔɑ spr - sɪgpɔ sɪg shr - sələ thr - f:lə squ - sk slə]	bl -[bələ gl - gəʊlə tr - təʋə fr - fəwə pl - pələ cl - kələ gr - gəʋə dr - dəwə dr - dəwə tw - təwə sn - sənə pr - pəʋə spr - spəʋə shr - səʰʋə thr - təhə squ - swʊʰə]
Correct:	sw pl sn sl sm	sw cr st sl sp bl sm scr

APPENDIX 7-2: WORD AND NONWORD READING - MICHAEL (J1)

WORDS				NONWORDS			
REGULAR		IRREGULAR		REGULAR		IRREGULAR	
siege	[seɪk] DK	choir	[hɔʊtʃ]	diege		choiy	
grill	[gɪʊ gəlu] (glue)	flood	[ʃʌd fʌt] (foot)	crill		plood	
drug	drum	aunt	nut	brug		aund	
slot	[sɒf] (soft)	wolf	✓	flot		wolt	[wuft]
lime	lemon	pint	[pɪnd] paint	kime		jint	
film	✓	sign	[ʃaɪn] ✓	pilm	[f tʃəməlin pɪlʃ]	hign	hide
task	[a²t atʃ] (arch)	dove	[dəʊtʃ] DK	rask		pove	
shin	sugar shirt	wand	[wænd] DK	shim		wamp	
hatch	[heɪtʃ həʊt] DK	bread	✓	natch		cread	ice cream
spade	[s s 'spɛəkɪ sspɛᵏtɪ] (spaghetti)	glove	[gə'rub gəlʌb] DK	spake		slove	
prince	[bɪl pleɪk] DK	tongue	[t' əʊk 'tʃeɪ 'təʊ 'təʊgeɪt] (part of school ?)	drince		fongue	
plug	[pəlu] DK	bowl	[bəlɒ² bəʊwə] DK	flug		nowl	
blade	[bəlɪŋk] DK	swan	[swɛŋ] DK	clade		swad	
bleat	bleach	shove	[ʃəʊwʸə ʃɛ 'ʃəʊ'wə] (shower)	cleat		chove	
snail	[sɛs] ✓	suede	superman	spail	[spəʊ]	duede	
globe	[gələʊb] DK	sword	wool	flobe	[fəʊp]	swort	
cask	[ætʃ kætʃ æk æsk] DK	vase	[vã zɪz] (varnish)	pask		jase	

APPENDIX 7-2 (contd) - MICHAEL (T1)

WORDS				NONWORDS			
REGULAR		IRREGULAR		REGULAR		IRREGULAR	
match	✓	breath	[b3v] (birth)	tatch	tissue	freath	
plug	[grəʊ: bləʊ²] DK	ward	work word	flug		warg	
bitter	[ˈbɪtæ] (litter)	double	[bəˈwəʊt bwəʊp wəʊp dəʊt] (for ladders)	vitter		louble	
thimble	[fɪmbə fɪmb fɪʊm] (film)	sausage	[sɔʊkˈ səʊ tʷeɪ] DK	shimble		hausage	
tutor	[təʊwə tʌk tʌkwə tʌf tʌə tʌptʃa] DK	loser	[lɒst lɒs ə]	nutor		soser	
lobster	[lɒ²stə lɒst lɒtpə lɒp lɒvst] (lost)	lettuce	[lɛtˈtə lɛ²ə] (letter)	hobster		pettuce	
market	✓	police	✓	garket	[gəˈʊɑdn] (garden)	kolice	[kɒɒk əʊlk lɛɪt əʊkeɪ]
divine	[dʷʊuɪdʒ dʒuʊɪʃ] DK	steady	[sæd ʃed slaʊt slaʊk] (afloat for aboat in Barbados)	bivine		skeady	
organ	orange	lever	liver	urgan		dever	
lemon	✓	litre	[lɪtˈ] DK	pemon	[p3ʂu]	bitre	
market	✓	island	[ɛs ɪslæncləg] ✓	garket		islank	[aɪk island aɪk]
mixture	mince	colonel	[kaʊk kaʊlə] (cocacola)	rixture		polonel	
bitter	[bɪtæ pɪtæ] (litter)	marine	[mɒʂ mɛlɒʐ] (mosh melwus)	vitter	[vfɪʊm]	narine	
thimble	film	biscuit	[bɪkɒs] DK	shimble		kiscuit	

Reference: Parkin, A.J. (1982) Phonological recoding in lexical decision: Effects of spelling to sound regularity depending on how regularity is defined. Memory and Cognition, 10, 43-53.

APPENDIX 7-2: WORD AND NONWORD READING - CAROLINE (T1)

WORDS				NONWORDS			
REGULAR		IRREGULAR		REGULAR		IRREGULAR	
siege	[ssiL səlɪb səlɪpk sLək] OK	choir	[gəʊs holə gəʊs] (holyghost) something like star.	diege		choiy	
grill	[grɛ gərawə gərə grə grə]	flood	food - No [fəʌn fətæn] (lives in the water)	crill		plood	
drug	dig - No [dʌg dɪd dʌd dɪd dʌk] (digging)	aunt	uncle - no got [eɪ] in it name of an animal (ant)	brug		aund	
slot	[səL səL] slam slum piece of cake	wolf	✓	flot		wolt	wolf
lime	If it said to it be 'time' [lə laɪm] ✓	pint	paint	kime	[kəræn kəvæn]	jint	
film	[fɪsɪn 'fɪLʌm] OK	sign	[sɪnə] ceiling [sæn son] singing	pilm		hign	
task	[tas tas dast das] OK	dove	['duvæL] (like French)	rask		pove	
shin	[ʃa:n ʃʌnɪ] shine	wand	[vɪŋə] [wɒnə] (somebody beat you in a face)	shim		wamp	
hatch	[hætrə] OK	bread	✓	natch		cread	[sɪ'Li kri kəvi]
spade	✓	glove	[gʊʌb] [gəLʌb] ✓ (put it on your hand)	spake	[skæt]	slove	[sə'Lɒk]
prince	Princess Ann	tongue	[twək twɒk] OK	drince		fongue	
plug	[pLʌm]	bowl	[bəʊw bəLəʊ bəʊ bəʊ: bəʊ] ✓	flug		nowl	[haʊL 'hæləʊ naʊ nəLəʊ]
blade	[meɪ bə deɪ bədeɪ bədæ]	swan	[wɜnz] snake - no worms	clade		swad	
bleat	[bə bə Lə'ɪt 'ɪtɪn 'ɪtɪn bəLeɪ 'bLeɪ'ɪtɪn] OK	shove	[ʃ'fəLəʊ] (shadow)	cleat		chove	
snail	✓	suede	[sə'deə səLɪŋ sLɪmn] (slim)	spail	[spL3L:]	duede	
globe	[gəʊL sfwan gərʌn] (name of a bird)	sword	[w3 w3s sw3 s] (recognised word) A card game	flobe		sworf	
cask	[skædz sk ska ski kə'L3 sʌL] OK	vase	[vəLi viæz] OK	pask		jase	

APPENDIX 7-2 (contd) - CAROLINE (T1)

WORDS: REGULAR		WORDS: IRREGULAR		NONWORDS: REGULAR		NONWORDS: IRREGULAR	
match	✓	breath	['bredzə 'bezkʌpt 'beztʌz bɪtzæ] OK	tatch	[tʌt tɒt təlæk]	freath	
plug	[pʌm pʌn] (plum)	ward	word	flug		warg	
bitter	[betə bætə bʌtə] or butterfly. Not butter 'cause its a [ʌ]	double	[də'wæt dəwəlæt] OK	vitter	OK [fɪndə vɪt]	louble	
thimble	[bɪtzæ]	sausage	[sotsədi 'sokəri] pig meat, along thing ✓	shimble		hausage	[hæ'sæm]
tutor	[tʌt tuwət təwæt] OK	loser	[ləʊz] OK	nutor		soser	
lobster	[bɒ'lɒt bk lɒg] OK	lettuce	[tələt təlep] OK	hobster		pettuce	
market	✓	police	policeman ✓	garket		kolice	[kə'læ kə'lɒp kɒp]
divine	[dwæli] driving	steady	[strat] (start)	bivine		skeady	
organ	orange-No [ɔgrə] OK	lever	[əlif lɪtə let lɪtə] (litter)	urgan		dever	
lemon	✓	litre	[də lʌt lʌt lɪt lɪk lɪkt] (Lick)	pemon	[pə'læn pə'vi]	bitre	
market	✓	island	✓	garket	[gəʊk gɒt]-No [gɒlɪk]	islank	[ˌæ nə'pˀæŋk 'aɪ nə'kˀæ̃]
mixture	[m m mɪt mɪnɪt] OK	colonel	[kənɒn kələ kənə] (like a number)	rixture		polonel	
bitter	[bɪtæ]	marine	marry-no [mæri]	vitter		narine	
thimble	[θɪm təlem təhə] OK	biscuit	beautiful butterfly	shimble		kiscuit	

Reference: Parkin, A.J. (1982) Phonological recoding in lexical decision: Effects of spelling to sound regularity depending on how regularity is defined. Memory and Cognition, 10, 43-53.

APPENDIX 7-3: SILENT READING TESTS

APPENDIX 7-3a: HOMOPHONE MATCHING TEST (COLTHEART 1980)

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APPENDIX 7-3B: KNOWLEDGE OF ORTHOGRAPHIC RULES (Baron and Strawson 1976).

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APPENDIX 7-3C: SEMANTIC ODD-ONE-OUT TEST

	Set A	Set B
Practice:	dog table cat	cow stool chair
	car man lady	van bed lorry
	pen pencil mat	walk run mop
	plate dish book	carrot peas road
	coat hat box	fork handbag basket
Test:	beer coffee tea	moon sun star
	ship boat plane	snow rain wind
	orange banana potato	ant bee spider
	rose oak daisy	school house flat
	gloves shoes boots	bus coach bike
	light match torch	glass mug cup
	robin sparrow duck	paint paper crayon
	elephant pig lion	red blue square
	cat puppy lamb	in small under
	apple cake bun	leg ear eye

APPENDIX 7-4: READING QUESTIONNAIRE (FRANCIS 1982)

M = Michael (CA 11:09), C = Caroline (CA 12:11).

1. Do you like reading?
   M: A bit - yes.
   C: Yes.

2. What do you like about it?
   M: How Sir reads - it funny.
   C: The story. Children in the story - interesting.

3. What don't you like about it?
   M: Its got nothing to like about.
   C: I don't like to write about it - too hard - I can't do it. Don't know spelling. Have to go to Sir. Too frightened. He might shout at me.

4. Which book do you like best (a) at home, (b) at school.
   M: Anyone. (a) I don't read at home. (b) Start. In space book.
   C: (a) Wizard of Oz (looks at pictures with her sister).
   (b) None of them - too hard.

5. Do you find it easy to remember words?
   M: Yes.
   C: No. If you got a lot of work to do and don't remember the words.

6. What do you do to read a word when you can't remember it?
   M: Don't know.
   C: Like in your mind. It gone. When look at page, think of word, then it disappears in your mind.

7. What do you do when you come to a new word?
   M: Learn it. (How?) Spell it. Spell the words.
   C: I don't know what it is.
   (How would you read this - bup? C put her finger on the "b" and read "up", thjen uncovered the "b" and said "bub").

8. Do pictures help you to read?
   M: No. (Why not?). Don't.
   C: Yes.(How?). When you look at a picture it looks like you know it, like tea (gestured drink).

9. Does "sounding" words help you to read?
   M: Yes. (Does it always work?). Yep.
   C: Yes, sometimes. Not a very lot. When the word is different, like "we, se and pe, se pe and ou" all mixed together because it helps you to find out the first one but the middle one you can't get.

10. Does it help if you think of another word that looks like the one you are trying to read.
    M: Yes. (How?). Like any word. Looking at the word. (When doesn't it help?). Doesn't help when you don't look at the word. You look at another word and it don't help.
    C: Sometimes. (How?). Don't know. (When doesn't it help?). When the word is different in the middle. (C pointed to a word card "heer" which happened to be on the table). If cover "he", (did so with her finger), it sounds different, you don't know what it is.

11. Do you think reading is useful to children of your age?
    M: Yes. (Why?). It do. (Why?). Don't know (pause) Read when you want to talk to people and you don't know nothing. Read in supermarket or go to wrong place.
    C: Yes, because its good for you. Because if you cannot read, you don't know what the word is. When you do your work and read something, you don't know what it is. Don't like it when everybody sitting down and you have to read (i.e. in school).

12. How do you think reading could be useful to grown-ups?
    M: Don't know. It is. Like when you want to read, they read and talk to people.
    C: Don't know about that. For you to know something.

13. Does anyone tell you they want you to be able to read? Who?
    M: Miss. H. (unit teacher). My mum. Nobody.
    C: Yes - Sir. (This led onto a discussion not recorded here. In summary, C lacks confidence in the classroom situation and is frightened of asking her teacher for help.

14. Does anyone help you to learn to read? Who?
    M: Teachers. Mr. F. (the maths teacher). (How?). Looking into books. Look at the picture and then read it. (How else?). Learning maths and all that.
    C: No. (C felt that she had had no help from her teachers with reading but that her mother and sister had helped her by telling her the words which she would then repeat).

15. Would you like to do more reading in school if you could?
    M: Yes.
    C: Yes - not in front of children.

16. What would you like to do in reading time?
    M: Don't know. T.V. kid.
    C: Sit and read anything.

17. What would you like to do instead of reading?
    M: Don't Know. (When asked if he prefers swimming he responded that he did. He felt that learning to swim was far more important than learning to read because "When the floods come you drown and you die". The school is in the Thames flood area and the children have had evacuation practices).
    C: Like doing arts.

APPENDIX 7-5: SPELLING RECOGNITION TEST (* child's response)

MICHAEL	CAROLINE
lip* lepp pil	lip* lup pil
apel lape apple*	apel apple* lape
fis shif fish*	fhis fish* shif
mabship membership* shembip	membership* shembip bnbship
pte tep pet*	pte bet pet*
trumpet trpbbie* petrum	trumpet* petrum duidry
satk sack* sak	sak suak sack*
smber temsepber september*	setemer temsepber september*
pupi pats puppy*	puppy* pupi puppet
satesatar* cigarette siguret	siguret cigarette silonwet*
finger* figger ginfer	finder* figger finger
umbeler umbrella* rberhertel	umbeler umturd umbrella*
raratostand udersand* understand	udersand undercellow understand*
trafik traffic* tarres	tiffip tafik traffic*
bump* bup borrt	bup bump* pubm
kap cap* pak	cap* kap pak
tulip* tottper choolip	choolip* tolip tulip
rifeshmet* [illegible] refreshment	withfirstmint* refreshment rifeshmet
kitten* keten netik	kitn kittle kitten*
tean* tet tent	tent* tet tnet
arterer avencher* adventure	andbackself avencher adventure*
trap* part thewenmt	unekiry trap* part
catclog catalog* catalogue	catanlog* catalogue catlog
pakit* packet pater	packet* balk pakit
nest* nexts sten	nest* net sten
koler collar* locker	koler kiltoy collar*
instuktid* nisokder instructed	instructed indivrd instuktid*
poter* polish loship	loship bybrdwn polish*
contented* ketetid kitr	ketetid cantartit* contented
back bak bank*	bak bank* nabk

APPENDIX 7-6: MICHAEL AND CAROLINE'S RESPONSES ON CAMPBELL'S (1982) EMBEDDED NONWORD SPELLING TEST

The children were instructed to listen to the following list of words. They were to stop the tester every time they heard a nonword and then write it down. Michael never stopped the tester, believing every item to be a word. Thus, his definitions are given.

Stimuli	Definition Michael only	Spelling Michael	Spelling Caroline
dish			
night			
coal			
/brəʊl/	In Barbados	Barik	bludend
lady			
boil			
/wɔɪl/	animal	werll	wraned
leg			
kite			
/jaɪt/	light	letr	judnerat
moon			
lead			
/ʃid/	-	sheed	shunad
doll			
pen			
/slɜθ/	-	safl	sclosf
brick			
pear			
heɪn	hair	hard	hirad
hue			
talk			
/lɔk/	God	Lock	lidenard
tape			
rule			
/smud/	smoothe out	sBas	sunrand
cake			
should			
/jʊd/	jam in India	jam	duteatd
tray			
plane			
heɪn	eat it	hallings	danerE
book			
bun			
/gʊd/	-	gotinog	grvad
fox			
plum			
/tid/	tea	tedinge	trvad
fish			
care			
/nɛə/	-	nenet	brAon
peach			
/spəʊl/	like a cloth	sorrting	srAct
earth			
/zɜθ/	earth with s on it	Eastsing	zrAsocd
pipe			
plum			
/tid/	-	Tenes	traven

APPENDIX 7-6 (cont)

Stimuli	Definition Michael only	Spelling Michael	Spelling Caroline
bird			
toy			
chair			
/brɛə/	-	badr	bubber
fruit			
birth			
/dʒə/	-	drne	brend
pork			
/sɔk/	meat	soad	sacrk
worm			
grass			
/sɛə/	-	sarne	sernd
glass			
train			
/skreɪn/	you rub out with a cloth - clean	saren	senacrod
plant			
tree			
/mɔk/	that is a word	morke	minacek
box			
light			
/skreɪt/	you mean like "scrate" the paper?	sorke	sarceek
neck			
good			
/bʊd/	-	boor	buacd
dive			
[illegible]			
/praɪt/	-	bolte	Brdanceoy
boy			
royal			
/jɔɪl/	-	telgt	yethorad
ball			
cup			
/dʊd/	-	dup	deransd
sock			
desk			
/dɔɪl/	-	dlole	neryanud
girl			
hole			
/nəʊl/	-	nelote	noters
coin			
feed			
/trid/	-	tera	harnecd
leaf			
food			
/tʊd/	-	tock	terdanttle

APPENDIX 7-7a: IMITATION AND SPELLING OF WORDS AND NONWORDS

(+ = correct)

	MICHAEL		CAROLINE	
WORD	IMITATION	SPELLING	IMITATION	SPELLING
nest	+	nes	nɛs	net
spider	[spmaɪdə	sd	spaɪ²ə	sqied
wasp	+	wot	wɒps wɒs wɑ²s bi	yeeb
snowman	sməʊ snəʊmæn	sawin in a swmo sowinman swon	snəʊmæn	+
bucket	+	butg	+	bant
spade	+	sddin	speɪ speɪd	sandig
crab	kxəwæb	crip	+	crust
star	+	+	+	+
kite	keɪ²	citk	+	+
guitar	tə²²ɑ	gtur	'tɪ 'kɪ dɪ²ətɑ	tiptart
basket	+	brs	bækɪt bækɪts	beaktelel
pencil	+	pdeplepi	pesiʊ	+
chips	dʒɪps +	+	+	+
NONWORDS				
/nʌst	+	nus	nʌs	bust
spəɪdə	+	spd	spɔdə	[illegible]
wɛsp	ʷɛst	west	swɜfθ	wet
snimɒn	snᵈimɒn	son	sm snimɒn	sisdn
bɪkʌt	bɪkʌ²p	bk	bɪtɪk bɪkæt	bittrat
spəʊd	–	–	spəʊ	sbon
krɛb	kuɛb	snlt	+	tunsang
sti	+	sdl	+	stent
kɔɪt	+	cwot	+	–
gæɪtɔ	gətə²ɔ	gte	tit²ɔ dæ dɪtɔ	dartnsg
'bɛskæt	'bɛskæ	beat bsetcat	bɛstæˡ	bests
pɪnsəl	'pɛnsiʊ	psoun	pɪnsəʊ]	pinsand
tʃʌps/	+	cttene	+	chod

APPENDIX 7-7b: IMITATION AND SPELLING OF CVC WORDS

MICHAEL (+ = correct) CAROLINE

WORD	IMITATION (Michael)	SPELLING (Michael)	IMITATION (Caroline)	SPELLING (Caroline)
sit	+	+	+	+
dog	+	+	+	+
tom	+	+	+	+
bat	+	+	+	+
bob	+	bom	+	bop
tot	+	tolm	+	+
cup	+	+	+	+
nob	+	Aod	+	dop
bop	+	bivp	pop bobə bop bot	+
dip	+	divino	tʃɪp dɪp	tip
gag	[djædg gæp	gings	+	gog
nick	+	sunuk	nɪpk' nɪk'	nok
peck	+	Bikp	+	peak
can	+	+	+	+
dot	+	+	+	+
bun	+	Bum	bʌm	+
bag	+	+	+	+
ten	+	+	+	+
tick	+	tek	+	+
mob	+	+	+	+
nan	nænd	Nad	+	non
nod	+	nod	+	dod
tub	dt=ʌg	+	tʌt tʌb tʌp tʌbə	tup
pam	+	pnt	+	+
gut	+	TuT	+	+
gob	+	gon	+	+
pad	+	pat	pæd də dog pæg pæ:t pædə	bud
men	+	+	+	+
mat	+	+	+	+
numb	nʌm^b	nob	+	+
kim	+	+	+	+
tag	+	+	+	+
cab	+	+	+	cabk
mop	+	+	+	+
pub	+	pom	+	puppm
peg	+	+	+	+
back	+	+	+	+
mick	+	mica	+	mak
keg	+	+	kɛ^{2}dt gɛg gɛd gɛt	gat
kick	kɪk kɪt	kig	kɪt kɪt' kɪk]	kit
pen	+	+	+	+
duck	+	dumk	+	+
bed	+	+	+	+
mud	+	+	+	mit
mum	+	+	+	+
pet	+	+	+	+
nit	+	+	+	nat
cat	+	+	+	+
gun	+	gum	+	+
pop	+	+	+	+
gap	+	+	+	gam
din	+	+	+	+
dad	+	+	+	+
gum	dgʌm	dun	+	+
mug	+	+	+	pug
nap	+	niak	+	+
ted	+	tad	+	+
nag	+	+	+	nac
dab	+	dan	+	dom
bomb	+	bon	+	bam
dumb	+	dumn	+	dam

APPENDIX 8-1 SPEECH DATA SAMPLE (T2)

Subject: Michael

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[nɛs	✓	nɛs	nʌst	✓
	Spider	✓	✓	✓	ˈspaɪdə	✓
	Wasp	✓	✓	wɒs	wɛsp	✓
	Ducks	✓	✓	dʌk	dæks	✓
	Biscuits	✓	✓	✓	ˈbæskɔɪt	ˈvæstaʊ ˈbæskaʊt
B.	Snowman	✓	✓	✓	ˈsnɪmɒn	ˈsĩmɒn ˈsnɪɒn ˈsnɪmaʊ
	Scarecrow	ˈskɛəkaʊ	ˈskɛəkaʊ	ˈskʊɛəkaʊ	ˈskɜkreɪ	ˈskɛəkraʊ ˈsɜkreɪ ˈskɜkeɪ
	Scarf	✓	✓	✓	skɑθ	skaf
	Slipper	✓	✓	ˈslɪpəs	ˈslɛpə	✓
	Caravan	ˈkævəˌvæn	✓	ˈkævəˌvæn	ˈkɪrɪˌvɪn	✓
C.	Television	✓	✓	✓	tɒlovʌʒn	ˈtɛlɪvɪʒn
	Dragon	✓	✓	ˈtræ ˈdrægn	drɪgn	✓
	Treasure	ˈʧvɛ və ˈʧɛʒə	ʧʊɛvə	ʧ ˈʧrɛʒə	ˈbrɪʒə	✓
	Castle	✓	✓	kl ˈkasaʊ	ˈkʌsl̩	ˈkasaʊ
	Fire engine	✓	✓	ˈfaɪʒɪn	ˈfa ˈændʒn	ˈfaɪ ˈɛndʒɪn
D.	Bucket	✓	✓	✓	ˈbɪkʌt	✓
	Spade	✓	✓	✓	spaɪd	✓
	Crab	kʊæb	kʊæb	kəvæb	kreb	kræb
	Star	✓	✓	✓	stɪ	ˈstɪv
	Kite	✓	✓	✓	kɔɪt	kʊɔɪtˈ
E.	Burglar	✓	✓	ˈbɜgələ	ˈbægli	✓
	Rocket	ʊɒkɪʔ	✓	ʊɒkɪʔ	ˈrɛkət	rɛkək ✓
	Guitar	✓	✓	gɪˈta	gæˈtɔ	✓
	Rollerskates	ˈʊaʊləˈskeɪts	✓	ʊo: skeɪt	ˈræliskaʊts	✓
	Motorbike	✓	✓	✓	ˈmɪtɪˌbaɪk	mɪtɪbaɪtˈ
F.	Basket	✓	✓	✓	ˈbɛskæt	bɛskæk
	Pencil	✓	✓	✓	ˈpɪnsəl	✓
	Chips	✓	✓	✓	ʧʌps	ʧɒps
	Chocolate	✓	✓	✓	ˈʧɪkɪləʊt	ˈʧɪkɪləʊts
	Orange	ˈɒʊɪnʤ	✓	ˈbʊɪnʤ	ˈɛrænʤ	✓]

APPENDIX 8-1. SPEECH DATA SAMPLE (T2)

Subject: Caroline

	Target Word	Naming	Imitation	Continuous Speech	Target Nonword	Imitation
A.	Nest	[nɛs nɛst nɛsk nɛs[k]	✓	nɛs	nʌst	nʌsk
	Spider	spaɪd[ʔ]ə	✓	'spaɪ[d]ə	'spəʊdə	spəʊ ✓
	Wasp	✓	✓	wɒs[pʔ]	wɛsp	✓
	Ducks	✓	✓	dʌ2[k]	dæks	✓
	Biscuits	bɪ bɪstɪt bɪskɪt	bɪskɪt'	'bɪskɪt	'bæskɔɪts	'bæs 'bæs, bæs pʌns 'bæspaɪk 'bæskaɪk
B.	Snowman	snəʊmɛn	snəʊmɛn	'snəʊmɛn	snɪmɒn	'snɪ[l]'mɒm
	Scarecrow	'skɛə'krəʊ	skɛə skɛə k:grəʊ	sk skə skjɛəkəʊ	'skɜkreɪ	'skɜkeɪ 'skrɜkeɪ
	Scarf	✓	✓	✓	skɑθ	skɑf
	Slipper	ɕɪpə²	'ɕɪpəz	ɕɪpəz	slɛpə	'slɪpə
	Caravan	'kærʔɪvæn	'kærəvæn	'kærɪvæn	'kɪrɪvɪn	✓
C.	Television	'tɛlɪ'vɪʒn	'tɛlɪ'vɪʒn	'tɛlɪ'vɪʒn	,tɒlə'vʌʒn	'tɒlə'vɪʒn
	Dragon	✓	dʒræɡn	✓	'drɪɡn	'dʒʌɡn
	Treasure	ɥ ɥɛzəz ɥ trɛvəz	'trɛʒə	trɛʒəz	'trɪʒə	✓
	Castle	kɑs 'kɑstəʊ	✓	✓	'kʌsl	✓
	Fire engine	faɪ: 'ɛndʒɪn	✓	faɪ ɛndʒɪn	'fɑ'ændʒn	faɪ ɛndʒɪn
D.	Bucket	✓	✓	✓	'bɪkʌt	✓
	Spade	✓	✓	✓	spəʊd	✓
	Crab	✓	✓	✓	krɛb	✓
	Star	✓	✓	✓	stɪ	✓
	Kite	✓	✓	✓	kɔɪt	✓
E.	Burglar	bɜɡə bɜɡlɪs bɜɡls	bɜɡə	bɜɡə	'bɑɡlɪ	'bɑ:lɪ
	Rocket	'ʋɒkɪt	✓	ʋɒkɪt'	rɛkət	✓
	Guitar	✓	✓	✓	'ɡætɔ	✓
	Rollerskates	'ʋəʊləskeɪʔ ʋəʊləsteɪk	'ʋəʊlə ʋəʊləskeɪt	ʋəʊ'ə skeɪt	'rælɪskɔʊts	'rælɪs'skəʊt 'rælɪ'stəʊks
	Motorbike	'məʔə'baɪt	'məʔəbaɪt	baɪt baɪk baɪt 'məʊtəbaɪk	'mɪtɪbəʊk	'mɪtɪbəʊt
F.	Basket	✓	✓	✓	'bɛskæt	✓
	Pencil	✓	✓	✓	pɪnsəl	✓
	Chips	✓	✓	✓	ɥʌps	✓
	Chocolate	✓	✓	✓	'ɥɪkɪlɔʊt	'ɥɪkəlo²k ɥɪkəɥɒk
	Orange	'ʋɒɪnʒ	'ʋɒɪnʒ	ʋɒɪ̃ʒ	ɛrændʒ	✓]

APPENDIX 8-2: CLASSIFICATION OF SPEECH ERRORS AT T2 (Total)

	MICHAEL	CAROLINE
SYLLABLE STRUCTURE		
Cluster Reduction	8	9
Syllable Reduction/Weak	4	1
Groping	3	13
Metathesis	0	3
Intrusions	4	8
Omissions	2	5
SUBSTITUTIONS		
Fronting	3	8
Backing	0	1
Other	1	1
ARTICULATORY COORDINATION		
Assimilation	2	3
Labialisation	8	8
Voicing	1	5
Frication	5	2
Weak Articulation	0	5
Distortion	0	6
Double Articulation	0	1
VOWELS		
Substitution	0	10

APPENDIX 8-3 : NUMBER OF ERRORS PER WORD AT T2

(M = Michael, C = Caroline)

Target	Naming		Imititation Word		Imititation Nonword		Continuous Speech	
	M	C	M	C	M	C	M	C
nest	1	3	0	0	0	1	1	1
spider	0	1	0	0	0	0	0	1
wasp	0	0	0	0	0	0	1	1
ducks	0	0	0	0	1	0	1	2
biscuits	0	2	0	2	4	5	0	1
snowman	0	1	0	1	2	1	0	1
scarecrow	1	1	1	3	2	2	2	4
scarf	0	0	0	0	1	1	0	0
slipper	0	3	0	3	0	1	1	3
caravan	1	2	0	1	1	0	1	1
television	0	2	0	3	2	1	0	2
dragon	0	0	0	1	0	2	1	0
treasure	4	5	3	1	0	0	2	3
castle	0	2	0	0	1	0	1	0
fire engine	0	1	0	0	3	2	2	1
bucket	0	0	0	0	1	0	0	0
[illegible]	[illegible]	0	0	0	0	0	[illegible]	0
crab	1	0	1	0	0	0	1	0
star	0	0	0	0	0	0	0	0
kite	0	0	0	0	1	0	0	0
burglar	0	4	0	1	0	1	0	1
rocket	1	1	0	0	0	0	1	1
guitar	0	0	0	0	0	0	1	0
rollerskates	1	2	0	2	0	3	1	1
motorbike	0	1	0	1	1	1	1	3
basket	0	0	0	0	0	0	0	0
pencil	0	0	0	0	0	0	0	0
chips	0	0	0	0	1	0	0	0
chocolate	0	0	0	0	1	4	0	0
orange	1	2	0	2	0	0	1	3

APPENDIX 8-4: MICHAEL AND CAROLINE'S LEXICAL DECISION RESPONSES ON THE SPEECH TASK STIMULI AT T2 (X = ERRORS)

WORDS	MICHAEL	CAROLINE	NONWORDS	MICHAEL	CAROLINE
nest				X	
spider					
wasp				X	
ducks				X	
biscuits				X	
snowman				X	
scarecrow				X	
scarf				X	X
slipper				X	X
caravan				X	
television				X	
dragon					
treasure				X	
castle					
fire engine				X	X
bucket					
spade					
crab				X	X
star					X
kite					
burglar					
rocket					
guitar					
rollerskates				X	
motorbike				X	
basket					
pencil	X			X	X
chips					
chocolate					
orange					

APPENDIX 8-5: MICHAEL AND CAROLINE'S RHYME PRODUCTION RESPONSES AT T2

	MICHAEL	CAROLINE
hat	mat cat at	hat cat bat rat nat lat
key	me dee leaf	key bee lee fee knee
comb	moan	bone roan known lone
bin	lin din min fin	bin tin fing ling clean
shell	bell ell dell	shell bell nell
draw	Miss V not tell me about draw, draw door kaw	draw floor mo
map	cat cap	lap nap flap
log	mog dog clog	log wog frog dog
bear	care lare mare	bear dare fair lair
sew	mo bo lo	so mo low
sun	sun won done	lun man dan
wool	sheep	wiu wul lu, will dill bill
eye	eye kie	spy lie eye nye
bed	bed dead ked led med	dead net lead ret wreck ret
four	four door	four door law four
ring	ring king	ling ring ding ring bing
fish	fish dish kish fish	dish fish lish fish rish
can	can dan ban	can ban can lan can fan
heart	heart bark dark	dart heart lart heart bart
lion	iron lion dion	iron farlin (filing) fe-le farin (firing) nylin(nylon)

APPENDIX 8-6a:WRITTEN RHYME RESPONSES (NORMAL CONTROLS SAMPLE)
(Two items - pig and plate - were given for practice first).

Stimulus	**S1F CA7:2, RA 7:5**	**S2F CA6:9 RA6:10**	**S3F CA7:1 RA7:5**
hat	mat cat fat rat	dat cat tobcat	mat cat rat bat hat
key	-	keys keyt	hey pey
comb	home mon	combs combse	-
bin	in din win	bin binse	-
shell	del well	shells	-
drawer	dool	drawering	-
map	nap	-	-
leg	dag	-	-
bear	heir	-	-
sew	ray	-	-
sun	run bun	-	-
wool	-	-	-
eye	-	-	-
bed	deid	-	-
four	mur	-	-
ring	-	-	-
fish	wish shif	-	-
can	han ven	-	-
heart	-	-	-
iron	-	-	-

Stimulus	**S4M CA7:3 RA8:2**	**S5M CA7:11 RA7:6**	**S6M CA7:11 RA8:2**
hat	gat nat bat	lat kat	fat pet cat sat mat hat
key	tee knee see pea	ley sey	sey wey ley mey pey ney rey fey
comb	bone done gon	-	bomb somb gomb domb momb lomb
bin	Dine gin Din	tin pin	fin tin din min lin sin gin cin
shell	Bell dell	lell sell	bell fell tell sell gell
drawer	pawr gooer	-	lawer mawer cawer sawer
map	pape gape nap	pap gap	flap clap bap cap tap
log	bog dog gog	goy	mog fog gog sog tog
bear	Dea Be nert	lear rear	fear cear rear sear tear gear
sew	pok nok wrete	-	cew flew clue blue glue you
sun	bun gun dunne	tun	bun fun run cun wun blun flun
wool	pull gull dull	-	cool gool yool rool fool sool

APPENDIX 8-6a (contd)

	S7M CA6:9 RA6:11	S8F CA8:8 RA7:10	S9F CA8:4 RA7:0
eye	bye die giue	lye	fluy buy fuy muy tuy duy
bed	dead ged ned	ted led	fed ded red head ced
four	bare Door store	tour kour	mour bour rour dour sour your
ring	bing ding ling	-	fing sing hing ding bing ming
fish	pisch Disch gish	wish tish	dish sish bish ish
can	ban Dan bal Lal	lan pan	van man ban han ran fan
heart	barth darth nart	-	beart geart ceart seart feart
iron	nion gion dieon	-	siron biron niron ciron giron
hat	cat pat rat mat	fat mat sat cat pat bat	ham Ham fram am Sam
key	he be thee	he me see	-
comb	home bome	home lome	-
bin	pin hin	Tim Tin thin in	miss fis in
shell	wall hall ball	well tell fell bell	-
drawer	bur hur tur	saw wall door	-
mop	hop tap rap	nap fap	hap tap sap
log	rog hog	fog dog	tog hog mop pog
bear	her mer	fair hair mair	mear sear bearse
sew	how tow	-	met eat feet
sun	run hun	fun run gun	man ban bun
wool	hul tul	-	-
eye	bos tis	buy	-
bed	hed ded	fed	hen men ten fen
four	hur burr	-	-
ring	ping hing	fing thing	-
fish	hish wish	wish	mish his pig fea
can	wan zan pan	fan ban	pan san fan
heart	tot rot	cart	-
iron	bron tron	-	-

PAGE NUMBERING AS IN THE ORIGINAL THESIS

	S16M CA 8:4 RA 7:9	S17M CA8:7 RA8:0	S18F CA 8:6 RA 8:3
hat	rat cat sat	mat Rat cat	fat nat mat flat
key	see ley me	ney ley sey	he my kneen Fly
comb	home fome somb	dom bom lom	home nome Fome
bin	sin lin zin	din lin cin	in tin fin pin
shell	sell mell smell	whell khell dhell	fell nell
drawer	[illegible]	brawer frawer grawer	nawer correr
map	clap tap sap	bap tap lap	hap shop
log	Jog mog kog	dog Rog mog	hog Forg dog
bear	fair hair lair	dear lear cear	here Fair
sew	mo co do	mew lew cew	low no
sun	gun won son	nun gun tun	hum thmim
wool	sool fool mool	dool gool mool	Ful
eye	seye liy fiy	cye lye nye	sizh fly
bed	med led fed	med ded ced	head said Fed
four	or cour tour	wour dour gour	tur naw
ring	sing king ming	ting ling bing	thing ing
fish	dish kish mish	lish mish wish	dish wish
car	san ann man	dan lan ran	can man
heart	start smart bart	leart geart teart	matin
iron	sion loin hion	dran lran cran	firenen

APPENDIX 8-6b: MICHAEL AND CAROLINE'S WRITTEN RHYME RESPONSES

	MICHAEL	CAROLINE
PRACTICE		
pig	big	dig wig
plate	mlate gate	weight gate
STIMULUS		
hat	mat cat dat	cat fat rat mat lat wat bat
key	me ley wey	bee fley
comb	momb bomb	phone door dawn
bin	pin din	pin fin tin lin
shell	bell cell mell	fall tail
drawer	door coor	more law
map	rap sap	lap rap cap
log	dog wog bog nog sog	frog wog dog
bear	cear lear mear	fair near lear
sew	cew lew	bowl
sun	cun dun lun	fun lun bun
wool	dool lool bool	loo do
eye	dye wey sey	fly lie
bed	red ded fed	red Ted led dead
four	dour lour mour	law poor door
ring	ring ding king	wing bring ding
fish	fish cish	dish lish
can	dan ban	fan ban lan
heart	deart	deart
iron	liron	lion nlyon

APPENDIX 8-7: SOUND BLENDING DETECTION TEST SHEET (T2)

TARGET	TEST SHEET		
PRAM	ramp	pram	prim
SLOT	slop	lots	slot
BUST	stub	busk	bust
LOAF	loaf	foal	leaf
SANG	sank	sang	snag
LUMP	plum	lump	limp
SNAP	snap	span	snip
POOL	peel	loop	pool
POTS	pets	pots	spot
BOWL	bowl	bone	blow
GRIN	ring	grip	grin
CHUM	chum	much	chub

APPENDIX 8-8: MICHAEL AND CAROLINE'S SOUND BLENDING PRODUCTION RESPONSES AT T2 (+ = CORRECT)

STIMULUS	MICHAEL	CAROLINE
l-ea-f	+	+
s-e-nt	S-E-N-T +	snet
pr-a-m	it doesn't make up a word - prom promp - we call it a push chair	+
sl-o-t	slopt +	+
b-u-st	+	busst basket
l-oa-f	+	+
s-a-ng	spring S-A-I-M	s-a-nz-g sigger slag
l-u-mp	+	l-u-l-p lup
sn-a-p	+	+
p-oo-l	+	pe-l pel
p-o-ts	pot pop +	poter potsel
b-ow-l	+	baal
gr-i-n	+	+
ch-u-m	chump +	chub

APPENDIX 8-9a: MICHAEL AND CAROLINE'S SYLLABLE BLENDING PRODUCTION RESPONSES (+ = CORRECT)

WORD	MICHAEL	CAROLINE	NONWORD	MICHAEL	CAROLINE
BA-BY	+	+	DA-DY	+	+
CA-RRY	+	+	TA-WY	tatty	+
RU-LER	+	+	YU-RER	youer	yourvet
DI-NNER	+	+	GI-MMER	gibmer	giver
TEA-CHER	+	+	PEA-SHER	peach	peash +
LI-TTLE	+	+	FI-PPLE	feipple	faithful, feipru
PO-TA-TO	+	+	BO-KA-KO	+	pokako
RA-DI-O	+	+	LA-GI-O	ladio rado	+
GO-RI-LLA	+	+	DO-LI-WA	doligwa	dolidwa dolider
CA-RA-VAN	+	+	TA-WE-ZAN	ta[illegible]san	tatzewan
TO-MA-TO	+	+	GO-NA-GO	gonano	dor +
COM-PU-TER	+	+	SON-TU-KER	sekuter	ge setuger

APPENDIX 8-9b: MICHAEL AND CAROLINE'S SOUND BLENDING RESPONSES AT T2 (+ = correct, - = not attempted)

WORD	MICHAEL	CAROLINE	NONWORD	MICHAEL	CAROLINE
TO	+	+	FOO	+	feeoo
GO	+	+	KOE	cool coo	+
ME	+	+	YEE	yoe	youkee ee
LIE	+	+	YIE	+	ye-kie
SAY	+	sayd	TAY	tays	te-ay
DOOR	+	detor dotoy	ZOOR	tore	zuz ze-oz
PEN	cook with pan	pear	SEN	faig	se es
MAT	+	hat	DAT	+	tat dat
CUP	+	+	FUP	+	fe-kup fe-pup furp
LOG	+	+	MOG	ug	mbe map
MOON	noon moryu Monday	oom noom	HOON	foon +	hoom
SACK	+	skat +	VACK	+	+
PLATE	+	+	KLATE	ate	kyate
SWEEP	+	sweet swert squawk sheep	SREEP	+	seep
TENT	te-me-pe tap	te-able	HENT	hate	hate
LAMP	-	lam lap lam	FAMP	foomp	fab fib
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] seen	[illegible]
GRAB	grape	grab grabd grabbed	PRAB	bat prat	pe-re pub
PLANK	plan +	-	GLANK	glag	-
STAMP	sint simp	-	SPAMP	swump	-
SWEETS	sweet	-	SKEETS	skeed	-
TRUNK	ke-o-ump tank	-	PRUNK	prumngk	-
CRISP	kt ip tank trunk	-	TRISP	trip	-
MATCHES	music mitch	-	FATCHES	fatch fashel	-

APPENDIX 8-10: MICHAEL AND CAROLINE'S LETTER KNOWLEDGE AT T2

I. GRAPHEME-PHONEME KNOWLEDGE (errors)

	MICHAEL	CAROLINE
LETTERS (upper case)	Y - don't know	100% correct
LETTER SOUNDS (lower case)	a - e c - s e - e or i r - R y - Y x - e	c - e - i i - I r - R u - y
BLENDS (lower case)	gr - ge dw - dr tw - trw	tr - tw sp - sbe (all other 2 consonant blends were identified correctly but segemented inappropriately eg bl/be-le, fr/fe-re)
	spr - spl thr - tr squ - skr	spr - seprek sepre shr - sh she she-be thr - twe

II. PHONEME-GRAPHEME KNOWLEDGE

	MICHAEL	CAROLINE
LETTER NAMES	correct but mixed upper and lower case:- A l g z u b H i o s n d k t r v m Q F X P y j e c w	100 % correct All upper case
LETTER SOUNDS	x - s	e - u x - k r - no response y - no response
BLENDS	sw - sl cr - cl tr - tl fr - fl st - stl gr - gl dr - dl dw - wl tw - twl pr - pn scr - str spr - stp shr - sch thr - Ful squ - srq	dw - Dn tw - Tr br - Bl spr - CBl thr - frl squ - srw

APPENDIX 8-11: WORD AND NONWORD READING - MICHAEL (T2)

WORDS				NONWORDS			
REGULAR		IRREGULAR		REGULAR		IRREGULAR	
siege	size	choir	chose chop	diege	diagram	choiy	[tʃɒᵊlə]
grill	✓	flood	food	crill	criminals crimes crim [kr-ɪ-lə]	plood	plug [plug]
drug	drunk drum drug drunk OK	aunt	✓	brug	[blugr brʌg bʊʌg ʌg brʌg] ✓	aund	around
slot	[sɒf slɒf]	wolf	✓	flot	✓	wolt	[wəʊ: wʌlfənt wʌfmənt]
lime	✓	pint	pitch	kime	[kəlɪps klɪps]	jint	[dʒʌdʒənt] judge
film	films	sign	✓	pilm	plum	hign	[haɪ]
task	[teɪsk] (taste)	dove	drove [dʌv] OK	rask	risk	pove	pub
shin	✓	wand	woodland wonder	shim	[s tʊɪms stʊɪms]	wamp	[wa:mb wɒmp] swamp
hatch	[ætʃ] OK	bread	✓	natch	nitch	cread	[kwaɪ kraɪ]
spade	[skɛtˈtɪ bəsˈgɛtɪ] (spaghetti) or spam	glove	[gləʊv]	spake	[spæk]	slove	slope
prince	prince princess ✓	tongue	tonight	drince	din darts	fongue	[flɒg ʏ fləʊʏ]
plug	✓	bowl	blow	flug	[flʌg] flood [flʌg] ✓	nowl	[naʊ:]
blade	[bələʊt blitʃ]	swan	✓	clade	[kleɪs] case	swad	swans swan
bleat	[bəlit bəlip] (pleat)	shove	[ʃəʊfə]	cleat	[kʊˈaɪᵊtɪ]	chove	[tʃəʊb tʃəʊn]
snail	✓	suede	susan	spail	[sp ˈspæki ˈspetɪ ˈsketɪ] (spaghetti)	duede	[dʌgn]
globe	[gələʊb gəlʌb]	sword	[swɒnd]	flobe	[flɒb]	sworf	[ss:ɒf s:ɒf]
cask	[kas katʃ kɒts]	vase	vaseline	pask	[pɒ:sk pask] (past)	jase	[grasɪ]

APPENDIX 8-11 (contd) - MICHAEL (T2)

WORDS: REGULAR		WORDS: IRREGULAR		NONWORDS: REGULAR		NONWORDS: IRREGULAR	
match	✓	breath	[bref brits bredʒ]	tatch	✓	freath	French
plug	✓	ward	words	flug	✓	warg	[wɜsk wɔtʃ wɔʃt]
bitter	✓	double	✓	vitter	✓	louble	['lɒbə]
thimble	[trʌmbl̩]	sausage	[ʃ æ] sugar	shimble	[ʃlɪmɪn ʃʌmʌn]	hausage	[haʊsp] house without are [haʊseɪdz]
tutor	[tʌb]	loser	[ləʊs]	nutor	[hʌtrəʊ]	soser	socket
lobster	['lɒsbə] ✓	lettuce	litter	hobster	[hɒsbʔɪs] hospital	pettuce	[pʊɛt]
market	✓	police	✓	garket	[gɔ guat guat]	kolice	['kaɪ 'kaɪ 'kaɪsl̩]
divine	drive	steady	steal	bivine	believe	skeady	['sʊɛdɪz 'sʊɛdɪz]
organ	orange	lever	leave	urgan	ungreat	dever	[dɛv]
lemon	✓	litre	[litʃ litʃərə litter]	pemon	✓	bitre	[ˌbɪ'tʌs]
market	✓	island	✓	garket	['gadəŋk 'kipə] (garden keeper)	islank	[aɪsk]
mixture	✓	colonel	colour	rixture	[rɪ'mɪts tʃə rɪ'mɪtʃə]	polonel	[pəʊ'lɒn pləʊl]
bitter	✓	marine	['mærɪleɪn] (marilyn)	vitter	[frɛn²s fɛns]	narine	nutties
thimble	[trʌmbl̩]	biscuit	biscuits	shimble	[ʃɪnʃaɪn ʃɪmʃaɪn]	kiscuit	kissed

Reference: Parkin, A.J. (1982) Phonological recoding in lexical decision: Effects of spelling to sound regularity depending on how regularity is defined. Memory and Cognition, 10, 43-53.

APPENDIX 8-11: WORD AND NONWORD READING - CAROLINE (TA)

WORDS				NONWORDS			
REGULAR		IRREGULAR		REGULAR		IRREGULAR	
siege	[sɪgəʊ]	choir	choice	diege	[daʊg]	choiy	[ʃu ʃiʊ]
grill	✓	flood	float [fəʊd fəʊlud] OK	crill	cream - no [kʊɪŋ krɪ~l]	plood	blood bleed [pəlit]
drug	✓	aunt	✓	brug	[bra:g bʊagə]	aund	[ʌ~gl]
slot	✓	wolf	✓	flot	[fəlot]	wolt	[wuf wufstə wuftəd]
lime	✓	pint	[pri~ prit]	kime	come [kʌm]	jint	[dʒɪgə dʒɪtə]
film	✓	sign	✓	pilm	plum [pɪlʌm]	hign	[haɪn] ✓ high with 'n' on it
task	✓	dove	drove	rask	✓	pove	[pəʊz pəʊ pəʊs pəʊsə]
shin	✓	wand	[rænd]	shim	shame [ʃaɪm]	wamp	[womp]
hatch	✓	bread	✓	natch	[næʒʃ] ✓	cread	[kʊɪn kʊɪnd]
spade	✓	glove	[klʌb] ✓ (on your hand)	spake	spike spoke	slove	[səlɒz səlop]
prince	✓	tongue	tangerine	drince	dice	fongue	[fəʊl fəʊ:]
plug	✓	bowl	✓	flug	[fəl flʌg] ✓	nowl	✓ [naʊl]
blade	[bləd] not blood [bləd]	swan	✓	clade	[kleɪt kleɪv]	swad	snored
bleat	[bɜt]	shove	shone	cleat	[kəlik kəlikt kəlit] ✓	chove	[kəʊd]
snail	✓	suede	[skut səʊ] OK	spail	[spil]	duede	[dəʊu dəʊʊ]
globe	[kəlʌb kəlob]	sword	✓	flobe	[fəlobə]	sworf	[snu sswuf səwif]
cask	✓	vase	✓	pask	✓	jase	[dʒes]

APPENDIX 8-11(contd) - CAROLINE (T2)

WORDS				NONWORDS			
REGULAR		IRREGULAR		REGULAR		IRREGULAR	
match	✓	breath	✓	tatch	✓	freath	[fʊ fʊɒg fʊə²ʃ]
plug	✓	ward	word	flug	[flʌŋk flʌŋk]	warg	[wɑ:g]
bitter	✓	double	✓	vitter	✓	louble	[lʌbə]
thimble	[fʌm fʌndə fʌm]	sausage	[sɒs sɒsərɪ] ✓ can't say it like a hot dog	shimble	[ʃɪmtə ʃɪmə]	hausage	[hɒs'eɪdʒ 'hɒsəʊɪ]
tutor	✓	loser	[lɒs lɒsə]	nutor	[həʊtˀə]	soser	[səʊz səʊhə səʊ²z]
lobster	[lɒb stə lɒs bə lɒstə lɒbstə] (animal like a mouse)	lettuce	letter-No [letɪs] (name)	hobster	[hɒbstə 'hɒsbə 'hɒstə]	pettuce	[petəs petɪs]
market		police	✓	garket	[kˀʌk kʌt dʒ dʒ dʒɑ:t] OK	kolice	[kəlɪ]
divine	define	steady	staring	bivine	[braɪs]	skeady	skate [skɪt]
organ	orange-No [ɔʒɪn]	lever	leave	urgan	[hʌn'græn hæn'græn]	dever	[dɪvɪ dɪvɪ]
lemon	✓	litre	[lɪt]	pemon	[pəm pəb]	bitre	✓
market	✓	island	✓	garket	[gak kat kˀak]	islank	[ɪsklæk ɪ:slæk]
mixture	mix like mixed	colonel	clock cluck [klənu]	rixture	[vɪks fɪks]	polonel	[pəlaʊ 'pɒlaʊ]
bitter	✓	marine	Maria ['mɑ:rɪn] (girl's name)	vitter	[vɪ²tɪt vɪtə]	narine	[njeɪmɒn]
thimble	tummy tumble	biscuit	✓	shimble	[ʃɪmlə]	kiscuit	✓ ['kɪs'kɪt]

Reference: Parkin, A.J. (1982) Phonological recoding in lexical decision: Effects of spelling to sound regularity depending on how regularity is defined. Memory and Cognition, 10, 43-53.

APPENDIX 8-12:SPELLING RECOGNITION TESTS AT T2 (* = child's response)

MICHAEL			CAROLINE		
lip*	lep	pil	lip*	lup	pil
apel	appel	apple*	apel	apple*	appel
fis	shif	fish*	fhis	fish*	shif
mebship	membership*	miship	membership*	mebship	shembip
pet*	pte	tep	pte	bet	pet*
tuper	trumtep	trumpet*	trumpet	trump*	tumpt
satk	sack*	sak	sak	suak	sack*
Septmber	Seteber	September*	Setemer	Semieber	September*
pupe	puppy*	puppi	puppus	puppy*	puppet
siguret*	sicerk	cigarette	cigettare	cigarette*	siguret
finger*	figger	fling	finder	figger	finger*
urmpt	umbeller*	umbrella	umbeler	umburan	umbrella*
udesand	understand*	raratostand	unstander	understand*	udersand
traffic*	traffer	tarric	tiffip	tafic	traffic*
bup	pumb	bump*	bup	bump*	pumb
kap	cap*	pac	cap*	kap	pak
tulip*	tilup	choolip	choolip	trumlup*	tulip
readfashmet*	rifeshmet	refreshment	withfirstmint	refreshment*	refreshed
kitten*	nittek	cipt	kitn	kittel	kitten*
tet	tent*	tnet	tent*	tenret	tnet
avencher	addever	adventure*	andbackself	atforch	adventure*
trap*	tap	tarp	tarp	trap*	part
catlong*	catalogue	catclog	catanlog	catalogue*	catlog
packet*	packt	pack	packet*	pattek	pakit
nets	sten	nest*	nest*	nete	nets
coler	loccer	collar*	koler	clla	collar*
instructed*	instuktid	intaimp	instructed*	instaranded	instructed
poter	plish	polish*	poshil	plash	polish*
cetetid	contented	contenter*	contartit	ktened	contented*
back	bark	bank*	bak	bank*	bakn

APPENDIX 8-13: MICHAEL AND CAROLINE'S SPELLING OF WORDS READ CORRECTLY AT T2 (+ = CORRECT)

MICHAEL

REGULAR WORDS		IRREGULAR WORDS	
hatch	hach	bread	+
grill	glir	aunt	Atnn
lime	limen	wolf	+
shin	+	sign	sine
prince	[illegible]	swan	+
plug	pug	double	dugober
snail	+	police	poilce
match	mach	island	+
bitter	bit		
lobster	lobs		
market	marker		
lemon	+		
mixture	mixed		

CAROLINE

REGULAR WORDS		IRREGULAR WORDS	
grill	+	aunt	Auntrie
drug	+	wolf	+
[illegible]	+	sign	+
lime	+	bread	+
film	flim	glove	+
task	+	bowl	bow
shin	shim	swan	swarn
hatch	+	sword	+
spade	splad	vase	vask
prince	+	breath	brealth
plug	+	double	dolud
snail	+	sausage	susanger
cask	creek	police	+
match	+	biscuit	buiscult
bitter	pittly	island	Iceland Ireland
tutor	+		
divine	defindflasd		
lemon	leman		
market	+		

APPENDIX 8-14: MICHAEL AND CAROLINE'S IMITATION AND SPELLING OF WORDS AND NONWORDS AT T2 (+ = CORRECT)

	MICHAEL		CAROLINE	
WORD	IMITATION	SPELLING	IMITATION	SPELLING
nest	+	+	+	+
spider	+	+	+	+
wasp	+	wars	+	weep
ducks	+	drus	+	+
biscuits	+	bisecet	+	biscults
snowman	+	+	+	+
scarecrow	[skeəkuəd	scerwar	+	scracrow
scarf	+	seerfary	+	+
slipper	+	spely	+	+
caravan	+	cavan	+	carvan
television	+	televistion	+	+
dragon	+	drager	+	+
treasure		trase	ʧvɛʒə	treseasure
castle	+	castter	+	caslter
fire engine	+	fire negel	+	firengian
bucket	+	bug	+	+
spade	+	spad	+	+
crab	kuæb	+	+	crub
star	+	stair	+	+
kite	+	kit	+	+
[illegible]	-	[illegible]	bɜgə	[illegible]
rocket	+	Rock	+	+
guitar	+	grilter	+	guilte
rollerskates	+	Rolls	rəuə seɪ rəulə skeɪk	rolly skate
motorbike	+	morthbicye	+	+
basket	+	bastit	+	+
pencil	+	penil pecnil	+	+
chips	+	chirp	+	+
chocolate	+	choctlik	+	+
orange	+	orangr	ɒrɪ̃ʒ]	+

APPENDIX 8-14 (CONTINUED)

	MICHAEL		CAROLINE	
NONWORDS	IMITATION	SPELLING	IMITATION	SPELLING
/nʌst	+	nat	+	nesit
ˈspəʊdə	+	spod	+	spode
wɛsp	+	+	+	swipt
dæks	[dæɛks	deas	+	duciks
bæskɔɪts	+	bast	+	buskat
snimon	ˈsninəm ˈsniwon	sned	ˈnimõn	sumiy
skɜkreɪ	ˈskɛəkʊəʊs skɛəkʊeɪ	scercower	ˈskɜgeɪ ˈskɜkeɪ	scrowcrak
skaθ	skaf	scerful	skaf	scraps
ˈslɛpə	slɪpə slɛpə	sitp	+	slopper
ˈkɪrɪvɪn	+	carvaln	+	farlame kavon
tɒlɒvʌʒn	tɛlivɪʒn ˈtɒlɪvʌʒn	televintia	ˌtɒləvɪʒn	tolevision
ˈdrɪgn	+	drugeds	+	grodon
ˈtrɪʒə	+	teued	ˈbrɪza	troeaser
ˈkʌsl	+	catter	ˈkasʊ	kaslte
ˈfaˈændʒn	faɪə ɛndʒɪn ˈbɪkʌpt	fire nigtg, far	ˈfa ˈɛndʒɪn	for engian
bɪkʌt	bɪkʌt	biup	+	bitup
spəʊd	+	spouds	+	scop
krɛb	ˈkʊɛːb	carde	+	craup
sti	+	[illegible]	ski	skir
kɔɪt	+	cout	+	clat
ˈbagli	+	bulle	+	brelev
ˈrɛkət	ʊɛ rækɪt	relt	+	recokn
ˌgæˈtɔ	gæˈta	gart	+	gadin
ˈrælɪskəʊts	ˈrælɪsəʊts rælɪsəʊɪ	relleral	rælɪskəʊt	wrast
ˈmɪtɪbəʊk	mɪtɪbəʊʔt	imbout	+	bibota
bɛskæt	+	bastcat	+	bscuk
pɪnsəl	+	pieint	+	pencil
ʧʌps	+	chush	+	chislp
ʧɪkɪləʊt	ˈʧɪkɪləʊps ʧɪpɪləʊp	shillops	ʧɪʔɪləʊʔ	ckulop
ˈɛtrændʒ/	ɛːəndʒ ɛʊændʒ	ellamsh	ɛrǣʒ]	eran