Early Influences on the Development of Reading Skills

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Abstract

The way in which we learn to read, and the factors influencing the development of this skill are still the source of much debate. The present research aims to examine some of the issues surrounding this area. A group of children from 2 primary schools in Dundee were followed through their first 2 years at school, and their progress in reading and reading-related skills monitored. The longitudinal data were then analysed in terms of three main issues: (i) the nature of phonological awareness and its relationship to reading; (ii) the relative importance of rhyme skills and letter knowledge in early reading; and (iii) the contribution made to reading by visual skills.

Cross-sectional, experimental, data were also collected to investigate further the children's ability to use orthographic analogy strategies. In addition, a cross-cultural study was conducted comparing data from the present sample with children at schools in Fife and New Zealand, who had experienced very different approaches to reading instruction: either placing great emphasis on phonics (Fife), or using a 'whole-word' approach which does not encourage the child to break words down into phonemes (New Zealand).

The results of the longitudinal and cross-sectional studies revealed that letter knowledge at the beginning of schooling was extremely important, and its influence was demonstrated on the development of reading, phonological awareness and analogy use. Investigation of visual skills and their role in reading supported the results and suggestions of Johnston et al (Johnston, Anderson & Duncan, 1991; Johnston & Anderson, submitted) in indicating that *relative* visual-phonological skills have an important role in predicting reading success. Finally, the cross-cultural data indicated that regardless of instructional background, young children focus on the phonemic level of words in reading and phonological awareness tasks.

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Chapter 1

Introduction

Background

The ability to read plays a vital role in our everyday lives, and yet the processes by which we acquire and develop this important skill are still under debate. It is the intention of this research to investigate some of the most important issues currently in the focus of reading development research, and to further contribute to the search for answers. Firstly, models of reading and reading development will be outlined, before going on to consider the role of phonological awareness in developing reading. The contributions of visual skills, phonemic awareness, letter knowledge and rhyme skills to reading will also be discussed.

Models of Skilled Reading and Reading Development

One of the most influential models of skilled reading is undoubtedly the dual-route model of Coltheart (1978). In this model (see figure 1.1), there are two ways in which a word can be read: either by a direct visual route, mapping stored representations of written words onto spoken representations of written words - this may or may not involve semantic access; or by converting the graphemes into phonemes and 'sounding out' the word. This last route would mainly be used for reading unfamiliar or nonsense words which have no stored representations. Familiar words are read mainly by the direct route, since this is quicker and more efficient.

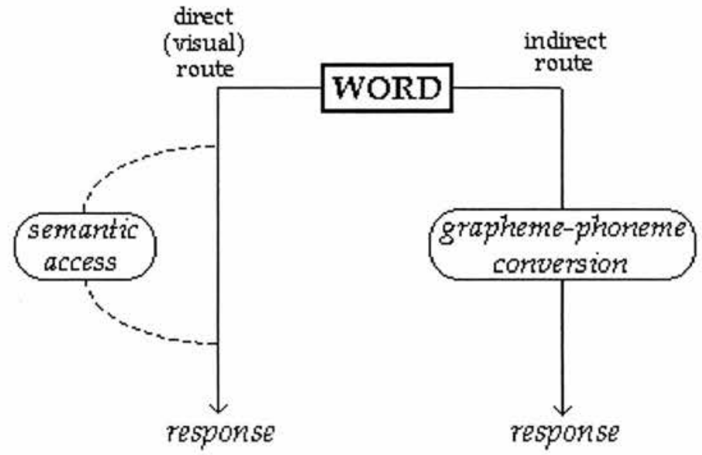

Figure 1.1 *- summary diagram of the dual-route model of skilled reading (Coltheart, 1978)*

A second important model of reading is that of Siedenberg and McClelland (1989), who developed a computational model of the way in which skilled readers identify words, and how this skill is developed. In this model, a connectionist view of the process of reading is described, in which the reader uses 'connections' between orthographic units in the written word and stored representations of how these units are pronounced. The connections are formed through experience with printed words, with strongest connections being formed for orthographic patterns which are most familiar and consistently pronounced. The reader can then use these connections to decide upon the most likely pronunciation (and hence identity) of a word.

A more recently proposed model of reading is the Knowledge Sources Account of Thompson and colleagues (Thompson and Fletcher-Flinn, 1993; Thompson and Johnston, 1993; Thompson, Cottrell and Fletcher-Flinn, 1996. See figure 1.2). According to this model the reader has two ***procedures*** available in order to read a word, namely ***recall*** (i.e., recognition of a familiar word), and

generation (this allows identification of new words, which cannot be read by recall procedures alone). Both of these procedures are available to, and may be used by, skilled readers, while the task for the beginning reader is to develop them. The procedures in this account rely on ***sources*** of knowledge. For recall, the knowledge source will obviously be the vocabulary of written words known by the reader. For generation, though, there are proposed to be four possible sources of knowledge. The first of these sources is information from *induced sublexical relations* - these are connections between phonological components and the orthographic components of written words. These are induced spontaneously as the reader acquires experience with print, and are specific to word position. So, for example, knowing the words *cat*, *got* and *pet* the reader will form a sublexical relation between the '/t/' sound at the end of the words and the letter 't' seen at the final position in print. It is proposed that children become aware first of word-initial letters and then word-final letters, with relations between other positions and units (such as central vowels and rimes) developing at a later point. The second source of knowledge comes from *taught grapheme-phoneme correspondences*, as found in phonics teaching regimes. The theory proposes that this source will be unavailable for children taught using a 'whole word' approach to reading (as in New Zealand) where no letter sounds are taught as part of reading instruction. Even if these children do learn such correspondences as part of their *spelling* instruction, it is argued that this knowledge does not transfer to become a knowledge source for reading (Thompson, Cottrell and Fletcher-Flinn, 1996). Analogy cues constitute the third source of knowledge. This enables the reader to use existing knowledge of orthographic representations in order to read a new word. The representations used are held to be sequences of two or more letters which match the position of the same pattern in the unfamiliar word. So, for example, knowledge of the words *cat, hat* and *sat* would enable the child to read the new word mat using the *'/-at/'* segment as an analogy cue. Although some theorists (most notably Goswami, 1986, 1988, 1993, 1994; see below) have argued that analogies based upon *rime* segments are most common, the Knowledge Sources Account does not propose any preference for the rime over other orthographic units. The fourth, and final, source for generation procedures is the context of the stimulus word, which may provide semantic and syntactic clues to the identity of the target word. Of course, this source of knowledge is only of use when reading a passage of prose. These sources are held to be available for skilled readers and also for young readers, each source developing from the very start of learning to read.

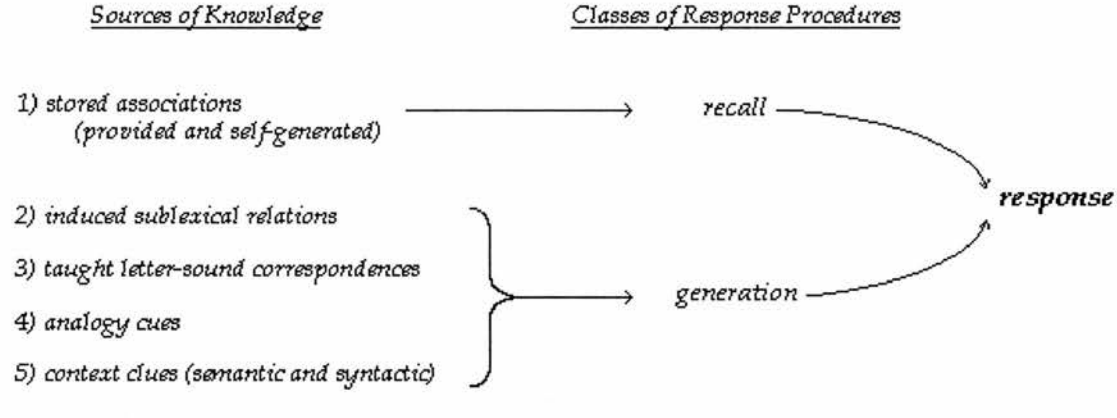

Figure 1.2 *- summary diagram of the Knowledge-Sources Account of reading (based upon Thompson, Cottrell and Fletcher-Flinn, 1996)*

As in many other areas of child development, such as cognitive, perceptual and moral development, the acquisition of reading skills has been seen by many influential theorists as progressing in a series of stages. In general, each stage is identified on the basis of the strategies employed by the child during it, and progression to the next stage occurs when these strategies are replaced by more effective ones. In this way the child reaches maturity in its reading skills. Marsh, Friedman, Welch and Desberg (1981) have proposed a four stage theory of reading development. Stage one is that of *linguistic guessing*. In this stage the child has available the strategies of rote learning and linguistic guessing. Associations between oral and printed patterns are learned by simple rote association. In sentences, words are guessed on the basis of context without taking any notice of the word's graphic features; unfamiliar words in isolation cannot be read. This strategy is inadequate since it may produce anomalous sentences and is of no use for reading words presented out of context. Because of this the child develops those strategies characteristic of stage two.

At stage two the child has available the strategies of rote learning and guessing based on linguistic and visual cues. This is the stage of *discrimination net guessing*. In this stage, responses to unknown isolated words are based on shared graphemic features with a known word; to begin with, the number of features processed is limited to only the initial letter. Words are only processed to the extent to which they can be discriminated from other words.

The third stage is that of *sequential decoding*. The strategies available at this stage are rote learning and decoding from left to right. Hence the child can now more reliably read unfamiliar words - so long as they are regular consonant-vowel-consonant strings - by decoding the letters into sounds. The major environmental factor facilitating the move to stage three is the increase in the size of the print vocabulary, making previous strategies inefficient. The major cognitive factor is said to be the child's move into the Piagetian stage of concrete operations. This move enables the child to attend to a word's sound as well as its meaning, and to process the order of a series of letters and co-ordinate them with a series of sounds.

The final stage in Marsh et al's model is that of *hierarchical decoding*. The move into this stage is facilitated by an increase in cognitive processing capacity, typically not present until the middle years of childhood. The child is now capable of rote learning, decoding using higher order rules, and analogy strategies. This enables him or her to deal with conditional rule patterns and other complex rules of the English orthographic system, such as conjunctive, disjunctive and class inclusion rules.

One of the main problems with this theory is that it is not fully compatible with models of skilled reading (such as those detailed above). Marsh et al's readers are well able to decode words by the time they reach stage 4. In most skilled reading models, however, skilled readers are able to read known words by a more efficient *direct* route, which is absent from Marsh et al's theory. The only 'direct' strategy included in the theory is that of 'rote-learning', but as Stuart and Coltheart (1988) point out, if this is available from stage one as claimed, then Marsh et al need to explain why this strategy is not sufficient to support skilled reading.

Frith (1985) proposes a three phase theory of reading acquisition. Each phase is identified by a particular type of skill. In the first phase the child is said to possess *logographic* skills, referring to the instant recognition of familiar words, perhaps on the basis of salient graphic features. At this point letter order is generally ignored, and phonological factors are taken into consideration only *after* the word has been recognised. In this phase the child will not respond to unfamiliar words in isolation, but when the word is in context, he or she will be able to use contextual and pragmatic cues in order to guess at its identity.

The second phase is known as the *alphabetic* phase. The child has now gained knowledge of, and is able to use, individual graphemes and their corresponding phonemes. Letter order and phonological factors are crucial, since the reader analyses the string grapheme by grapheme. This systematic approach enables the reader to pronounce novel and nonsense words, though not necessarily correctly. After the alphabetic phase, the child enters the *orthographic* phase. Now words are instantly analysed into orthographic units without phonological conversion. Frith states that the orthographic units ideally correspond with morphemes, the smallest meaningful units of the language (e.g., ***walked*** contains two morphemes: ***walk*** and ***ed***), and that these units are used to create words by recombination. Frith sees this as a modification of Marsh et al's model (1981), providing links to models of skilled reading. The terms *logographic* and *alphabetic* are claimed to cover the same processes as Marsh et al's *rote learning* and *sequential decoding* strategies respectively, and the term *orthographic* to replace their *analogy* strategy. Frith claims that *hierarchical decoding* (Marsh et al, 1981) can be considered either orthographic or an advanced form of the alphabetic strategy. Unlike Marsh et al's theory, Frith's model provides a direct reading route for skilled readers - where it does have problems, though, is in its lack of an *indirect* route at the most advanced stage. It would seem that Firth's alphabetic phase corresponds most closely with a non-lexical grapheme-phoneme route. However, she states that "once the orthographic strategy has become established... it is possible that [the earlier strategies]...cannot be used later without special retraining or in special (e.g., experimental) circumstances." (Frith, 1985, p306-307) Thus, Frith's theory may not be as compatible with models of adult reading as she suggests.

The dual-foundation model of Seymour (1990, 1993, 1997, 1999) proposes that reading development proceeds in four phases. These are not sequential stages, but rather are conceived of as being cumulative and partially overlapping. The first phase of the model (known as 'Phase 0') is concerned with 'Pre-Literacy' development. During this phase, the young child possesses no explicit knowledge of the alphabetic and orthographic systems of their language, and instead must rely on implicit linguistic awareness, referred to as 'epilinguistic'. Such awareness is not available to consciousness and is suggested broadly to follow the order: awareness of syllables; awareness of rimes; awareness of phonemes. Epilinguistic awareness of each type of structure forms the basis of a metalinguistic awareness of these same structures which becomes available to the reader in 'Phase 1'.

Phase '1' - 'Foundation Level Literacy' - is proposed to be a direct response to the experience of formal alphabetic instruction. Seymour proposes that during this part of development, two cognitive foundations (or processes) emerge. The logographic foundation is conceived of as a cognitive system allowing the child to recognise words as 'wholes', embedding visual and phonological information along with the particular word in which it is encountered. This foundation is proposed to develop in a similar way to the phases of development outlined by Ehri (1992, 1997; see below), beginning with visual recognition of the whole word, moving towards partial grapheme-phoneme recoding (based upon the first and last letters) and finally emerging as a complete phonemic representation of the word (though this information remains fixed to that particular word unit within the logographic foundation).

A second process termed the alphabetic foundation also emerges during this phase. This foundation is concerned with general rules of grapheme-phoneme conversion and allows the young reader to 'sound out' new words. Both of these foundations are dependent upon the child possessing letter-sound knowledge, and the foundations' relative rate of growth may be sensitive to the emphasis of the instructional regime which the child encounters. Thus, a strongly phonics-based approach may result in the alphabetic foundation evolving at a faster rate than the logographic, whereas the 'mixed' instructional technique used widely in Scottish schools is predicted to encourage parallel development of the foundations.

As mentioned above, another effect of the demands of instruction will be metalinguistic awareness (i.e. explicit awareness which is available to conscious reflection). Since learning to read will (almost without exception) involve training in letter-sound or letter-name skills, Seymour argues that in contrast to epilinguistic awareness, metalinguistic awareness will most commonly develop from awareness of phonemes to awareness of larger units such as rimes. This phase is suggested to take place over the first two to three years of schooling.

Phase '2' of the model involves the development of 'Orthographic Literacy', allowing the reader to store the abstract representations of their language's spelling system. Initially only simple structures are stored, though gradually more complex orthographic structures are also encoded. This small-to-large development of orthographic awareness is argued to be analogous to the progression seen in meta-linguistic (metaphonological) awareness. The mechanism driving this phase of literacy development is suggested to be an interaction between the child's pre-existing epi-linguistic awareness and the orthographic demands of learning to read and write an alphabetic language.

The development of 'Morphographic Literacy' - Phase '3' - is held to begin slightly later than phase 2, but to proceed in a similar fashion. Thus the child gradually becomes able to encode increasingly complex morphographical structures within their language system, and develops metalinguistic awareness of multi-morphemic structures.

Ehri (1992), has proposed a theory on the development of *sight word* reading. In keeping with the dual-route model (see above) she argues for a distinction between these two ways of reading words, but feels that the visual route in existing dual-route models requires re-definition. This new formulation proposes that sight-word reading develops through three different stages. The first of these is called *visual cue reading* and emerges in young pre-readers. These children still lack the letter knowledge required to make connections between the visual patterns of the written letters and their phonological representations. Because of this, visual cue readers make connections between words and their meaning and pronunciations (stored in lexical memory) which are arbitrary and have no direct relationship to the pronunciation of the letters in the written word. Thus, for example, the word ***McDonalds*** may be read by recognising the golden arches behind the word in its logo (e.g. Dewitz and Stammer, 1980; Harste, Burke and Woodward, 1982) - further support for this suggestion comes from the fact that such children can usually no longer read these familiar words when such arbitrary visual features are no longer present (e.g. Masonheimer, Drum and Ehri, 1984). Clearly such a strategy is highly inaccurate and unreliable.

Once a reader has gained knowledge of most of the sounds or names of letters in the alphabet and possesses sufficient phonemic awareness to focus on word-initial and -final sounds, Ehri suggests that a move is made into the second stage of sight word reading, namely *phonetic cue reading*. At this stage the child begins to form visual-phonetic connections between the letters within spelling and the sounds within the pronunciation of a word. These connections are more systematic than those in stage 1, and are easier to remember, making them a more reliable (but not perfect) method of sight-word reading. To begin with connections are made only to word-initial and -final letters, though with experience this will extend to other letters within words. Ehri does suggest, however, that special training may be required before consonants within blends (e.g. ***/s/*** in ***last***) can be detected.

Gradually (not discretely) with the acquisition of phonemic segmentation and phonological recoding skills, the child moves into the third and final stage of Ehri's model. This is termed *cipher reading*, and is characterised by connections formed between the *entire sequence* of letters in a written word and the *phonemic* constituents in its pronunciation. These connections will include 'part-part' (e.g., ***la → /lah/***) and 'part-whole' (e.g. ***la → lamp***) relationships, and form an extremely reliable system of sight-word reading.

The Nature of Phonological Awareness

Before now turning to a review of the literature relating to the various topics explored in the thesis, it is important to give a brief definition of the various subsyllabic structures which will be referred to in this work.

Vennemann (1988) has proposed that the structure of the syllable may be analysed linguistically into various levels of components (see figure 1.3). The syllable itself may be divided firstly into a *body* (the initial consonant/consonant cluster plus vowel) and *rime* segment (vowel plus final consonant/consonant cluster). Below this level, further analysis divides these structures down into the *onset* (initial consonant/consonant cluster), *peak* (vowel), and *coda* (final consonant/consonant cluster). The furthest level of division is at the individual phonemes of the syllable. If the onset and coda are single consonants, this level will be indistinguishable from the onset/peak/coda level. This thesis will focus largely on children's awareness of the onset/rime and phonemic levels of the syllable.

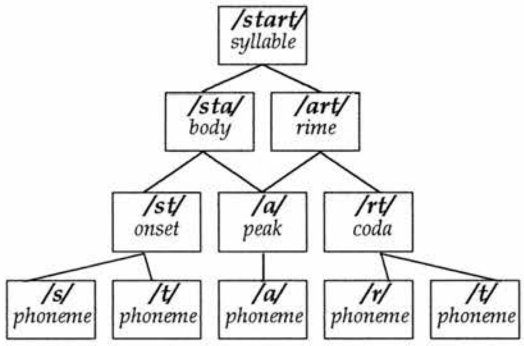

Figure 1.3 *- overview of the syllable structure (based upon Duncan et al, 1997)*

'Phonological Awareness' may be broadly defined as the ability to detect the phonological properties of words, such as being able to articulate the phonemes from which they are composed, or being able to distinguish whether or not two words rhyme. As will be discussed below, this 'awareness' need not be at a level which is available to *conscious* awareness - for example, it is possible to be 'aware' that two words rhyme, without being able to say *why* they rhyme (see, for example, Morais, Cary, Alegria and Bertelson, 1979; Morais 1991). Also, phonological awareness may refer to global properties of words (such as whether they rhyme), or may be awareness of constituent properties (such as the individual phonemes). The term *Phonological Awareness*[1] is often discussed and investigated as though it refers to a single skill or cognitive ability. In recent years, however, some researchers have begun to speculate that 'Phonological Awareness' may be divided into different subtypes. Meanwhile, others argue that the skills required to perform tasks tapping Phonological Awareness lie on a continuum.

The different viewpoints on Phonological Awareness may be broadly classified into four groups. Firstly there are those which have ignored rhyme-based tasks and concentrated on the nature of *phonemic* awareness. Secondly, there are theories which postulate that Phonological Awareness tasks tap a continuum of skills of different degrees of difficulty. Others propose two types of awareness based on the size of unit involved: i.e., phoneme awareness and onset/rime awareness. Finally there are theories which propose different subtypes of Phonological Awareness but which do not easily fit into any of the other categories. Each type of theory will be discussed in turn.

Phonemic Awareness

Some researchers have looked at the nature of Phonological Awareness, but for one reason or another have discounted rhyme-based tasks from their analyses.

In their 1984 paper, Stanovich, Cunningham and Cramer administered a variety of Phonological Awareness tasks to a group of 58 children. There were

[1] In this section, Phonological Awareness with capital letters will refer to the general construct.

ten tasks in all, three involving rhyme, and seven which did not involve rhymes. The children's performance on these tasks was then analysed in relation to reading ability one year later. However, the results on the rhyming tasks were at ceiling for these children, and so were not highly related to the other tasks or to reading ability. For this reason only the seven non-rhyming tasks were included in the analyses.

The non-rhyming tasks were highly inter-related, and predicted later reading skills well. A factor analysis was performed on these seven tasks, and this revealed that the tasks all loaded highly onto a single factor. The authors concluded that this was strong evidence that all Phonological Awareness tasks are equally effective in measuring this skill and at predicting later reading ability.

These results should be interpreted with a little caution, however, since all of the non-rhyming Phonological Awareness tasks involved the detection and manipulation of phonemes. This, in addition to the children's ceiling performance on the rhyming tasks, suggests that this study may in fact be evidence for two types of Phonological Awareness based on phoneme and rhyme skills.

Another researcher who has proposed a theory on the nature of Phonological Awareness but has discarded rhyme-based tasks from their analysis is Yopp (1988). In this paper, 10 tests of phonemic and rhyme-based awareness tasks were administered to 96 kindergarten children, and a principal components analysis performed on the results. Yopp found that the tests of rhyme did not appear to be related to the tests of phonemic awareness and so she discarded these results from further analyses, suggesting that they may be

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Small letters will be used to refer to sub-types of this awareness.

tapping different underlying abilities than the phoneme-based tasks. This is regrettable, since valuable information about these rhyme abilities and their relationship to reading was lost. Yopp's analysis, then, was of *phonemic* awareness tasks only. A factor analysis of the 9 phonemic tasks revealed two factors which Yopp terms *simple* and *compound*. These refer to the actual *tasks* which tap the awareness, and are defined by the number of cognitive operations required to complete them. Thus, tasks assessing 'simple phonemic awareness' require the child to perform one operation (e.g. segment a word) and then give a response. 'Compound phonemic awareness' tasks, on the other hand, require the extra operation of holding a given sound in memory, while completing a second operation, e.g. deleting a phoneme whilst remembering the remaining phonemes and then blending them to give a response. Here, Yopp has in effect proposed that there are two types of Phonological Awareness - rhyme awareness and phonemic awareness - and, further, that phonemic awareness may be subdivided into simple and compound awareness.

Phonological Awareness as a Continuum

Stanovich (1992) has proposed that Phonological Awareness should be thought of as a continuum from *'shallow'* to *'deep' sensitivity*. Stanovich prefers the term phonological *sensitivity*, as it avoids philosophical arguments about consciousness aroused by the word 'awareness'. Shallow sensitivity is seen as an ability to judge and compare the overall structure of words, for example in an oddity task, where the child must pick out the word which does not rhyme. Deep sensitivity, on the other hand, refers to an ability to manipulate the phonemes and letters which make up words, e.g. in a phoneme segmentation task, where the child is asked to break down a word into its constituent phonemes (e.g. ***book*** ⇨ /b/-/oo/-/k/). Between these two extremes lie various intermediate levels of sensitivity, involving units larger than phonemes. An example would be a phoneme deletion task where, for instance, the child may be asked to say a word (e.g. ***stop***) without its initial phoneme (⇨ '***top***'). Stanovich sees the continuum being defined in terms of the type of response a child is asked to give in a task, as our examples show, and so the different points on the continuum are very much tied to individual tasks. Unfortunately, the continuum is poorly defined in the paper, and its relationship to reading development is unclear.

Cataldo and Ellis (1990) talk of *implicit* and *explicit* awareness. It is assumed that Phonological Awareness growth follows a continuum, developing from implicit to explicit awareness. In their study they investigated the relationships between these two types of awareness and young children's emerging reading and spelling skills. What is meant by the terms *implicit* and *explicit* is not clearly explained, though it seems that Cataldo and Ellis identify them in terms of the level of "phonemic awareness" demanded by the different phonological tasks, with explicit tasks requiring "analysis of words for explicit sound content" and implicit tasks involving analysis "for overall similarity of sound content" (p105). Thus, for example, Bradley and Bryant's (1983) oddity task, in which the child has to choose which word does not contain a unit shared by the others, was used to tap implicit awareness. Meanwhile, a phoneme segmentation task, which required the children to break words down into their constituent phonemes, was employed as a test of explicit awareness. The study followed a group of 40 children through their first 2 years at school, and their developing reading and spelling skills were monitored. The results of a path analysis revealed that implicit phonological awareness only contributed significantly to reading and spelling in the first year at school. The explicit awareness task was found to contribute to spelling performance in both years of the study, but predicted reading only in the second year. The authors conclude that this is evidence of a development from implicit awareness initially towards explicit awareness, and see the emergence of a relationship between explicit awareness and reading in year 2 as a mark of the commencement of an alphabetic stage of reading. Implicit awareness is presumed to develop prior to, and to be predictive of, reading ability, while explicit awareness is held to develop as a consequence of learning to read (see also Snowling, Hulme, Smith and Thomas, 1994).

Onset/Rime Awareness Vs Phonemic Awareness

Goswami and Bryant (1990) have strongly advocated a distinction between two types of Phonological Awareness based on the size of units involved. In their book, Goswami and Bryant stress a distinction between phonological awareness for phonemes, and phonological awareness for onsets and rimes. The former of the two is argued to assist in learning grapheme-phoneme conversion rules and spelling skills, and develops as a *consequence* of alphabetic instruction. Awareness for onsets and rimes, on the other hand, is held to develop naturally *prior* to reading instruction, and assists in the development of orthographic 'word families' which may be used to facilitate reading new words.

Bowey and Francis (1991) also discuss the distinction between awareness for phonemes and for larger units and describe them as *phonemic* and *phonological* awareness respectively (also Treiman and Zukowski, 1991). In agreement with Goswami and Bryant (1990) they feel that *phonemic* awareness is a consequence of learning to read, but argue that *phonological* awareness is both a precursor to, *and* a consequence of, reading instruction (see also Johnston, Anderson and Holligan, 1996).

A study by Muter and Taylor (reported in Muter 1994) supports this distinction between awareness for phonemes and for rime units. In this longitudinal study, 38 children were followed from nursery through to the end of their second year at school. They were tested at various intervals on their ability to perform tests of Phonological Awareness, including both rhyming and phoneme based tasks. A series of principal components analyses were then performed on this data across the 3 years of the study, and this revealed 2 main factors. Muter terms these a *segmentation* factor and a *rhyming* factor, reflecting the tasks which loaded most highly on each. These two factors correspond with those proposed by Goswami and Bryant, although Muter's view of their role in learning to read is slightly different. Muter (1994) proposes that it is phoneme segmentation and letter knowledge skills which play a vital role in emerging reading, with rhyme awareness becoming important only after one or two years of school.

It has also been argued, however, that the use of onsets and rimes found in many of these studies is due to the type of teaching program which the children receive. Seymour and Evans (1994), tested Scottish children who received a 'mixed' approach to reading, i.e. they were given phonics training alongside 'whole-word' reading. A group of young children were given tests of segmentation, rhyming and alliteration skills. The results did not show any bias towards the use of onset and rime units, and instead seemed to demonstrate the use of smaller units in both reading and phonological awareness tasks. The authors suggest that the reason for the discrepancy between this result and those of other studies may be that those children who are taught through a 'mixed' or phonics reading program will focus on smaller units than those receiving instruction based on whole-word or analogy strategies. In agreement with Goswami and Bryant, though, Seymour and Evans argue that awareness for phonemes and awareness for onsets and rimes should be treated as two types of Phonological Awareness, each with distinct contributions to reading development. (See also Seymour & Elder, 1986; Seymour & Evans, 1992).

Other Proposed Dichotomies of Phonological Awareness

Wagner and Torgesen (1987) conducted a re-analysis of earlier research by Lundberg, Olofsson and Wall (1980). Lundberg et al collected data on reading and Phonological Awareness from children during their first two years of reading instruction. Wagner and Torgesen conducted a principal components analysis on the data and found that the Phonological Awareness tasks loaded onto two factors, the first involving tasks of phoneme and syllable manipulation and detection, and the second factor consisting of a syllable segmentation task (using pegs to represent syllables) and a test of rhyme production. Wagner and Torgesen argue that this shows that Phonological Awareness tasks are largely tapping a single skill. This conclusion seems to ignore the fact that rhyme production (along with a concrete syllable segmentation task) loaded onto a *second* factor, suggesting that a separate skill is being tapped. These results then, might be taken as evidence of two types of phonological awareness.

Another paper (Morais, 1991), has put forward the idea that Phonological Awareness is composed of two subtypes. Morais proposes that these are: *analytic phonological awareness*, referring to the capacity to consciously isolate the constituent parts of a word; and *holistic phonological awareness*, defined as the capacity to consciously judge properties of whole words. An additional feature of analytic phonological awareness is that it includes a metatheory of the processes being carried out by the subject, whilst holistic phonological awareness does not. Morais' two types of Awareness refer quite clearly then, to *conscious* awareness (c.f. Stanovich, 1992; see above), and unlike most of the above theories are defined by the level of conscious manipulation involved, rather than the tasks which tap them. Instead, Morais feels that certain tasks may be ambiguous, tapping either type of awareness depending on the strategy employed by the subject. An example given is of oddity tasks, which could be carried out by comparing overall (holistic) properties of words, or can be performed using segmental analysis. Morais himself calls for further research to clarify the relationship between existing phonological tasks, and these two types of awareness.

In her 1994 paper, Bowey talks of *phonological awareness* (attributed to Morais, 1991) and *phonological sensitivity* (attributed to Stanovich, 1992) as two distinct subtypes, an apparent confusion of two quite different theories on the nature of Phonological Awareness. Bowey defines these two types of awareness as explicit and implicit phonological analysis respectively, and links them to the tasks which tap them - phoneme segmentation is given as an example of explicit phonological analysis (*phonological awareness*), and rhyme generation as an example of implicit phonological analysis (*phonological sensitivity*). As this theory is ill-defined and does not appear to be founded in any particular research, it will not be included in the discussion below. However, it does serve as an example of the way in which differing viewpoints are being confused in the literature, and of why clearer definition is urgently required.

Gombert (1992) has also proposed that two types of phonological awareness exist, and these are referred to as epiphonological and metaphonological awareness. Epiphonological awareness is seen as an 'implicit' type of knowledge in that it is not available to conscious awareness or reflection. Such awareness would be found in young children (and adults) who have not yet received training in an alphabetic language. Gombert views instruction in literacy to be an important trigger for the development of metaphonological or *conscious* awareness of the units of the language. Although learning to read and write is thought to be the main trigger of this development, the theory also suggests that any kind of phonological training may induce a metaphonological awareness in the child. Further, Gombert believes that it is early *epi*phonological awareness which has been tapped by tasks such as the Odd Man Out task of Bradley and Bryant, and that it is this implicit awareness of rhymes upon which large-unit theories have based their proposals. It is suggested on the basis of such results that epiphonological awareness does indeed progress from large units (syllables) down towards phonemes. However, in light of work such as that of Seymour and Evans (1994) and Duncan et al (1997), Gombert (1999) also argues that metaphonological awareness (which is built upon existing epiphonological knowledge) progresses in a different order, with conscious awareness of syllables probably emerging at the pre-school level (Gombert, 1999), followed by a development from phonemes towards larger units (such as rimes) once instruction commences. This disjoint development is due to the fact that at the beginning of literacy instruction (both reading and writing), the phoneme plays a very important role. As vocabulary develops, the rime unit becomes a useful way in which to organise the lexicon. This theory may explain why some research indicates a large-to-small progression in phonological awareness, whilst others find a small-to-large pathway - different levels of awareness (epi- or meta-) have been tapped.

It is apparent from this review that there exist in the literature many different formulations regarding the nature of Phonological Awareness. Unfortunately, little notice has been given to the contradictions between the viewpoints, resulting in confused statements such as those of Bowey (1994) reported above. In chapter 2, these issues are examined in the light of the results of the present study.

Rhyme and Phoneme Awareness in Early Reading

Recent research on early literacy acquisition has come to be dominated by reading acquisition theories which place emphasis on pre-school rhyme awareness as the vital foundation in learning to read (e.g., Goswami and Bryant, 1990; Goswami 1993, 1994; MacLean, Bryant and Bradley, 1987). Other researchers, however, argue that knowledge of grapheme-phoneme rules are essential (e.g., Johnston, Anderson and Holligan, 1996; Stuart and Coltheart, 1988; Share, Jorm, MacLean and Matthews, 1984). Each viewpoint claims evidence to support itself, resulting in studies showing apparently contradictory findings.

Small-Unit Theories

'Small-Unit' theories are those which propose that a child cannot progress in their early reading unless they have knowledge of the so-called 'alphabetic principle' (e.g. Byrne and Fielding-Barnsley, 1989), that is, an awareness of the phonemes which make up words, and the way in which they map onto written letters (graphemes). These theories argue that in order to read unfamiliar words and build up their vocabulary it is essential for the child to be able to analyse the phonemes which make up the word.

Many studies have found links between phonemic awareness and reading ability (e.g., Stuart and Coltheart, 1988; Stanovich, Cunningham and Cramer, 1984; Rack, Hulme, Snowling and Wightman, 1994; Share, Jorm, MacLean and Matthews, 1984). The results of other studies suggest that a *conscious* awareness of the relationship between graphemes and phonemes does not emerge until after reading instruction has begun (e.g., Morais, Cary, Alegria and Bertelson, 1979). The nature of the relationship has been more recently viewed as a reciprocal one, with early phonemic awareness advancing children through the first stages of reading, which in turn enhances their awareness of the way in which phonemes form words (e.g., Perfetti, Beck, Bell and Hughes, 1987; Morais, 1991; Bryant and Goswami, 1987).

Awareness of larger subsyllabic units, such as rimes, are not held to be important to the initial years of reading, though some recent papers have suggested that these units may play a role after the first two years of reading instruction (Muter, 1994; Cataldo and Ellis, 1990). It is suggested that by this stage the child has become familiar with certain combinations of graphemes which are pronounced in the same way. Since the rime of a word is usually more consistently pronounced than the body the child can use knowledge of such units to more effectively organise their lexicon and correctly decode new words. Small unit theorists would contend that the child must be able to recognise and decode the rime at the phonemic level before they can notice patterns of consistency amongst such units in other words (Bruck and Treiman, 1992; see below).

Large-Unit Theories

The proposals of small unit theories are in contrast to those of 'Large-Unit' theories. Much early research contrasted young children's ability to detect syllable and phoneme-sized units, and this work demonstrated that syllables were easiest particularly for pre-school children (Liberman, Shankweiler, Fischer and Carter, 1974). Later work, though seemed to indicate that between these two 'levels' of awareness lies an intermediate level of onset and rime awareness. Treiman and Zukowski (1991), for instance, demonstrated that in a 'same-different' matching task, young children found it easier to detect shared syllables than shared 'onsets and rimes'[2] which in turn were easier than an initial/final phoneme condition.

The clearest statement of the large-unit viewpoint is probably the work of Goswami and Bryant (1990) in which they set out their theory of reading acquisition. Large unit theorists argue that the phonemic level of the word is not accessible to children who are just beginning literacy instruction. Evidence for this claim is drawn from studies such as that of Morais et al (1979) which demonstrated that the illiterate adults in their study only became capable of conscious detection and manipulation of phonemic segments of speech *after*

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[2] It should be noted that rime units were not investigated separately from onsets, and so this may not be clear evidence of importance for *rime* units.

they had been given instruction in the alphabetic principle through learning to read.

Instead researchers argue that awareness of *rime* segments naturally arises before schooling through nursery rhymes and word games (e.g., MacLean, Bryant and Bradley, 1987) and that it is knowledge of these segments which allows the young reader to decode words into their onset and rime components (e.g., Goswami, 1993; Goswami and Mead, 1992). The work of Bradley and Bryant (1983) is held up as an important demonstration of how children's pre-school rhyme awareness is closely linked to their reading achievement in the first years of schooling[3]. The results of other studies too appear to support a link between pre-school rhyme awareness and subsequent reading achievement (Bradley and Bryant, 1985; Lundberg, Olofsson and Wall, 1980).

Goswami and Bryant argue that by breaking a word into its onset and rime, the child is able to read other words which share this rime, and hence organise the lexicon into 'families' of words. This process is similar to that proposed by Muter (1994; Muter, Snowling and Taylor, 1994) outlined with small-unit theories above, but unlike Muter, Goswami and Bryant hold that this process takes place at the very earliest stages of reading, and that it is only later in reading development that the child becomes aware of, and able to consciously manipulate, the phonemic structure of the word.[4]

In order to compare the apparently contradictory evidence and arguments of large and small unit theories, Duncan, Seymour and Hill (1997)

[3] Though see discussion of this conclusion below.

set out to systematically analyse the units of awareness of a sample of children in Dundee, Scotland. This sample of children were in their first year of literacy instruction, and composed two groups, one of which had received training at the nursery stage to enhance their phonological awareness.

First of all, the children were asked to read nonwords which had been constructed from segments of words in their reading books. There were four types of nonword: 1) onset + rime, e.g., ***bot*** = *big* + *got*; 2) body + coda, e.g., ***ban*** = *bad* + *pin*; 3) body + rime, e.g., ***mook*** = *moon* + *look*; 4) onset + peak + coda, e.g., ***tog*** = *tin* + *hot* + *pig*. The expectations of large unit theory would be an advantage for nonwords constructed from large units, i.e., conditions 1) onset + rime and 3) body + rime, whereas small unit theories would predict no difference between conditions, since all will be read by sounding out individual phonemes. The results upheld the predictions of small-unit theories. Further, the group of children who had superior rhyming skills performed similarly to the other children.

Next an investigation was made of the subsyllabic level of focus for the children's orthographic awareness. In this task, the children were asked to circle a target sound in visually presented reading scheme words. The target sounds were manipulated to include all subsyllabic structures. Once again, the results showed no difference between the two groups of children, with all subjects showing superior awareness for small units.

A final task was created in order to systematically investigate the children's phonological awareness of units of various sizes. This was termed the Phonological Common Unit Identification task. In this task, the child hears

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[4] However, Goswami has recently amended this position to one similar to that of Muter et al (1994) in which analogy use develops later in reading development and is preceded by a period driven by phonemic awareness (Goswami, 1998).

two words, e.g. ***hip - hot***, and must give the sound shared by the two targets, in this example */h/*. In this way it was possible to investigate awareness of small units such as onsets, peaks and codas as well as the larger body and rime segments. The results of the task showed clearly that the children's awareness was greater for small rather than large units. A further manipulation of the complexity, in particular of onsets and codas, demonstrated that awareness was in fact greatest at the phonemic level. Once again both groups performed in a similar way, preferring small units. In interpreting their results, Duncan et al, referred to the theory of Gombert (1992) as a possible explanation of how the finding of small unit awareness in this and other studies (e.g., Seymour and Elder, 1986; Seymour and Evans, 1992) may be reconciled with the work of others which emphasises importance of larger units (in particular the rime). In this theory, as described above, Gombert has suggested that those studies which have shown importance for rime units (e.g., MacLean et al, 1987; Bradley and Bryant, 1985) have been tapping *epi*phonological awareness, which is seen to progress from large-to-small units. Other studies such as that of Duncan et al, which indicate that the phonemic level is important for young readers have been tapping *meta*phonological awareness, which Gombert (1999) argues will proceed through a small-to-large path once instruction begins.

In a follow-up to their 1997 paper, Duncan, Seymour and Hill (in press) tested the same sample of children on their orthographic and phonological skills in the second year of schooling. The evidence from both areas indicated that the children's metalinguistic awareness was indeed progressing in a small-to-large pathway, with awareness of rime units and use of rime-based analogies just beginning to emerge. In their conclusion, though, Duncan et al remain cautious as to whether such a pattern is a natural and inevitable progression

(Ehri and Robbins, 1992) or simply the result of the particular teaching regime and orthography encountered by the children.

Many other studies have been carried out investigating the relative importance of knowledge of small and large units to beginning readers. The literature commenting on this topic may be broadly divided into four main camps (although there is some degree of overlap between the positions): 1) those stressing the importance of alphabet knowledge to young readers; 2) those who argue that rhyme awareness is the most important factor in learning to read, and that children use this knowledge from the very start; 3) those who argue that the use of rhyme awareness becomes important at a later stage, which must be preceded by a period of learning about the phonemic structure of words; and 4) those who contend that whether a child uses knowledge of phonemes or rimes in the initial stages of reading depends upon the type of instructional program which they receive.

Studies emphasising alphabetic knowledge

Some researchers do not feel that awareness of rimes is vital in learning to read, but rather that the ability to link written letters with their sounds plays an important role. Stuart and Coltheart (1988) carried out a longitudinal study of beginning readers and concluded that awareness of the links between sounds and their printed forms, in particular of the initial and final letters of words plays an important part in helping the child learn to read. Johnston, Anderson and Holligan (1996) also consider knowledge of graphemes and phonemes to be important. In a study with pre-school children they found that phonemic awareness was generally preceded by knowledge of letters of the alphabet. The results showed that it was this letter knowledge, rather than rhyme awareness, which predicted success in early reading attempts.

Studies by Thompson and his colleagues (e.g., Thompson & Johnston, 1993, unpubd; Thompson, Cottrell & Fletcher-Flinn, 1996) have looked at how children learn to read with and without explicit training in phonics, which teaches the child about grapheme-phoneme correspondences and the way in which they can be used to 'sound out' words. The results show that such training does give the child an extra resource in order to read new words, but that even in the absence of phonics instruction children use their experience with words in order to generate their own implicit awareness of grapheme-phoneme correspondences. Thompson and Fletcher-Flinn (1993) proposed the Knowledge Sources account of reading based upon these results, in which knowledge of letters (in particular word-initial and final letters (c.f. Stuart & Coltheart, 1998, above)) plays an important role in reading at all levels of maturity (see above).

In a study of pre-school children, Kirtley, Bryant, MacLean and Bradley (1989) demonstrated that even before they begin to read, children may possess phonemic awareness. Although in their discussion, the authors claim that this awareness is limited to word onsets, their data shows that detection of word-*final* consonants was even more highly predictive of reading age than onset detection. A study by Content, Kolinsky, Morais and Bertelson (1986) also found that pre-readers could acquire complex phonemic segmentation skills easily with only a little help.

In a large-scale longitudinal study comparing the effects of many different factors on early reading development, Share, Jorm, MacLean and Matthews (1984) found kindergarten letter knowledge to be one of the strongest predictors of reading performance at the end of the first year of school, alongside phonological awareness. Demont and Gombert (1996) similarly found that for French children the best predictors of reading skill were measures of phonemic awareness taken at the commencement of the first year at school.

Cataldo and Ellis (1990) followed children through their first two years at school. The results of path analyses on the data showed that letter-sound knowledge at the beginning of the first year at school contributed to year one reading ability, but only indirectly, via spelling. Early letter knowledge did directly affect reading in the *second* year of school, however.

Other evidence for the importance of phonemes in learning to read comes from studies which demonstrate that reading ability improves if children are trained in grapheme-phoneme relationships. For example, Bradley (1990) reports the results of training studies, which showed that the largest improvements in reading and comprehension were made by children given teaching of grapheme-phoneme correspondences. Treiman and Baron (1983) report that children trained in phonemic analysis were able to learn to read words more quickly than those who had not received training. Further, their data showed that children do not automatically or 'naturally' use onset and rime segments in order to read words (as Goswami has argued - see below), but rather that some ability to analyse the phonemic structure of words is required first.

The work of Nicholas, Kay and Mitchell (unpubd) has also demonstrated that decoding ability is strongly related to reading performance, and that some analytic awareness is necessary before a child can successfully use analogies. Although their study found that children could be helped to use analogies in order to read new words, they found no special status for analogies based on rimes as opposed to other word units.

The Knowledge-Sources account of Thompson and Fletcher-Flinn (1993), outlined above, similarly proposes no special status for analogies based on rime units. Although their proposed 'analogy cues' source may allow analogies based upon rime units, this is not necessarily the case. Rather, the source is thought to allow analogies based upon any known sequence of two or more letters which matches an orthographic pattern in the word to be read. Also, the 'sublexical relations' source of the Knowledge Sources account may include information about units larger than the phoneme, but these are not necessarily rime units; this source is instead concerned with analysing experience of all orthographic patterns in the word. The Direct-mapping Hypothesis of Rack, Hulme, Snowling and Wightman (1994) makes a similar proposal, suggesting that the child uses statistical relationships between written words and spoken words based on all features of the word, in particular the first letter (also Ehri, 1992).

Studies emphasising rime knowledge

Attention will now be turned to those studies which claim to show evidence of the importance of rhyme awareness and rime-analogy use from the very earliest stages of reading acquisition. One of the strongest supporters of this idea has been Goswami (e.g. 1986; 1988; 1993; 1994). In a series of experiments she demonstrated how children can be trained to use analogies based on rime units to read new words. Goswami claims that the onset/rime division is a natural one, and that these units can be distinguished by children "long before they begin learning to read" (Goswami, 1994, p23).

Bradley and Bryant (1983) carried out a longitudinal and training study with a large group of children beginning school. They conclude - and the paper is commonly cited as showing - that pre-school rhyme awareness is of great importance to subsequent reading achievement, and further, that training in how to categorise words by their rime units produces the best effects on reading performance. However, the results of the training study actually show that it was only once this categorisation training was combined with *alphabetic* training that significant improvements in reading were observed. This has also been pointed out by Bertelson, Morais, Alegria and Content (1985) in a direct response to the study, which they took as providing evidence of the importance of learning the alphabetic principle. In fact, the study failed to control for the training effects properly, since there was no group of children trained only on letter-sound correspondences. Thus, this widely mis-cited paper should not in fact be taken as clear evidence of superior reading due to training in the use of rime-based analogies.

Bryant (1990) argues that it is through pre-school knowledge of nursery rhymes that children's rhyme awareness develops and that this in turn will enable them to succeed in learning to read. As support for this he cites the work of Bryant, Bradley, MacLean and Crossland (1989) which found a significant relationship between pre-school nursery rhyme awareness and reading up to three years later. This viewpoint was set out most clearly in Goswami and Bryant's book (1990), which sets out a theory of reading development based upon the importance of nursery rhyme awareness and the use of rime-based analogies to beginning readers. (See above; also Goswami, 1993; 1994)

Further evidence of direct effects of rhyme awareness on reading has been given by Bryant, MacLean, Bradley and Crossland (1990) which found direct effects of both rhyme and phoneme awareness on children's reading. Similarly, Cataldo and Ellis (1990) demonstrated a direct path from Odd Word Out performance at the start of the first year and reading at the end of first year in their study, as did Bowey & Francis (1991).

Kirtley, Bryant, MacLean and Bradley (1989) also argue that onset and rime awareness has some influence on reading, although their results do not entirely support a strong direct influence. Their data revealed that for their sample, oddity tasks involving detection of onsets and rimes were no better predictors of reading than oddity tasks involving other units. Also, detection of final phonemes was found to be more highly related to reading than initial phoneme (onset) detection.

Theories proposing early use of rime awareness must allow for some phoneme detection skills, however, since the onset which is parsed from the rime is very often a single phoneme. Although some researchers ignore this issue, some have answered it by saying that children can only detect phonemes if they happen to be onsets. For example, Bryant (1990) argues that it is simply a 'coincidence' that some onsets are phonemes, and that these are a special case of phoneme (also Kirtley et al, 1989)! In discussing how analogy use should be taught in the classroom, Goswami (1994) explains that phonemes need only be taught if they are word onsets. Surely this is tacit acknowledgement (though the researchers do not admit it openly) of the fact that children do require at least some phonemic awareness in order to learn to read.

This fact *is* admitted more openly by other researchers. Bruck and Treiman (1992) investigated analogy use in a sample of first-graders. While they found evidence that the children could be *trained* to use analogies, the researchers concluded that in order to make full use of their onset and rime knowledge young children must first learn grapheme-phoneme correspondences. Bradley (1990) discusses the importance of rimes, but in addition cites evidence that young children also require knowledge of letter-sounds in order to learn to read successfully. Unlike the small-unit theories discussed above, however, Bradley does not believe that phoneme awareness *alone* makes any distinct contribution to reading, but rather that it only has an effect to the extent that it is impossible to learn to read and spell without using the alphabet. In saying this much, though, she is surely admitting that alphabet knowledge is *very* important in learning to read!

Studies suggesting that phonemic awareness precedes rime awareness

However, although researchers such as Bryant (1990), Treiman, Goswami and Bruck (1990), Bradley (1990) and Goswami (1993; 1994; Goswami and Bryant, 1990), amongst others, have stated that rime-based analogy use is a skill available to children from the earliest stages of learning to read (though in the studies this relies upon training or being given a 'clue' word to use), others feel that use of rime awareness in reading must be preceded by a period of learning about grapheme-phoneme correspondences and building up the lexicon, and only becomes important or widely used at a later stage in learning to read. For example, Cataldo and Ellis (1990) concluded from their data that rime-analogies are more likely to be used at later stages of reading development, once the child has built up a sufficiently large lexicon upon which to base these inferences. Prior to this level, phonemic and phonetic awareness, particularly for boundary letters, are argued to be important. It is not clear at which point the authors feel analogy use will become important in reading, although for spelling they postulate that the third year of instruction is a possible emergence point for analogy use.

Although Goswami has been a strong advocate of early rime analogy use as detailed above, more recently she has modified her theories in line with the view that analogy use must be preceded by a stage of learning about grapheme-phoneme correspondences and building up knowledge of word forms (Goswami, 1998).

The work of Muter (1994) has provided longitudinal evidence that phonological segmentation ability and phonemic awareness make the largest contribution to the first year of reading acquisition, and that only once the child has built up a reading sight vocabulary (possibly in the second or third year of schooling) will they begin using analogies in order to read new words. Similarly Muter, Snowling and Taylor (1994) found that even by the end of the second year at school, letter knowledge (measured at age 4 and age 5) rather than rhyming ability was significantly correlated to reading performance. They concluded that analogy use appears at a later stage in reading development than this, as the child's experience with regularities in words grows. Phonemic awareness was the most important factor in reading development prior to this stage.

Morais (1991) has also argued that some grapheme-phoneme awareness must be gained before children can successfully use rime-based analogies. He points out that in order to correctly pronounce a word based on analogy the child must be able to recognise not only the onset, but also the letters which make up the rime. Morais feels that rhyming ability is not related to analogy-based reading, but rather that rhyme awareness is simply a precursor to learning about the way in which words are constructed from different letter sequences.

As mentioned above, Gombert (1992, 1999) and Seymour (1997; 1999) have proposed a theory of phonological development which may account for some of the apparent contradictions between researchers arguing that rhyme awareness is a precursor to learning to read and those who argue that the beginning reader must learn about the individual phonemes of the word. This view proposes that before starting school (or in the absence of alphabetic instruction) the child possesses only an implicit *epi*phonological awareness, and further that this awareness follows a large (syllable) to small (phoneme) progression. Thus, these children may be able to perform on epiphonological tasks of rhyme awareness easily (e.g., Bradley and Bryant, 1983; Stanovich et al, 1984). Once a child begins to receive some external demand on their abilities (most usually when they begin learning to read), this epiphonological awareness forms the foundation for explicit or *meta*phonological awareness. Due to the nature of alphabetic orthographies it is argued that the units of focus for metaphonological awareness at this point will be phonemes, with explicit awareness for larger units such as rimes emerging after two or three years of schooling. In this way, Gombert and Seymour manage to account for the findings reported above, demonstrating the importance of alphabetic and phonemic knowledge in the early stages of reading.

Rime-analogies and the 'Clue-Word' task

A major strand of research on the 'phonemes or rimes' issue has investigated the use of 'orthographic analogy' strategies. Such a strategy involves using knowledge of the spelling patterns of one word, e.g., ***beak***, in order to guess the pronunciation of a new word which shares a common spelling pattern with the original word, e.g., ***peak***. Models of reading development such as that of Marsh, Friedman, Welch and Desberg (1981) have suggested that analogy strategies are available only at the most advanced stages of learning to read, once the reader has mastered grapheme-phoneme conversion rules and orthographic rules (such as the 'silent e' rule). Only then, it is argued, does the reader possess sufficient orthographic experience in order to be able to read new words by analogy to known ones. Another model of reading processes, the Knowledge Sources Account (Thompson and Fletcher-Flinn, 1993), proposes that analogy strategies are available as soon as the reader begins to encounter a sufficient amount of print, though the strategy will become more accurate and reliable as the child's knowledge of orthographic patterns increases.

Neither of these models places any particular importance on analogies based upon rime units rather than other parts of the word. It has been argued by some, though (e.g., Goswami, 1988; Goswami and Bryant, 1990; Bruck and Treiman, 1992), that the rime is of special importance in such strategies because it is more consistently pronounced than other units, such as the body (for example, the rime ***ade*** is almost always pronounced as '/ad/', while the body ***ma*** may be pronounced as 'may', 'mah' or even 'muh').

One of the most widely used techniques in investigating use of analogy strategies in children has been the 'clue word' task, in which the child is shown a *clue* word and then asked to read a list of *target* words, some of which share letters or rimes in common with the *clue* word. If the child manages to read one of the *target* words correctly this is taken as evidence that the child has used the clue word as a basis for an analogy strategy.

This task was first used by Goswami (1986), who used it to test whether young readers use analogy strategies spontaneously. Goswami took a sample of children ranging in age from kindergarten to the second year at school. She then split this sample into three groups based upon their reading ability: group 1 were non-readers (mean Chronological Age 5.4yrs), group 2 (mean Chronological Age 6.10yrs, Reading Age 6.10yrs) and group 3 (mean Chronological Age 7.1yrs, , Reading Age 7.4yrs). The children were first pre-tested on all of the words and nonwords used in the study, and were then tested over six sessions on their ability to use analogies. In each testing session, the child was shown a word and told it was a 'clue word'. They were then asked to read a group of words which shared their body or rime with the clue word (*target* words) or common letters with the clue word (*common letter* words), or else contained no common units with the clue (*control* words). The clue word remained visible throughout the post-training stage of the experiment. The analysis showed that for the two reading groups the improvement in accuracy from the pre- to post-training stages was greatest for *target* words, and further, that the number of rime-based target words read was greater than the number of body-based target words. For the non-readers the largest improvement at post-test was also for rime-based target words. From these results it was concluded that even very young readers are able to spontaneously use analogy strategies, and that these are mostly based on rime units.

In a second paper, Goswami (1988a) once again used a clue-word procedure to investigate analogy use. In the first experiment, a group of young readers (mean chronological age 6.3 years) and a group of non-readers (mean age 6.0 years) all took part in three conditions: 1) 'beginning', where the children were shown a 'clue word' which shared its body with the 'analogy' words at post-training; 2) 'end', where the clue word shared its rime with the analogy words; and 3) 'no clue', in which no clue words were shown to the children. As in the previous study the children were then asked to read a list of words which contained three 'analogy' words related to the clues in conditions 1 and 2, three words sharing 'common letters' with the clues, and three 'control' words. The results found that analogy words were read best, and that the 'end' condition scores were higher than for 'beginning' and 'no clue' conditions. The pattern of results was similar for the readers and non-readers (though mean scores were higher for readers), and was taken as evidence that training with rime-based analogies was most effective. A second experiment tested whether children are more likely to make analogies if shown two-words at training whose rimes are pronounced consistently (e.g., ***peak - beak***), inconsistently (e.g., ***peak - steak***) or are unrelated (e.g., ***peak - moat***). The results showed that analogies were made more frequently after seeing a 'consistent' word pair, though this finding is perhaps unsurprising since this condition provided *two* supporting examples of pronunciation for the rimes, whilst the other conditions provided conflicting or unrelated examples. Experiment 3 investigated analogy use when reading passages of prose. The children in this experiment were slightly older than in the previous experiments, having a mean chronological age of 7.0 years. The children were first tested on their ability to read all of the target words before seeing a story. A clue word was presented as part of the title of the story in one condition ('with title'), whilst a second condition had no title and thus no clue word ('without title'). Target words were contained in the stories which could be read either by a 'beginning' (body-based) analogy, an 'end' (rime-based) analogy, or simply shared common letters with the clue. The results showed that there were significant improvements for analogy words based on ends *and* on beginnings in the 'with title' condition. Also end analogy words were easier to read than the other types of words even at pre-test, leading Goswami to suggest that the words were not equally matched. An important result, glossed over in the paper, was that there was a significant improvement for beginning analogy words in the 'without title' condition, but not for other word types. Goswami concludes that "beginning analogies seem to be as important as end analogies" when reading prose (p263), though the results hint that beginning analogies are *more* important and do not depend upon training.

Other researchers have also used a task similar to that of Goswami, each with slightly different procedures and age groups. Broadly, though, clue word tasks follow the same three-stage pattern: 1) *pre-training*, in which the child's existing or baseline reading ability is assessed; 2) *training*, in which the child receives training that can help them to use analogy strategies; 3) *post-training*, where the child is shown a set of words of which some may be read using an analogy strategy.

Peterson and Haines (1992) carried out such a study with a sample of kindergarten children (mean age 5y 10m). The children possessed some reading skill, though exactly how much is not detailed. The children were grouped as 'high', 'middle' or 'low segmenters' according to their ability to segment sentences and words. The subjects were also pre-tested on their ability to read the words which would be used in the training and post-training phases. Half of the children then received a maximum of seven training sessions in which they were introduced to families of rhyming words and explicitly shown how the words were related. The control group did not receive any training during this period. Following training the children were tested on their ability to use rhyme analogies. A clue word would be shown (there were ten in all), and then the child was asked to read words which shared either their end (rime), beginning (first three phonemes), or only two letters with the clue word. The results showed that at *pre-test* those children with 'high' segmentation skills read more of the end analogy words than beginning or common letter, while the 'middle' and 'low' segmentation group read the beginning analogy words just as well as those sharing a rime unit. At post-test, children with good segmentation skills had shown a significant overall improvement in reading the words regardless of whether they had received training or not. Further, only the high segmentation group showed an extra advantage in response to training. These post-training results were not analysed separately for the different types of analogy units, however, and so it is not clear whether the improvements at post-test were due to an increase in rime-based analogy use, as Goswami would argue, or whether they were due to a general improvement in accuracy, which would have been facilitated both by having seen the words already at pre-test and (for those in the experimental group) by the extra reading instruction provided by the training phase. The results of the study show three things then: firstly, it is necessary for children to possess some phonemic awareness skills before orthographic analogies can be used; secondly it is only these advanced children who showed a great effect of rhyme training, whilst the children who had 'low' or even 'middle' segmentation ability did not show any significant improvement as a result of the training; thirdly, the analogies which the children made before training were not based solely upon rime units, but also on other word structures.

Similar conclusions were reached by Nicholas, Kay and Mitchell (unpubd). In their study a group of 5 - 7 year old children were tested. Nicholas et al categorised the children as non-readers, or readers (mean reading age 6y 3m). The children were first pre-tested on all of the experimental items. Every child then took part in four conditions, which investigated analogies based on different word units: rimes, beginnings (bodies), onsets (which were consonant clusters), and ends (codas, which were also consonant clusters). In each session, the child would be shown the clue word and told what it said. They were told simply that the word "might help them to read some of the words" on the test sheet and asked to read a list of analogy and control words with the clue word still visible. The analyses showed that only the children who could already read and possessed some degree of phonological analysis skills showed any effects of the clue word training. In addition it was found that the children showed no particular ability for analogies based on rime units compared to the other units tested. Nicholas et al concluded that analogies were not used spontaneously by the children at this stage, and further that some reading and decoding skills are necessary before a child can even be *trained* to use analogies successfully.

Another study to employ an analogy training technique is that of Walton (1995), who took a group of non-readers and gave them a period of training in either: a) reading rhyming words; b) reading rhyming words plus onset-rime teaching; or c) training with rhyming words and onset-rime skills with words in which these boundaries were visually represented, e.g., ***b ig***. The children were then tested on lists of shared-rime or shared-letter words with target words (on which they had been trained) still visible. It was found that the segmented spelling group (c) showed the greatest improvement for analogy words at the post-training phase. This result in itself is unsurprising, however, since these children were given the most detailed training. A more important finding was that there was only evidence of analogy use for children who had scored highly on tests of letter, rhyme and phoneme knowledge. Indeed, regression analyses showed that of these pre-training measures, phoneme identification was the strongest predictor of analogy use at post-training, with rhyme knowledge failing to predict analogy use at all. Although the author concludes that ability to detect word-final phonemes enabled the children to make *rime*-based analogies, this seems to be a great stretch of the results, particularly given the lack of relationship between rhyme skills and analogy use. A truer interpretation of the data would seem to be that, once again, phonemic awareness was an important precursor to being able to learn to use analogies.

Ehri and Robbins (1992) trained a group of 6 year old children on a series of analogy words sharing their rime segments. The children were then tested on their ability to generalise this skill by reading lists of words which shared either their rime or simply letters in common with training words. It was found that only children who already possessed good decoding skills (as measured by a nonword reading task) performed better with analogy words. Children who could not read nonwords, showed no benefit of learning about rime-based analogies. The authors concluded that use of analogy strategies is not spontaneous, but rather that its emergence depends upon a good knowledge of grapheme-phoneme relationships.

Bruck and Treiman (1992) looked at children aged 6.5 years. The children were trained to make analogies based upon either the rimes, initial CV units, or vowels of a set of target words. The following day, the ability of the children to generalise these techniques was tested by asking the subjects to read nonwords constructed from the set of training words. Half of the test items shared their rime with target words, and the other half shared their initial CV unit (body). No clue words were present during this test phase. It was found that only the group of children trained to make vowel-based analogies used their new skill in order to read the nonwords, whilst the 'rime' and 'body' groups did not appear to use the strategies which they had been taught. Yet again, the conclusion reached was that at the early stages of learning to read, phoneme-level awareness is relied upon and that although analogy strategies may conceivably develop at a later stage with the growth in reading skills and vocabulary, there was no evidence of spontaneous analogy use in this sample.

Muter, Snowling and Taylor (1994, expt 1) investigated whether analogy use is spontaneous in young readers by testing whether the improvements in analogy reading found by Goswami (1986, 1988a, 1990) were facilitated by the presence of the clue word during the testing phase. A group of 36 children with mean age of 6.3 years were first asked to read a list containing all of the experimental items, and were then taught to read a set of five clue words. In the post-training phase, five lists of words (one based on each clue word) were presented to the children. In each list, half could be read by rime-based analogy with a clue word, while the others simply shared letters (in a different order) with the target. For half of the children the relevant clue word was visible alongside it's own list during testing, whilst the remainder of the children did not see the clue words at this stage. It was found that an advantage for analogy words over control words was evident only for the children who had the clue word present at post-test, indicating that the children had not spontaneously used an analogy strategy.

Savage and Stuart (1998) report the details of two analogy task experiments. In the first of these, 6 year old children were assigned to one of four conditions: 'combined prompt', in which the children were shown clue words during the training stage, and also had the words pronounced for them during the post-training phase; 'phonological prompt', in which no clue words were shown to the children, but were spoken for them during post-training; 'no prompt', which involved the children being shown the clue words and taught to read them, but being given no verbal clue prompts during post-training; finally, an 'untaught' group received no training or clue words and were simply asked to read the target words again. The clue words were related to the target words either by a shared body, shared rime, or shared no common units. The results of the experiment revealed that the children in the first two conditions, who had received prompts, showed similar improvements to each other, and further that there was no specific advantage for rime-based rather than body-based analogies. Children who received no prompts at post-training (both the 'no prompt' and 'untaught' groups) did not show significant improvement in reading any of the target words indicating that use of analogies at this stage is dependent upon concurrent prompting and is not spontaneous. A second experiment tested whether spontaneous analogy use could be found if the children were provided with more than one example clue word for each target unit. One group of children were taught clues sharing the vowel digraph only with the targets, whilst a second group were taught clues sharing their vowel with two target words and their rime with two words. A third group were taught no clue words. No prompting was given to any group during the post-training phase. The results showed that both the 'vowel only' and 'vowel and rime' groups improved significantly in reading 'vowel' and 'rime' target words. Similarly to experiment 1, no advantage was observed for analogies based upon rimes as opposed to vowel-based analogies. No such improvement was observed for the control group. These results indicate firstly that young children can spontaneously apply analogy transfer if provided with several exemplars, and secondly (as before) that there was no special advantage for rime units in these analogies.

Visual Skills and Learning to Read

Although much of the research in reading development has concentrated of phonological awareness, other skills such as visual ability may also play a role. While it is intuitively obvious that visual processing plays an important part in reading words (which are, after all, visual stimuli), there is still debate as to how much visual skills influence the way in which children read and how good they become at reading. Influential models of reading development such as those of Frith (1985) and Marsh, Friedman, Welch and Desberg (1981; see above) envisage stages in reading development during which reading is seen as a visual process. Frith's model proposes that children begin by viewing words as wholes, recognising them as single units - this stage is known as the logographic stage (see also Morton, 1989). There then follows a period driven by alphabetic knowledge, after which comes the orthographic stage. This relies upon *visual* recognition of words, as in the logographic stage, though now the child can extract more information about the orthographic structure of the word. In Marsh et al's theory, visual information is important at stage 1, where words are recognised as whole units; at stage 2, where visual features are used to read new words; and at stage 4, where the reader may recognise word units (such as the rime) in order to read new words by analogy.

The evidence investigating the relationship between visual skills and reading ability, however, does not paint a clear picture. Some researchers have argued that visual skills are highly related to reading ability. Cataldo and Ellis (1990), for example, argue that the first stage of reading involves visual as well as phonological processing. As evidence for this they cite the longitudinal study of Ellis and Large (1988), which found that visual skills made up an important component in predicting reading development. Johnston, Anderson, Perrett and Holligan (unpubd) also cite evidence for a relationship between visual development and reading development. For instance it is pointed out that while Gattuso, Smith and Treiman (1991) concluded that there was little relationship between the skills during the first few years at school, their results actually showed that once performance was matched on visual and auditory discrimination tasks, and the task procedure changed to detection of differences rather than similarities, then there was a significant relationship between visual skills and reading. Johnston and Anderson (submitted) conclude that visual skills have a 'marked' influence on the way in which children's reading develops.

Much research regarding the relationship between reading development and visual skills has focused on poor readers and whether their problems may be due (at least for some children) to a deficit in visual processing skills. In a review of early data on visual matching task performance by poor readers, Vellutino (1979) argues that reading disabilities are not due to a deficit in visual skills. Fox (1994) carried out a study comparing the auditory and visual matching skills of dyslexics as compared to both reading age and chronological age controls. The results showed that the poor readers performed the visual-matching task at the same level as the reading age controls, but were deficient in this skill when compared to the chronological age matched group, suggesting a visual deficit for the poor readers. Differing results have been found by others, however. Siegel, Share and Geva (1995) compared performance of dyslexics to a reading age control group on an orthographic awareness task. This required the subjects to select orthographically legal pseudowords from visually presented pairs. The results of this study showed that the visual-orthographic skills of the dyslexics were *superior* to those of the reading age controls. Similarly, Johnston and colleagues (Johnston, Anderson and Duncan, 1991; Johnston and Anderson, submitted) have demonstrated that on tests of visual perception and visual-orthographic skills, poor readers performed normally for chronological age and were equal or superior to a reading age matched control group. Stanovich (1992) has suggested that visual deficits may only be found using brief presentations and psychophysical techniques, citing as evidence studies by Badcock and Lovegrove (1981), DiLollo, Hanson and McIntyre (1983) and Solman and May (1990), amongst others. However, this was not the case in the study by Fox (1994), for example. Stanovich's second suggestion, that visual deficits may occur in only a small subsample of the dyslexic population, seems more likely.

What evidence such as these studies shows is that even if some poor readers have visual deficits for chronological age, this is not the case for all dyslexics. In terms of normal reading this demonstrates that visual skills are not the *only* factor in determining reading skill, but the fact that a deficit in visual skills can affect performance shows that they are an important component in reading.

Rather than arguing that it is the absolute level of visual skill which affects reading development, there is some evidence that it is the *relative* level of visual skill (compared to phonological skill) which influences the way in which children read, and possibly how well they read. From research with 10 year old poor readers, Johnston and colleagues (Johnston, Anderson and Duncan, 1991; Johnston and Anderson, submitted) demonstrated that these children had phonological skills appropriate to their reading age, but also possessed visual skills at the level of chronological age controls. The results also showed that although the poor readers had no deficit in phonological awareness tasks for reading age, their performance in visual, reading and spelling tasks suggested that they had adopted a visual-orthographic approach to reading. Although the poor readers showed some problems reading nonwords, once the disparity between their visual and phonological skills had been controlled for it was found that nonword reading was appropriate for reading age. Thus, these children had developed good visual segmentation skills independently of their levels of phonological awareness, and this visual advantage had led them to a visual-orthographic approach to reading.

This view that relative levels of phonological and visual skills influence the way in which children learn to read links also with the work of those looking at individual differences in reading style. Baron and Strawson (1976) found that children's reading strategies varied greatly and introduced the terms 'Chinese' and 'Phoenician' to describe readers at opposite ends of the scale. Chinese readers use visual strategies to recognise words, on the basis of word-specific information such as overall shape. Phoenician readers, on the other hand, use spelling-to-sound rules to decode words (also Baron, 1979; Boder, 1973; Davidson, Olson and Kliegl, 1982). Treiman (1984) has also demonstrated that this range of styles can also be extended to spelling. A similar variety of reading styles was found by Beech and Harding (1984) who developed a 'reading style index' to detect differences. Harding, Beech and Sneddon (1985) found that using this index to follow children from age 8 to 11, a trend in development could be seen towards a more visual style of reading in keeping with the visual-orthographic stages proposed by Marsh et al (1981) and Frith (1985) above.

Overview of thesis structure

As has been discussed above, this thesis will explore several aspects of reading development. The following three chapters are concerned with longitudinal data from a two year study of children in Dundee, Scotland. In chapter 2 the nature of phonological awareness will be investigated, in particular whether there exist more than one type of phonological awareness. Chapter 3 is concerned with the relative importance and contributions of rhyme, phonemic awareness and letter knowledge in the first years of schooling. Chapter 4 looks at the contribution which visual skills make to learning to read. Chapters 5 and 6 contain reports of experimental studies carried out within the duration of the longitudinal study: Chapter 5 concerns a replication and extension of the clue-word experiment of Muter, Snowling and Taylor (1994); while Chapter 6 reports the results of a cross-cultural study based upon the work of Duncan, Seymour and Hill (1997). Finally, a general discussion and summary of the research findings will be given in Chapter 7.

Chapter 2
The Nature of Phonological Awareness

Introduction

As discussed in chapter 1, in recent years many different viewpoints have been put forward regarding the nature of Phonological Awareness in terms of whether it should be thought of as a single construct, or as two different types of skill.

The first theory reviewed was that of Stanovich, Cunningham and Cramer (1984), who proposed that phonological awareness should be thought of as a single factor, with different phonological tasks tapping the same skill. It was noted however, that because scores on rhyming tasks were at ceiling for the sample, this view was based upon tests of *phonemic* awareness only. It was demonstrated that the phonemic tasks loaded highly onto a single factor, and predicted reading well.

Yopp's theory also referred solely to phonemic tasks, this time because of a lack of relationship between rhyme-based and non rhyme-based tasks. Factor analysis suggested two factors, which Yopp proposed to be two types of phonemic awareness based upon the number of cognitive operations involved; these were termed 'simple' and 'compound' awareness.

A third viewpoint (Stanovich, 1992) argued that Phonological Awareness ought to be thought of as a *continuum* of awareness, from 'shallow' sensitivity - an ability to compare and judge overall properties of words - to 'deep' sensitivity, involving more complex awareness and ability to manipulate words at the level of the phoneme. Between these two extremes lie various intermediate levels of sensitivity, involving units larger than phonemes. Stanovich sees the continuum being defined in terms of the type of response a child is asked to give in a task, and so the different points on the continuum are very much tied to individual tasks.

Other theorists have proposed dichotomies between different types of Phonological Awareness. Cataldo and Ellis (1990) and Snowling, Hulme, Smith and Thomas (1994) speak in terms of 'implicit' and 'explicit' awareness. The former is viewed as an ability to analyse words for overall properties and is thought to develop prior to the commencement of reading instruction. Explicit awareness, on the other hand, is described as ability to analyse words at the phoneme level and is held to be a *consequence* of learning to read.

An alternative dichotomy proposed by several researchers is that of onset/rime awareness and phoneme awareness. Goswami and Bryant (1990) argue that onset/rime awareness develops naturally prior to any instruction in reading, whilst awareness of phonemes is a result of learning to read. Bowey and Francis (1991) argue for the same two types of awareness, but with onset/rime awareness (termed 'phonological awareness' by the authors) viewed as both a precursor to *and* a consequence of reading instruction. Phonemic awareness is seen to be a result of literacy instruction, in agreement with Goswami and Bryant (see also Johnston, Anderson and Holligan, 1996). Muter and Taylor (reported in Muter, 1994) also view the distinction between awareness of phonemes and onsets/rimes as important, but unlike the other theories just mentioned their view is that *phonemic* awareness is highly important at the start of learning how to read, with rhyme awareness becoming important only after one or two years of schooling.

Wagner and Torgesen (1987) argued on the basis of a re-analysis of the data of Lundberg et al (1980) that Phonological Awareness tasks load onto a single factor. However, this conclusion did not take account of the fact that rhyme production and syllable counting tasks had loaded onto a *second* factor, suggesting that a separate skill was being tapped. These results then, might also be taken as evidence of two types of phonological awareness.

Another paper (Morais, 1991), put forward the idea that Phonological Awareness is composed of two subtypes. Morais proposes that these are: *analytic phonological awareness*, referring to the capacity to consciously isolate the constituent parts of a word; and *holistic phonological awareness*, defined as the capacity to consciously judge properties of whole words. Morais' two types of Awareness are defined by the level of conscious manipulation involved, rather than the tasks which tap them, unlike most of the above theories. Instead, Morais feels that certain tasks may be ambiguous, tapping either type of awareness depending on the strategy employed by the subject. An example given is of oddity tasks, which could be carried out by comparing overall (holistic) properties of words, or can be performed using segmental analysis.

Finally, the theory of Gombert (1992; 1999) and Seymour (1999) also proposes that there are two types of awareness. *Epiphonological* awareness is available even in the absence of any alphabetic or phonological training and is argued to proceed from implicit knowledge of large units to implicit knowledge about small units. Once an external demand such as reading instruction is encountered, *metaphonological* awareness develops allowing conscious awareness of phonemes and only later becoming explicitly sensitive to rime units.

Present Study

In the present study, 5 tests of Phonological Awareness were used to follow its development across the two years of the study. These were: Rhyme Generation; Odd Word Out; Phoneme and Syllable Deletion; and Phoneme Segmentation. The theories discussed above provide many different predictions concerning the current study.

Firstly, the theory of Phonemic Awareness postulated by Stanovich et al (1984) would predict that tasks not involving rhyme (i.e. all phonological tasks except Odd Word Out-Rime Experiment condition and Rhyme Generation) are tapping a single skill. This would mean that they should be highly interrelated, be equally predictive of reading ability and should load on a single factor. Performance on the rhyme tasks should be at ceiling.

Yopp's research conclusions would predict associations between Rhyme Generation and the Rime Experiment condition of Odd Word Out, and that these would be distinct from the other tasks. Further, Yopp would predict that the Phoneme Segmentation task is a test of 'simple' phonemic awareness, and thus should reach high levels of performance sooner than the compound awareness tests: Phoneme Deletion and Odd Word Out (Onset Experiment, Onset Control, Rime Control). We would thus expect to find 3 factors in our analysis.

Thirdly, the theory that Phonological Awareness should be viewed as a continuum from deep to shallow sensitivity was proposed by Stanovich (1992).

On this continuum, the present tasks would lie in the following order (shallow ⇨ deep): Rhyme Generation, Odd Word Out (Rime Experiment condition), Syllable Deletion, Odd Word Out (rime control, onset control, and onset experiment conditions), Phoneme Deletion, Phoneme Segmentation. Since Stanovich proposes development from shallow to deep sensitivity, we would expect to see the shallow tasks reaching high levels of performance first, followed by the others in turn, with phoneme segmentation being the most difficult task to master. This theory might predict that factor analysis would show the tasks all loading onto a single factor but with the shallow tasks loading most highly onto this initially. At later points in the study, we may expect loadings for "deeper" tasks to have increased, as phonological sensitivity develops.

Similarly, we considered theories proposing that there exist implicit and explicit types of awareness, defined by the level of analysis required. Since this theory holds that development is from implicit to explicit awareness after a few years at school, we would expect implicit tasks like Rhyme Generation and Odd Word Out to be easier earlier than explicit tasks, i.e. Phoneme Deletion and Phoneme Segmentation. Factor analysis should show two distinct factors, similar to those predicted by onset/rime and phonemic awareness theories.

The next type of theory discussed was that based on word-units, proposing that awareness for phonemes is distinct from awareness for onset-rime units. These theories would predict differential performance on the Rhyme Generation and Odd Word Out (Onset Experiment and Rime Experiment conditions) tasks (and possibly Syllable Deletion) as compared to the control conditions of the Odd Word Out tasks, Phoneme Deletion, and Phoneme Segmentation. Factor analysis should show this distinction by loading the relevant tasks onto 2 factors. Beyond this, these theories diverge into three types. Goswami and Bryant propose that rhyme awareness develops *prior* to reading, and that phonemic awareness is a *result* of learning to read. If this is the case then we should find advantages for rime-based tasks at the start of the study, with increasing performance on the phonemic tasks only once the children develop their reading skills. The 'rhyme' task scores should also be better predictors of reading than phonemic tasks initially, with the two types of task having equal predictive power later in the study. Muter (1994), however, predicts the *opposite* scenario, with phonemic awareness important at the initial stages of reading, and rhyme skills developing only after 1 or 2 years at school. Thus, phonemic tasks would contribute most to reading at the early stages, with rhyme tasks only becoming important later. The third type of proposal is that of Bowey and Francis who would similarly predict distinct rhyme and non-rhyme factors, but would not predict rhyme skills to be at their best at the very start. It would be predicted that there should be some interaction between reading and 'phonological' (i.e. rime-based) awareness, although phonemic tasks should not interact but simply be driven by reading (at least in the early stages).

The final three theories of Phonological Awareness were slightly different from the others. The results of Wagner and Torgesen's analyses would predict that Rhyme Generation and Odd Word Out - Rime Experiment should load onto a separate, weaker, factor from the other Phonological Awareness tasks.

Morais holds that the two types of awareness, holistic and analytic, do not map directly onto Phonological Awareness tasks, but rather relate to the processes used by the child to perform them. Thus, it is possible that the

Rhyme Generation and Odd Word Out tasks and even initial position Phoneme Deletion (Content et al, 1986) could be performed using holistic *or* analytic awareness skills. Morais seems to feel that holistic awareness develops naturally prior to reading, but that analytic awareness skills are a result of learning to read. It is difficult to make predictions of the present study based on these ideas, since the type of awareness used to tap a particular task may vary across time *and* across individuals. Because of this, the theory may predict that the factor analysis will not show any consistent pattern.

Finally, the model of Gombert (1992, 1999) and Seymour (1999) was mentioned in relation to forms of phonological awareness. This viewpoint would place the Odd Word Out and Rhyme Generation tasks into the category of epiphonological tasks. Since epiphonological awareness of rimes is held to be available prior to schooling, this theory would predict that Rhyme Generation should be simple for the children to perform even at block 1; also the Rime Experiment (and, possibly, Rime Control) conditions of the Odd Word Out task should also be simple for the children even at the beginning of primary 1. Epiphonological awareness of phonemes emerges slightly later than for rimes, but should be sufficiently developed to allow the children to perform well on the Onset Control and Onset Experiment conditions from early on. The remaining three tasks require explicit awareness of the units in question and so would be classed as metaphonological. Syllable deletion should still be fairly simple for even the young children, though, since Gombert (1999) has suggested that meta-awareness for syllables probably emerges before schooling begins. The phoneme segmentation and phoneme deletion tasks require metaphonological awareness of phonemes, however, and so it may be predicted that performance on these tasks should improve rapidly during the study period. It has been suggested that the epiphonological tasks requiring rhyme knowledge may predict reading only towards the middle or end of primary 2, and that reading ability should predict performance in the two phonemic metaphonological awareness tasks.

Methods

Subjects

Subjects were recruited from two primary schools in Dundee, both of which draw their pupils from a wide range of social backgrounds. All children in the primary one classes were given letters for their parents, and only those children whose parents replied giving permission were included in the study. This gave a total number of 62 children at the start of the study: 30 children at school 1; and 32 children at school 2. By the end of the study this number had fallen to 48 children: 21 at school 1; 27 at school 2. Two classes were involved at each school, three of which were single primary 1 classes at the start of the study, and a fourth, in which the children were the lower age group of a primary 1/2 composite class at this point.

Both schools employed a 'mixed' approach to reading instruction, as is common in Scottish schools. The children's reading books emphasised a 'whole word' approach, in which the children were taught to recognise words from their reading books by sight. This was done by giving the children 'word tins' containing pieces of paper each with a sight word written upon it, which the children were required to practice and learn. Once all (or most) of the words could be recognised correctly in isolation, the child was allowed to move onto the next level of the reading scheme and given a new set of scheme words to put into their tins. Alongside the whole word reading instruction, training in phonics was given, teaching the children the sounds of the alphabet and also drawing attention to these sounds within words. In the first year of school attention was drawn particularly (though not exclusively) to word-initial sounds. Explicit training in sounding and blending as a word-attack strategy was not given until primary 3 (beyond the range of the present study), though some advanced readers may have been taught some blending skills towards the end of primary 2. These patterns of literacy instruction were true of both schools involved in the study, the main difference being the particular phonics and reading schemes employed: school 1 used the *Letterland* scheme as a phonics base along with the story books which accompany the series, whilst the *Oxford Reading Tree* was the main reading scheme used; school 2 loosely employed the *Sounds Alive!* phonics scheme (tailored by the individual teachers), alongside the *Ginn Reading 360* reading scheme. A second difference between the two schools was the rate at which the phonics programs proceeded: whilst school 1 had taught all 26 letter sounds by the Christmas of primary 1, school 2 took until May of the first year to complete the alphabet.

The children were followed from the November of their first year at school, when their average age was 5 yr 3 mth (range: 4y 9m – 5y 9m), until the October of primary 3, when they were on average 7 yr 1 mth old (range: 6y 5m – 7y 7m). More information on the children at each block of testing is provided in appendix 1. Testing blocks were carried out as follows: block 1, November - February of primary 1; block 2, May - June of primary 1; block 3, October - February of primary 2; block 4, May - June of primary 2 and August - October of primary 3.

The children were tested individually, with the exception of the spelling tests which were carried out in small groups of 4–6 children. Testing took place in a quiet room away from the rest of the class, and each session lasted between 10–20 minutes on average. Testing took place for two days per week at each school and, as far as possible, no child was seen more than once on any day. All testing sessions were tape-recorded to allow a review of all that happened, and in order to gain any extra information available (*e.g.*, comments made by the children which provided insight into how they performed tasks). Only data for those children present throughout the entire study were used in the present analyses. This gave a total of 48 subjects.

Procedure and Materials

Ready-to-Read Word Test *(Clay, 1979)*

At block 1, reading ability was measured using Clay's Ready-to-Read Word Test. This test is specially designed to be sensitive enough to detect the very first signs of reading ability in young children. In the test, the children were presented with a card which has 3 lists of high frequency words on it. Two words on the sheet, namely ***I*** and ***a***, were not included in scoring, because of their ambiguous status as words or letters. This left a total of 43 words. The children were asked to look carefully through the lists and to read any words that they knew. They were also encouraged to try to guess if they were unsure. Corrective feedback was given only for the first word, and no time limit was enforced. The number of words correctly read was then totalled to give a score out of a possible maximum of 43.

***British Ability Scales - Word Reading* (Elliot et al, 1983)**

After the first block of testing, reading ability was measured using the British Ability Scales Word Reading Test. This allows age-standardised norms and reading ages to be calculated. In the task, the child was given a sheet, on which were 90 words progressing in difficulty. The child was then asked to read the words one at a time, and was encouraged to attempt to guess the identity of unfamiliar words. A piece of paper was used as a guide, to help the children to concentrate on the line of words which they were currently reading. No corrective feedback was given during the test, and no examples preceded the test stimuli. Testing continued until the child made errors on 10 successive words. Reading was not timed, and there were no time limits imposed. Responses were scored 1 point if correct, and the total raw scores were then converted into age-standardised scores and reading ages for each child.

***Rhyme Generation Task* (Johnston, Anderson & Holligan, 1996)**

In order to test the children's awareness of rhymes and ability to generate rhyming words, the rhyme generation task devised by Johnston, Anderson and Holligan (1996) was employed. In this, the child was asked to give as many words as possible which 'sound like' or 'end the same way as' a stimulus word spoken by the experimenter. Three practice trials were given, in which the experimenter helped the child to think of rhyming words, and demonstrated what was required in the task. Twelve experimental stimuli were then given, and the children's correct responses noted. No corrective feedback was given, though rhyming words supplied by the children were used as a prompt so that, for example, if the child gave the word ***pin*** in response to the stimulus ***tin***, the experimenter would say, *"Good. Now can you* *tell me any more words that sound like* ***tin*** *and* ***pin****?".* No time limit was imposed. At block 1, testing was continued for each stimulus until the child could not think of any more rhymes. At block 3, the children's performance had improved so much that a maximum of 5 correctly rhyming responses for each stimulus word was introduced. This had the added benefit of equalising differences between extrovert children, who found it easy to give many answers, and introvert children, who were more reluctant to make responses.

Odd Word Out Task ***(Scott-Brown & Lee, unpubd)***

The Oddity task employed in the present study was a slightly modified version of that devised by Scott-Brown and Lee (unpubd), following the original task of Bradley and Bryant (1983). At block 1, when the children carried out the task for the first time, testing was preceded by an introduction to the concept of 'odd one out' using flashcards with pictures on them. This continued for a couple of minutes until the child seemed to understand the concept clearly. At all testing blocks, the children were asked to repeat groups of three words (there were 3 such word triplets), simply to practice repeating the words. This was followed by the task itself. The experimental stimuli were split into 4 blocks, each with 2 practice and 6 experimental trials. Testing blocks were based on those proposed by Kirtley, Bryant, MacLean and Bradley (1989) and Goswami and Bryant (1990), and were as follows:

a) *Onset Experiment* In this condition the distracter items shared a common initial phoneme (onset), which the target item did not, *e.g.,* ***peg pin car****.*

b) <u>*Onset Control*</u> As the name suggests, this condition was designed as a control for the Onset Experiment condition. The distracter items shared their final phoneme (coda), but the target item did not, *e.g.,* ***lip mop*** ***<u>week</u>***. Thus, the items share the same number of phonemes as in the onset experiment condition (one), however this phoneme is no longer the onset and requires breaking up the rime unit in order to access it.

c) <u>*Rime Experiment*</u> In the Rime Experiment condition, the common unit shared by the distracter items was the rime, *e.g.,* ***hip lip*** ***<u>week</u>***.

d) <u>*Rime Control*</u> This condition may be considered a 'control' for the Rime Experiment condition because the distracter items shared the same number of phonemes as those in the Rime Experiment condition (two). Here, the distracter items shared their initial CV (body), which involves the onset, plus *part* of the rime, *e.g.,* ***peg pen*** ***<u>car</u>***.

Half of the children in any block of testing were randomly allocated to receive these 4 conditions in the order b, a, d, c, while the remainder of the children were tested in the order d, c, b, a. The experimenter would say 3 words, which the child was then asked to repeat. This ensured that errors did not occur due to the child mis-hearing the stimuli. The subject was then asked to choose *"Which word ends/starts differently?"* or *"Which word has a different sound at the start/end?"*. At the beginning of each condition, the experimenter would alert the child to which part of the word they should focus on by saying, *"Now it's the start/end of the word that's important"*. One point was awarded for each trial answered correctly, giving a maximum possible score of 6 for each condition (maximum total = 24).

Phoneme and Syllable Deletion Task

In this task children are asked to say how a word would sound if part of it were deleted. For example, a child might be asked to *"Say **pat** but don't say /p/"*, to which the correct response would be *"at"*. The original task of Rosner (1975) contains only 13 items, which means there are few examples of each type of deletion (indeed, there are no final phoneme blend-splitting deletions in the task - see below). In addition, Rosner's instructions suggest that testing be discontinued after 2 errors, which means that not all types of deletion will be tested, and makes assumptions about the types of deletions the children will be able to perform. In order to overcome these problems, an extra 47 items were devised, to give more trials for each type of deletion and to ensure equal coverage of the different types. Also, testing was not discontinued, so that every child received all 60 words. In all, then, there were 10 trials each of: initial syllable deletion, *e.g.*, ***hedgehog → hog***; final syllable deletion, *e.g.*, ***birthday → birth***; initial phoneme deletion, *e.g.*, ***pat → at***; final phoneme deletion, *e.g.*, ***book → boo***; initial blend-splitting deletion, *e.g.*, ***drive → dive***; final blend-splitting deletion, *e.g.*, ***damp → dap***. It should be borne in mind that many of the syllable deletion items were compound words (see appendix 3), such that the deletion simply involved splitting the word back into two words. This could conceivably have made these stimuli much easier for the children to perform, however this does not appear to have had a very large effect since scores for the task were far from ceiling levels (see below).

In testing blocks 1-3, the original 13 items were presented together during one test session, and the extra items were presented in a separate session. The extra items were split into two lists, each containing roughly similar numbers of each type of deletion in the order: initial phoneme deletion; final phoneme deletion; initial phoneme blend-splitting deletion; final phoneme blend-splitting deletion; initial syllable deletion; final syllable deletion. The children were randomly allocated list 1 or list 2 first.

At block 4, it was realised that having 47 deletion items in one test was monotonous for the children. For this reason, all 60 deletion items were merged, and split into two lists of 30 items, each covering all types of deletion in the same order as that given above. These two lists were then presented as part of two separate testing sessions. All children received these lists in the same order.

For every presentation of the task, testing was preceded by two practice items (2 or 3 more were given if required at the first two blocks of testing). No time limits were imposed. The children were awarded a score of 1 for each deletion performed correctly, giving a maximum of 10 points for each type.

***Phoneme Segmentation Task** (Yopp, 1988)*

The Yopp-Singer test of phoneme segmentation ability was used in the present study. This consists of a list of 22 words, 10 of which contain 2 phonemes, with the remaining 12 words containing 3 phonemes. In the task, the children were asked to say, *e.g., "all the sounds in **go**"*, and correct responses were in the form of segmented phonemes, *e.g. "/g/ - /o/"*. Three practice items were given first, followed by the 22 test items, which were split into two lists of 11 words. Subjects were randomly allocated so that half of the children received list 1 first, and the other half received list 2 first. The 2- and 3-phoneme words were randomly mixed through the lists.

Results

Rhyme Generation Task

All rhyming responses, whether words or nonsense words were marked as correct. The total numbers of correct rhyming responses produced by each child were used in the analyses.

At block 1, the mean number of rhyming responses given was 11.48 (*SD=14.37*). At block 3, the mean number correct was 23.08 (*SD=16.63*; maximum possible = 60 at this testing point).

Odd Word Out Task

For the Odd Word Out task, there was a maximum possible score of 6 for each of the 4 conditions. Because the correct response had to be chosen from 3 options in each trial, the chance level of performance was 2 out of 6 for each condition. Only those conditions where analysis of the 95% confidence interval showed the average score to be above chance were included in the present analyses. In addition, since the different conditions exceeded the chance level at different stages in the study, the 4 conditions were treated as separate variables for the analyses. (As a reminder, the conditions were as follows: Onset Experiment, *e.g.*, ***peg pin car***; Onset Control, *e.g.*, ***lip mop week***; Rime Experiment, *e.g.*, ***hip lip week***; Rime Control, *e.g.*, ***peg pen car***.) Figure 2.1 shows the average scores in the Odd Word Out task, along with 95% confidence intervals. The chance level of 2 is also shown.

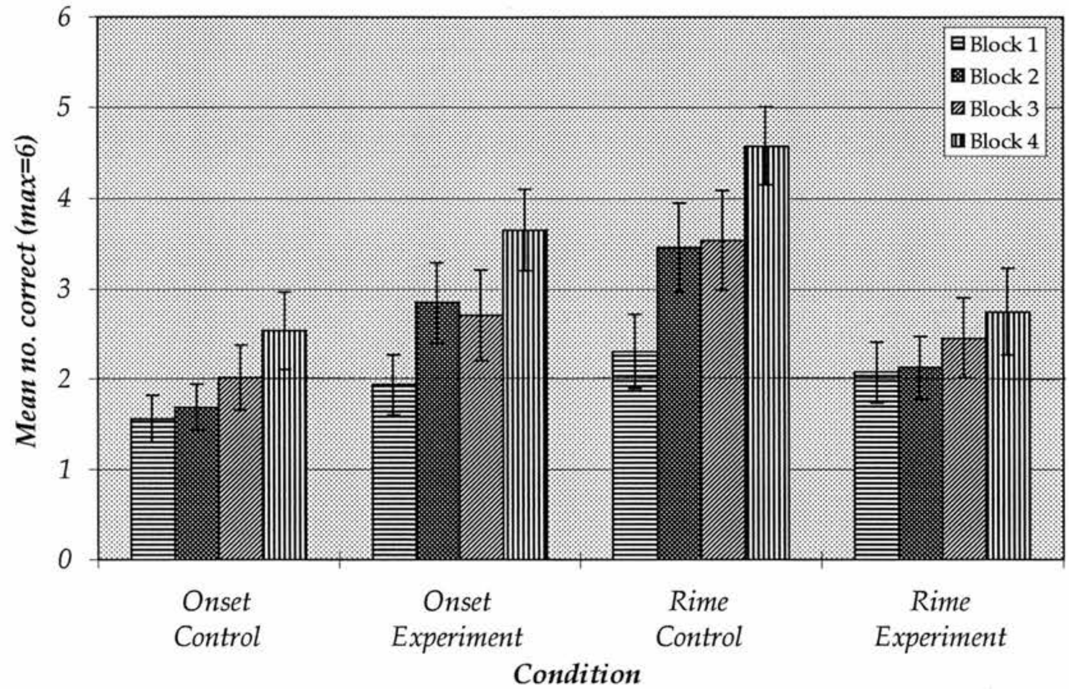


Figure 2.1 - Mean scores for the Odd Word Out task across time. Chance level = 2. Bars represent 95% confidence intervals.

The mean scores for the Onset Control condition were: block 1, 1.56 (*SD=0.90*); block 2, 1.69 (*SD=0.90*); block 3, 2.02 (*SD=1.23*); and block 4b, 2.54 (*SD=1.49*). These scores reached above chance levels at block 4b. In the Onset Experiment condition, average scores were: block 1, 1.94 (*SD=1.16*); block 2, 2.85 (*SD=1.50*); block 3, 2.71 (*SD=1.74*); and block 4b, 3.65 (*SD=1.56*). These scores became significantly greater than chance at block 2. Rime Control mean scores were as follows: block 1, 2.31 (*SD=1.40*); block 2, 3.46 (*SD=1.70*); block 3, 3.54 (*SD=1.90*); and block 4b, 4.58 (*SD=1.49*). Rime Control scores exceeded chance levels from block 2. Mean scores in the Rime Experiment condition were: block 1, 2.08 (*SD=1.16*); block 2, 2.13 (*SD=1.21*); block 3, 2.46 (*SD=1.52*); and block 4b, 2.75 (*SD=1.66*). The scores for this condition began to exceed chance levels at block 3.

Phoneme and Syllable Deletion Task

Correct responses to phoneme deletion and syllable deletion items in this task were analysed separately. Initial and final deletions were grouped together for the purposes of the present analyses.

The average number of correct responses for Phoneme Deletion (maximum = 40) were as follows: block 1, 4.19 (*SD=4.89*); block 2, 8.98 (*SD=7.94*); block 3, 13.65 (*SD=9.39*); block 4a, 19.02 (*SD=9.19*). The mean scores for the Syllable Deletion items (maximum = 20) were: block 1, 7.69 (*SD=5.59*); block 2, 11.13 (*SD=6.12*); block 3, 13.27 (*SD=5.60*); block 4a, 14.83 (*SD=4.98*).

Phoneme Segmentation Task

For the present analyses, the number of words entirely segmented correctly was taken as a score for the Phoneme Segmentation task. The mean scores for the task were (max=22): block 1, 3.12 (*SD=5.23*); block 2, 9.12 (*SD=7.05*); block 3, 11.75 (*SD=7.07*); block 4b, 13.02 (*SD=4.51*).

Reading Ability

At block 1, reading ability was measured using the Clay Ready-To-Read Task. The mean number of words read correctly in this task was 3.00 (*SD=3.05*).

Reading performance was measured at subsequent testing blocks by the British Ability Scales Word Reading test. The raw scores for this task (i.e. number of words read correctly) were used for the present analyses, in order to avoid the loss of sensitivity which accompanies converting the scores to reading ages. Mean scores were: block 2, 9.46 (*SD=7.39*); block 3, 14.56 (*SD=10.62*); block 4a, 31.63 (*SD=16.56*).

Task	*Time*	*Mean*	*S.D.*	*S.E.*	*Var*	*Task*	*Time*	*Mean*	*S.D.*	*S.E.*	*Var*
Rhyme Generation	Block 1	11.48	14.37	2.07	206.51	Phoneme Deletion	Block 1	4.19	4.89	0.71	23.94
Task	Block 3	23.08	16.63	2.40	276.50	Task	Block 2	8.98	7.94	1.15	63.08
							Block 3	13.65	9.39	1.36	88.23
							Block 4	19.02	9.19	1.33	84.49
Odd Word Out -	Block 1	1.56	0.90	0.13	0.80	Syllable Deletion	Block 1	7.69	5.59	0.81	31.20
Onset Control	Block 2	1.69	0.90	0.13	0.82	Task	Block 2	11.13	6.12	0.88	37.43
	Block 3	2.02	1.23	0.18	1.51		Block 3	13.27	5.60	0.81	31.31
	Block 4	2.54	1.49	0.21	2.21		Block 4	14.83	4.98	0.72	24.82
Odd Word Out -	Block 1	1.94	1.16	0.17	1.34	Phoneme	Block 1	3.12	5.23	0.75	27.30
Onset Experiment	Block 2	2.85	1.50	0.22	2.25	Segmentation Task	Block 2	9.12	7.05	1.02	49.69
	Block 3	2.71	1.74	0.25	3.02		Block 3	11.75	7.07	1.02	49.98
	Block 4	3.65	1.56	0.23	2.45		Block 4	13.02	4.51	0.65	20.36
Odd Word Out -	Block 1	2.31	1.40	0.20	1.96	Clay Reading Test	Block 1	3.00	3.05	0.44	9.28
Rime Control	Block 2	3.46	1.70	0.25	2.89						
	Block 3	3.54	1.90	0.27	3.62						
	Block 4	4.58	1.49	0.21	2.21						
Odd Word Out -	Block 1	2.08	1.16	0.17	1.35	BAS Reading Ability	Block 2	9.46	7.39	1.07	54.68
Rime Experiment	Block 2	2.13	1.21	0.18	1.47	Test	Block 3	14.56	10.62	1.53	112.85
	Block 3	2.46	1.52	0.22	2.30		Block 4	31.63	16.56	2.39	274.15
	Block 4	2.75	1.66	0.24	2.74						

Table 2.1 - Table of descriptive statistics for Phonological Awareness and Reading tasks.

A summary of the descriptive statistics for these tasks is given in Table 2.1.

Scaling of variables

As can be seen from Table 2.1, some variables possessed very large variances compared to others. For this reason, some variables were scaled by being multiplied by a constant in order to make their variances more comparable with the others. The procedure of scaling variables independently rather than standardising them (and hence making all variances equal to 1) is recommended as a preparation for Structural Equation Modelling (Bentler, 1995).

The following variables, then, were scaled (scaling constants are shown in brackets after each variable): Rhyme Generation, blocks 1 (0.1) and 3 (0.1); Phoneme Deletion, blocks 1 (0.4), 2 (0.2), 3 (0.2) and 4 (0.2); Syllable Deletion, blocks 1 (0.2), 2 (0.2), 3 (0.2) and 4 (0.4); Phoneme Segmentation, blocks 1 (0.4), 2 (0.2), 3 (0.2) and 4 (0.4); BAS Reading Ability, blocks 2 (0.1), 3 (0.1) and 4 (0.1).

Descriptive statistics for these scaled variables are shown in Table 2.2. These scaled variables, which will be denoted by a ' mark after the variable name, will be used in all analyses in the present chapter.

Table 2.2 - Descriptive statistics for scaled variables

Task	*Time*	*Scaling Constant*	*Mean*	*S.D.*	*S.E.*	*Var*
Rhyme Generation'	Block 1	0.1	1.15	1.44	0.21	2.07
	Block 3	0.1	2.31	1.66	0.24	2.77
Phoneme Deletion'	Block 1	0.4	1.67	1.96	0.28	3.83
	Block 2	0.2	1.80	1.59	0.23	2.52
	Block 3	0.2	2.73	1.88	0.27	3.53
	Block 4	0.2	3.80	1.84	0.27	3.38
Syllable Deletion'	Block 1	0.2	1.54	1.12	0.16	1.25
	Block 2	0.2	2.23	1.22	0.18	1.50
	Block 3	0.2	2.65	1.12	0.16	1.25
	Block 4	0.4	5.93	1.99	0.29	3.97
Phoneme Segmentation'	Block 1	0.4	1.25	2.09	0.30	4.37
	Block 2	0.2	1.83	1.41	0.20	1.99
	Block 3	0.2	2.35	1.41	0.20	2.00
	Block 4	0.4	5.21	1.80	0.26	3.26
BAS Reading Ability'	Block 2	0.1	1.89	1.48	0.21	2.19
	Block 3	0.1	1.46	1.06	0.15	1.13
	Block 4	0.1	3.16	1.66	0.24	2.74

Correlational Analyses

Next, the correlations between each Phonological Awareness task and concurrent reading ability were analysed.[1] Correlation tables for each block are presented in Table 2.3.

[1] Odd Word Out conditions which fell below chance were not included in the analyses.

Table 2.3.1 - Table of correlations for block 1. Rhyme' = Rhyme Generation'; Phon Del' = Phoneme Deletion'; Syll Del' = Syllable Deletion'; Phon Seg' = Phoneme Segmentation'; Clay = Clay Ready-to-read. *(*p<.05 **p<.01 ***p<.001)*

	Phon Del'	***Syll Del'***	***Phon Seg'***	***Clay***
Rhyme'	.304*	.143	.302*	.079
Phon Del'		.681***	.520***	.356**
Syll Del'			.348*	.244
Phon Seg'				.172

Table 2.3.2 - Table of correlations for block 2. Phon Del' = Phoneme Deletion'; Syll Del' = Syllable Deletion'; Phon Seg' = Phoneme Segmentation'; OE = Onset Experiment; RC = Rime Control; Reading' = BAS Reading Ability. *(*p<.05 **p<.01 ***p<.001)*

	Syll Del'	***Phon Seg'***	***OE***	***RC***	***Reading'***
Phon Del'	.776***	.392**	.635***	.454***	.675***
Syll Del'		.354**	.458***	.405**	.541***
Phon Seg'			.303*	.144	.276
OE				.677***	.458***
RC					.450***

Table 2.3.3 - Table of correlations for block 3. Rhyme' = Rhyme Generation'; Phon Del' = Phoneme Deletion'; Syll Del' = Syllable Deletion'; Phon Seg' = Phoneme Segmentation'; OE = Onset Experiment; RC = Rime Control; RE = Rime Experiment; Reading' = BAS Reading Ability. *(*p<.05 **p<.01 ***p<.001)*

	OE	***RC***	***RE***	***Phon Del'***	***Syll Del'***	***Phon Seg'***	***Reading'***
Rhyme'	.087	.248	.165	.200	.086	.182	.273
OE		.525***	.391**	.630***	.345*	.333*	.544***
RC			.444**	.570***	.524***	.192	.457***
RE				.538***	.374**	.035	.535***
Phon Del'					.754***	.339*	.607***
Syll Del'						.303*	.390**
Phon Seg'							.307*

Table 2.3.4 - Table of correlations for block 4. Rhyme' = Rhyme Generation'; Phon Del' = Phoneme Deletion'; Syll Del' = Syllable Deletion'; Phon Seg' = Phoneme Segmentation; OC = Onset Experiment; OE = Onset Experiment; RC = Rime Control; RE = Rime Experiment; Reading' = BAS Reading Ability. *(*p<.05 **p<.01 ***p<.001)*

	OE	RC	RE	Phon Del'	Syll Del'	Phon Seg'	Reading'
OC	.432**	.287*	.384**	.535***	.475***	-.259	.453***
OE		.531***	.228	.418**	.276	.134	.396**
RC			.476***	.328*	.416**	-.145	.453***
RE				.241	.317*	-.144	.463***
Phon Del'					.781***	-.115	.593***
Syll Del'						-.186	.335*
Phon Seg'							-.163

In addition, the relationship between each task and reading across time were examined.

Table 2.4 - Table of correlations between Phonological Awareness tasks and reading across time. Concurrent correlations in italics. Rhyme' = Rhyme Generation'; Phon Del' = Phoneme Deletion'; Syll Del' = Syllable Deletion'; Phon Seg' = Phoneme Segmentation; OC = Onset Experiment; OE = Onset Experiment; RC = Rime Control; RE = Rime Experiment; Reading 1 = Clay Ready-to-read; Reading' = BAS Reading Ability *(*p<.05 **p<.01 ***p<.001)*

	Reading 1	Reading' 2	Reading' 3	Reading' 4
Rhyme' 1	_.079_	.145	-.016	.034
Rhyme' 3	.414**	.283*	_.273_	.268
	Reading 1	Reading' 2	Reading' 3	Reading' 4
Phon Del' 1	_.356**_	.416**	.312*	.289*
Phon Del' 2	.470***	_.675***_	.589***	.534***
Phon Del' 3	.454***	.593***	_.607***_	.629***
Phon Del' 4	.280*	.479***	.473***	_.593***_
	Reading 1	Reading' 2	Reading' 3	Reading' 4
Syll Del' 1	_.244_	.288*	.302*	.186
Syll Del' 2	.459***	_.541***_	.413**	.371**
Syll Del' 3	.353**	.435**	_.390**_	.411**
Syll Del' 4	.362**	.442**	.342*	_.335*_

	Reading 1	Reading' 2	Reading' 3	Reading' 4
Phon Seg' 1	.173	.309*	.352**	.285*
Phon Seg' 2	.103	.276	.460***	.484***
Phon Seg' 3	-.079	.135	.307*	.465***
Phon Seg' 4	-.105	-.147	-.226	-.163
	Reading 1	Reading' 2	Reading' 3	Reading' 4
OC 1	.327*	.297*	.225	.046
OE 1	.230	.220	.249	.348**
RC 1	.593***	.464***	.370**	.270
RE 1	.246	.151	.148	.253
	Reading 1	Reading' 2	Reading' 3	Reading' 4
OC 2	.193	.162	.238	.272
OE 2	.298*	.458***	.511***	.571***
RC 2	.341*	.450***	.400**	.535***
RE 2	.368**	.458***	.471***	.459***
	Reading 1	Reading' 2	Reading' 3	Reading' 4
OC 3	.335*	.357**	.262	.236
OE 3	.382**	.486***	.544***	.642***
RC 3	.441**	.444**	.457***	.530***
RE 3	.300*	.477***	.535***	.439**
	Reading 1	Reading' 2	Reading' 3	Reading' 4
OC 4	.465***	.494***	.495***	.453***
OE 4	.415**	.371**	.391**	.396**
RC 4	.405**	.339*	.365**	.453***
RE 4	.274	.294*	.366**	.463***

Factor Analyses

Factor analyses were carried out on interrelated Phonological Awareness tasks for each of the 4 testing blocks. Varimax rotated factor solutions were calculated (where appropriate), and factor loadings of less than 0.5 were discounted. Details of each analysis are given below.

Block 1

No Odd Word Out condition means were above chance at block 1, and so these scores were not included in the analysis. Once these data had been removed there remained 4 variables, namely: Rhyme Generation', Phoneme Deletion', Syllable Deletion' and Phoneme Segmentation'. These were entered into a factor analysis, which revealed that all of the variables loaded highly onto a single factor, and that 55% of the common variance was accounted for by this. As the variables loaded onto a single factor (eigenvalue = 2.20), no rotation was carried out on the solution matrix. The loadings for the tasks in order of strength (highest loading first) were as follows: Phoneme Deletion' = .89; Syllable Deletion' = .78; Phoneme Segmentation' = .74; Rhyme Generation' = .50.

Block 2

At block 2, the Onset Control and Rime Experiment conditions of the Odd Word Out task had below-chance means, and so were excluded from the factor analysis. This left 5 tasks to be entered into the analysis: Phoneme Deletion'; Syllable Deletion'; Phoneme Segmentation'; Odd Word Out - Onset Experiment; Odd Word Out - Rime Control. These variables all loaded highly onto a single factor (eigenvalue = 2.90) which accounted for 58.1% of the common variance amongst the tasks. Their loadings were as follows: Phoneme Deletion' = .88; Onset Experiment = .83; Syllable Deletion' = .81; Rime Control = .72; Phoneme Segmentation' = .52.

Block 3

The Rhyme Generation' task failed to correlate highly with any of the other Phonological Awareness tasks except Odd Word Out - Onset Control, and so it was discarded from the factor analysis. Rhyme Generation' did not even correlate significantly with reading ability at block 3 (r = .273, p=.061), and so it seems that the task may be tapping skills unrelated to reading. The Onset Control condition of the Odd Word Out task remained below chance, and so was once again excluded from the analysis.

Odd Word Out - Onset Experiment, Odd Word Out - Rime Control, Odd Word Out - Rime Experiment, Phoneme Deletion', Syllable Deletion' and Phoneme Segmentation' were entered into the factor analysis. The results showed that the variables all loaded highly onto a single factor (eigenvalue = 3.20) with the exception of Phoneme Segmentation' which failed to load significantly onto this factor (loading = .44). The loadings for the other tasks were as follows: Phoneme Deletion' = .91; Syllable Deletion' = .78; Rime Control = .77; Onset Experiment = .75; Rime Experiment = .65. 53.3% of common variance was accounted for by this factor.

Block 4

All 4 Odd Word Out conditions had exceeded chance level at block 4, and so were included in the factor analysis. Phoneme Segmentation', however, failed to correlate highly with any of the other tasks, including reading, and so was discarded from the analysis. This left 6 variables: Onset Control; Onset Experiment; Rime Control; Rime Experiment; Phoneme Deletion'; and Syllable Deletion'.

The factor analysis (with Varimax rotation) revealed 2 factors, on which the variables loaded differentially. Factor 1 (eigenvalue = 3.06) consisted of: Phoneme Deletion' = .92; Syllable Deletion' = .87; and Onset Control = .65. Factor 2 (eigenvalue = 1.01) was indexed by Rime Control = .84; Rime Experiment = .75; and Onset Experiment = .65. Analysis of the common variance amongst the tasks showed that the factors accounted for 51.1% and 16.8% respectively. Reliability analyses were then carried out on these two factors, and revealed that factor 2 had a standardised α coefficient of just .6770. When the 6 tasks were entered together, the resulting factor was very reliable, with a standardised α coefficient of .8054. It was concluded therefore that the data support just one factor at block 4.

A summary of the results of the factor analyses is given in table 2.5. These indicate that rather than there being two separate factors of Phonological Awareness, that the tasks were in fact tapping the same skill.

Table 2.5 - Results of factor analysis. Rhyme' = Rhyme Generation'; Phon Del' = Phoneme Deletion'; Syll Del' = Syllable Deletion'; Phon Seg' = Phoneme Segmentation'; OC = Onset Control; OE = Onset Experiment; RC = Rime Control; RE = Rime Experiment.

Block 1		Block 2		Block 3	
	Factor 1		*Factor 1*		*Factor 1*
Phon Del'	.890	*Phon Del'*	.884	*Phon Del'*	.907
Syll Del'	.779	*OE*	.827	*Syll Del'*	.782
Phon Seg'	.739	*Syll Del'*	.809	*RC*	.769
Rhyme'	.504	*RC*	.717	*OE*	.748
		Phon Seg'	.519	*RE*	.650
				Phon Seg'	.438
eigenvalue	2.200	eigenvalue	2.903	eigenvalue	3.200

Block 4		
	Factor 1	***Factor 2***
Phon Del'	.922	.155
Syll Del'	.871	.198
OC	.654	.363
OE	.321	.645
RC	.190	.843
RE	.129	.746
eigenvalue	3.065	1.007

Single Factor

Standardised α = .805

Structural Equation Modelling

Having determined that the phonological tasks loaded onto one factor, these factor variables were used to explore the relationship between Phonological Awareness and reading skill. Phonological Awareness *factor variables* were created using the results of the factor analyses. These were then scaled using a constant of 0.4, in order to make their variances comparable to those of the other variables. Descriptive statistics for these variables can be seen in Table 2.6.

These variables were then used in a series of structural equation models to test the relationships between Phonological Awareness and reading across time. The EQS for Windows program was used to carry out these analyses. In order to simplify the analysis, this process was broken down into 3 parts: block 1 ⇨ block 2; block 2 ⇨ block 3; and block 3 ⇨ block 4.

	Mean	*S.D.*	*Var*	*Mean'*	*S.D.'*	*Var.'*
Phonological Awareness 1	5.61	4.93	24.35	2.24	1.97	3.90
Phonological Awareness 2	12.16	5.61	31.43	4.86	2.24	5.03
Phonological Awareness 3	14.09	6.41	41.05	5.64	2.56	6.57
Phonological Awareness 4	23.26	7.18	51.52	9.30	2.87	8.24

Table 2.6 - Table of descriptive statistics for Phonological Awareness factor variables before and after scaling. Scaling constant = 0.4

Block 1 ⇨ Block 2

Using correlational data, a fully saturated model of the relationship between reading and Phonological Awareness at times 1 and 2 was created (see figure 2.2). This model was run using a maximum likelihood estimation method, and the standardised coefficients generated by this run are shown in figure 2.2. As the model is fully saturated, goodness of fit statistics were not calculated.

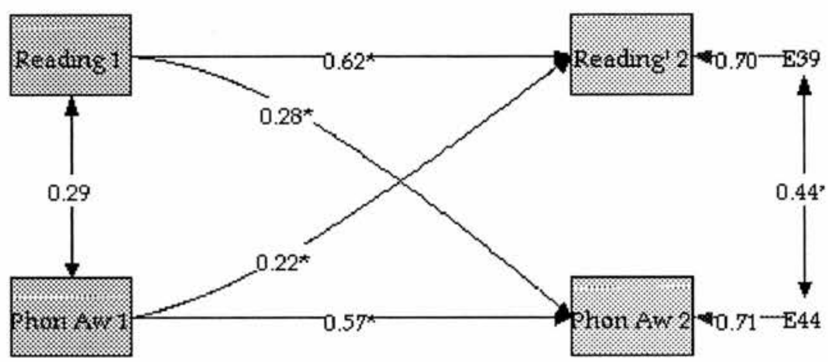


Figure 2.2 - Path model for reading and Phonological Awareness tasks at blocks 1 and 2 (Full model). Standardised solution coefficients are shown.

The equations for the standardised solution were as follows:

$$Reading'(2) = .620 \times Reading(1) + .222 \times Phon\ Aw(1) + .697 \times E$$

$$Phon\ Aw(2) = .275 \times Reading(1) + .572 \times Phon\ Aw(1) + .710 \times E$$

The coefficients for the error terms in these equations indicate that 51% of the variance in reading at time 2 was accounted for by the model, and that 50% of the variance in Phonological Awareness at time 2 was accounted for by reading, and Phonological Awareness at time 1.

In order to investigate further, two more runs of this model were made: once without the Phonological Awareness(1) ⇨ Reading(2) path; and then without the Reading(1) ⇨ Phonological Awareness(2) route. (See figures 2.2.1 and 2.2.2)

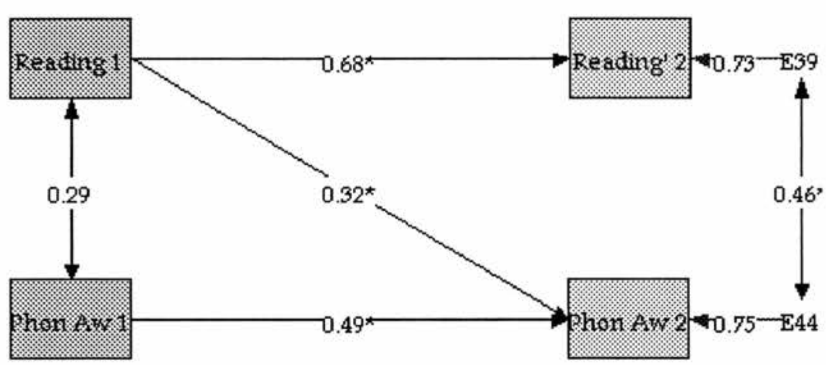


Figure 2.2.1 - Path model for reading and Phonological Awareness tasks at blocks 1 and 2. Reading(1) ⇨ Phonological Awareness(2) model. Standardised solution coefficients are shown.

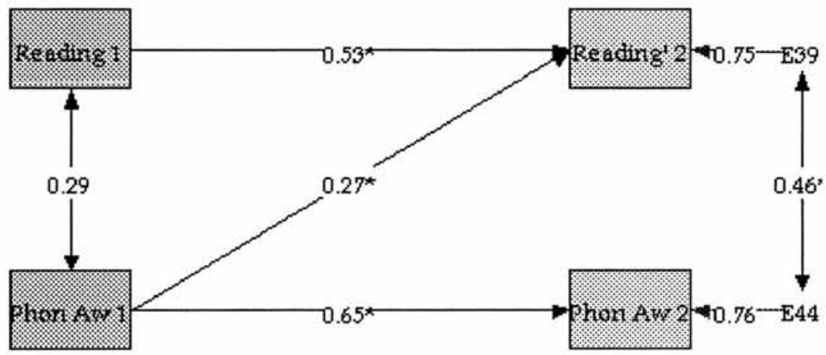


Figure 2.2.2 - Path model for reading and Phonological Awareness tasks at blocks 1 and 2. Phonological Awareness(1) ⇨ Reading(2) model. Standardised solution coefficients are shown.

The first of these models (3.5.1) had a χ^2 value of 4.163 (*d.f.=1*) with *p=.041, Bentler Bonett Normed Fit Index (NFI) =.948, Bentler Bonett Non-Normed Fit Index (NNFI) = .745* and *Comparative Fit Index (CFI) = .958.* The significant χ^2 value indicates a poor fit to the data. The standardised solution equations were:

Reading'(2) = .685×Reading(1) + .729×E

Phon Aw(2) = .318×Reading(1) + .495×Phon Aw(1) + .750×E

These show that only 47% of the variance in Reading at time 2, and 44% of the variance in Phonological Awareness at time 2 were accounted for by this model. The standardised path coefficients are shown in figure 2.2.1.

For the third model (figure 2.2.2), similar statistics were obtained: χ^2 = *6.042 (d.f.=1), p= .014; NFI = .925, NNFI =.594, CFI =.932.* The χ^2 value for this model was more highly significant than that for model 3.2.1, indicating an even poorer fit to the data. The standardised solution (shown in figure 2.2.2) was as follows:

Reading'(2) = .533×Reading(1) + .271×Phon Aw(1) + .747×E

Phon Aw(2) = .653×Phon Aw(1) + .758×E

Here, 44% of the variance in Reading at time 2, and 43% of the variance in Phonological Awareness at time 2 were accounted for by the model.

Both of these models attained significant χ^2 values meaning that they did not fit the data well. Because of this, the model was tested with vocabulary and alphabet knowledge variables added at block 1 to see whether these variables were contributing extra variance which the existing variables were not. It was found that the full model still did not fit the data, however once all paths with a value of less than 0.2 were removed, the resulting model did fit the data. This revised model is shown in Figure 2.2.3.

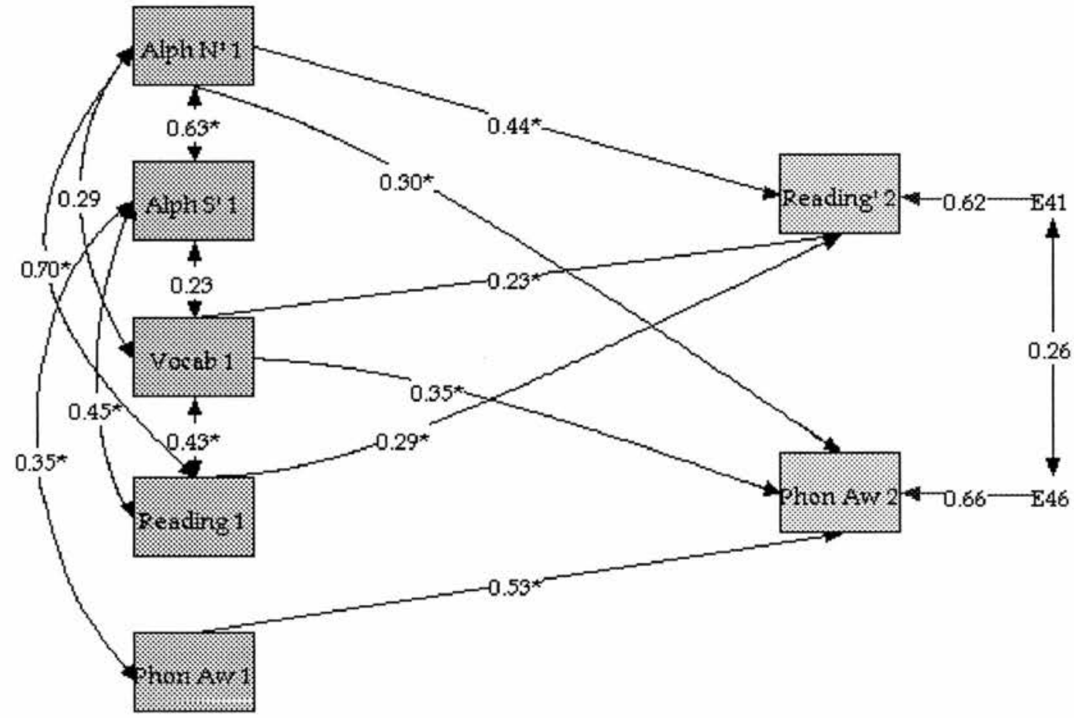


Figure 2.2.3 - Path model for Phonological Awareness and Reading at blocks 1 and 2 - with extra block 1 variables. Standardised solution coefficients are shown.

The statistics for this model were as follows: $\chi^2 = 11.99$ (*d.f.=7*), *p=0.101; NFI = .936, NNFI = .910, CFI = .970.* These statistics indicate that the model fits the data well. It was able to account for 62% of the variance in reading at block

2, and 56% of the variance in Phonological Awareness at block 2. The standardised equations for the model were:

$$Reading'(2) = .225 \times Vocabulary + .288 \times Reading(1) + .437 \times Letter\ Name\ Knowledge + .620 \times E$$

$$Phon\ Aw(2) = .352 \times Vocabulary + .304 \times Letter\ Name\ Knowledge + .533 \times Phon\ Aw(1) + .660 \times E$$

In contrast to the previous model of this time period, we now see that there is no interaction between Phonological Awareness and reading across year one, and that block 1 vocabulary knowledge and ability to give letter names contribute significantly to both reading and Phonological Awareness at block 2.

<u>*Block 2 ⇨ Block 3*</u>

The EQS analysis from block 2 ⇨ block 3 involved reading at times 2 and 3, Phonological Awareness factor variables at times 2 and 3, and Phoneme Segmentation at time 3 (which did not load onto the Phonological Awareness factor at time 3). A diagram of the full model is shown in figure 2.3.

Analysis of this model produced a χ^2 value of 1.500 (*d.f.=1, p=.221*), suggesting a good fit to the data. This was confirmed by the fit indices: *NFI = .990, NNFI = .966, CFI = .997*. The standardised path coefficients are shown on the model (figure 2.3); the equations from which they are taken are:

$$Reading'(3) = .736 \times Reading'(2) + .152 \times Phon\ Aw(2) + .542 \times E$$

$$Phon\ Aw(3) = .144 \times Reading'(2) + .752 \times Phon\ Aw(2) + .525 \times E$$

$$Phon\ Seg'(3) = .407 \times Reading'(2) + .913 \times E$$

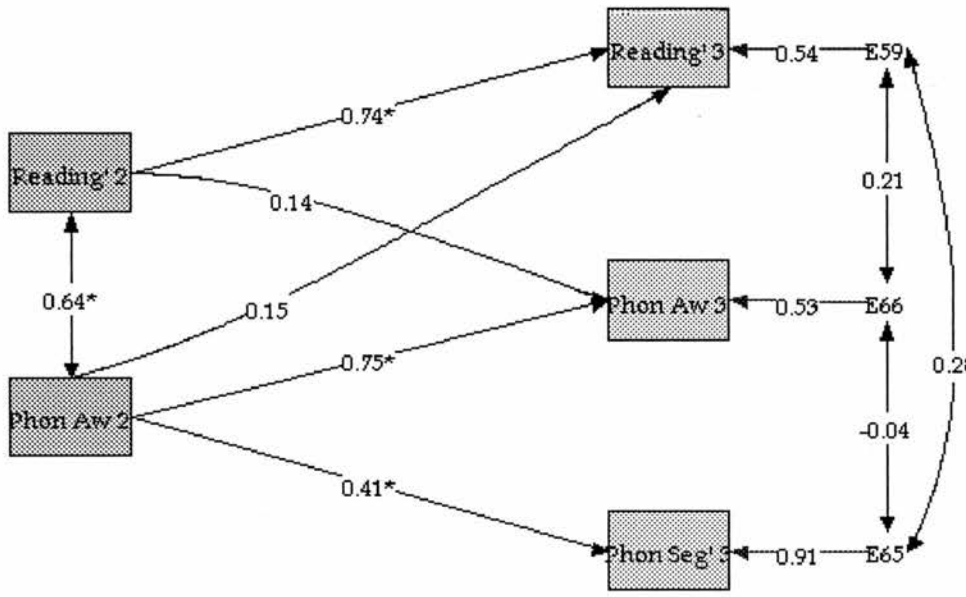


Figure 2.3 - Path model for Phonological Awareness and Reading at blocks 2 and 3 (Full model). Standardised solution coefficients are shown.

Error term coefficients indicate that a total of 71% of the variance in Reading at time 3, 72% of the variance in Phonological Awareness at time 3, and just 17% of the variance in Phoneme Segmentation at time 3 has been accounted for by this model.

Since the interaction relationships between Phonological Awareness and Reading across time were not significant, no further variations of this model were tested.

Block 3 ⇨ Block 4

The correlations between Reading', Phonological Awareness and Phoneme Segmentation' at time 3 and Reading' and Phonological Awareness at time 4 were all significant, and so the fully saturated model in figure 2.4 was tested first.

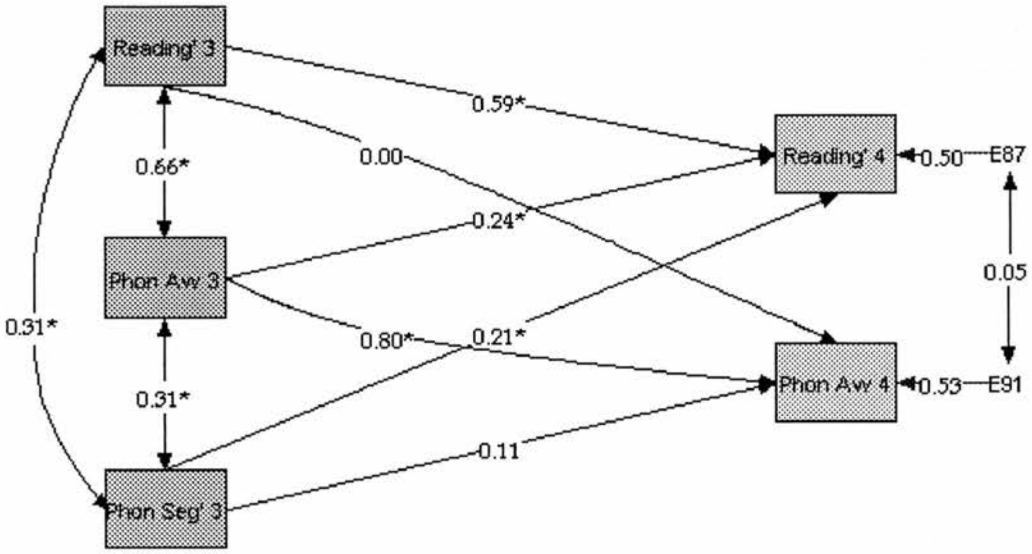


Figure 2.4 - Path model for Reading and Phonological Awareness at blocks 3 and 4 (Full model). Standardised solution coefficients are shown.

As this model is fully saturated, goodness of fit statistics were not computed. The standardised solution equations for the model were as follows:

$$Reading'(4) = .590 \times Reading'(3) + .210 \times Phon\ Seg'(3) + .243 \times Phon\ Aw(3) + .504 \times E$$

$$Phon\ Aw(4) = .003 \times Reading'(3) + .108 \times Phon\ Seg'(3) + .805 \times Phon\ Aw(3) + .533 \times E$$

This model was then re-run, without those paths whose coefficients were not significant, giving the model shown in figure 2.4.1. This trimmed model had a χ^2 value of 1.85 (*d.f.=3, p=.6049*). The goodness of fit index values were as follows: NFI = .988; NNFI = 1.026; CFI = 1.000. All of these values indicate a very good fit to the data.

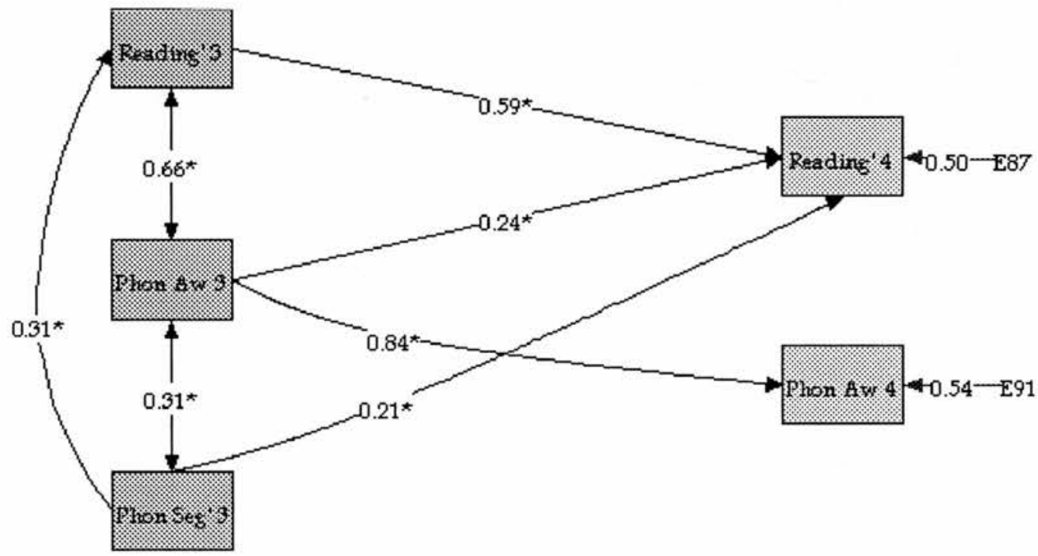


Figure 2.4.1 - Path model for Reading and Phonological Awareness at blocks 3 and 4 (without n.s. paths). Standardised solution coefficients are shown.

75% of variance in reading at time 4 was accounted for by this model, along with 71% of the variance in Phonological Awareness 4. Standardised solution equations for this model were:

$$Reading'(4) = .590 \times Reading'(3) + .210 \times Phon\ Seg'(3) + .243 \times Phon\ Aw(3) + .504 \times E$$

$$Phon\ Aw(4) = .840 \times Phon\ Aw(3) + .542 \times E$$

In summary, the path analyses indicated that from block 1 through to block 3 there was no interaction between Phonological Awareness and reading across time (though significant covariance was shared at each individual time). From block 3 to block 4, though, it was observed that whilst Phonological Awareness made a significant contribution to later reading skill, reading made no significant impact on later Phonological Awareness.

Discussion

The results of the factor analyses suggest a fairly coherent picture of the Phonological Awareness tasks loading on just one factor. Although the analysis at block 4 initially suggested that there were 2 factors, this was not upheld by the reliability analysis. The tasks were strongly inter-related at each testing block, with the possible exception of Rhyme Generation and Phoneme Segmentation which seemed to become less closely related to the other Phonological Awareness tasks and to reading in the later stages of the study.

It is also worth noting the very poor performance in the Odd Word Out task, with no conditions exceeding chance at the beginning of schooling, and one condition (Onset Control) not becoming significantly above chance until the end of year 2. It is not immediately obvious why the present group of children should find the task so difficult. Although the stimuli were not taken from the studies of other researchers such as Kirtley, Bryant, MacLean and Bradley (1989) or Bradley and Bryant (1983) who had found even young children able to perform at above-chance levels, the present task *had* been used without any problems in a study by the undergraduate students who created it (Scott-Brown and Lee, unpubd). In addition, the current task was administered to a group of children in Fife schools as part of a comparative study reported in chapter 7. These children were chronologically matched to the main sample at the time of the 3rd block of testing, though their scores on the Odd Word Out task were closer to the final scores for the main sample. It should be noted that these children had been receiving an accelerated program of phonics and were ahead of their peers in reading ability. The results do suggest that the task items are not impossible for children of this age, and supports the possibility that the difficulties were not the result of the stimuli or instructions given, but to some characteristic within the subject group themselves. The experimenter was aware of some children simply forming a response set and responding with the last word in each trial, however this lack of effort would not seem adequate to account for the 69% (Rime Control) to 92% (Onset Control) of children scoring at or below the chance level of 2 correct at block 1. By block 4, over 50% of children were still scoring 2 or less trials correct in the Rime Experiment and Onset Control conditions. This suggests a genuine difficulty in performing the task rather than simply an attentional or motivational problem. A possible explanation for this pattern of performance is given by one of theories as discussed below.

Structural Equation modelling of the causal relationships between the factor of Phonological Awareness and reading ability indicated a changing pattern across time. Firstly initial reading and Phonological Awareness skills, although weakly correlated, did not make significant contributions to each other, nor did these skills interact with each other during the first year of school. From the end of year 1 to the middle of year 2 (block 2 ⇨ block 3), Phonological Awareness and reading skills failed to make significant contributions to each other across time, although there was evidence of significant concurrent interaction between these skills at time 2, and at time 3. Across the children's second year at school, Phonological Awareness played a significant role in developing reading skills, but reading made no contribution to later Phonological Awareness. Although it did appear at first that there was an interaction between reading and Phonological Awareness from block 1 to block 2, further investigation revealed that this was due to the very strong influence which block 1 letter knowledge was having on these variables at both time points. This influence of letter knowledge will be discussed further in the next chapter. We see then that during the first year and a half of instruction there was no reciprocal relationship between reading and Phonological Awareness, as has been suggested by some researchers (e.g. Morais, 1991; Perfetti, Beck, Bell and Hughes, 1987), but during the second year the relationship is one-way from Phonological Awareness to reading skills.

We will now look at how these results relate to each of the hypotheses presented in the introduction.

Firstly, Stanovich et al (1984) proposed that rhyme skills should be considered separate from other tests of Phonological Awareness and that all phonemic awareness tasks load together on a single factor. At first glance this may seem similar to the situation that has emerged in the present study. The results showed tasks to load onto a single factor of Phonological Awareness, and Rhyme Generation at block 3 is not correlated to the other tasks, which might seem to agree with the hypothesis. However, on closer inspection, the findings do not support those of Stanovich et al. A major difference is in the children's scores on the rhyming tasks: while Stanovich et al found their kindergarten children to be at ceiling, the present results do not show such an effect at the beginning of testing. In particular, the scores in the Odd Word Out task were extremely poor, with ability to pick out a non-rhyming word (Rime Experiment) not exceeding chance levels until the 2nd year of schooling. Further, Rhyme Generation scores *did* correlate with other Phonological Awareness tasks at the beginning of the study, and loaded with them onto a single factor. Factor analysis found tasks of syllable and other word units loading together with phoneme-based tasks suggesting that phonemic awareness is not separate from awareness of other units. Also, the pattern of results for Phoneme Segmentation shows that not every test of phonemic awareness remains strongly related to other Phonological Awareness tasks or reading ability.

Many of these points raise similar problems for the view of Phonological Awareness held by Yopp (1988). Once again, we did not find rhyme-based tasks to load separately from the others or reading at block 1, even though the task did separate from the other tasks by block 3. The split of the 'simple' task, Phoneme Segmentation, from the other Phonological Awareness tasks might seem to support Yopp's distinction between two types of phonemic awareness, but this split does not occur until the later stages of the study. In addition, whilst Yopp found that tests of 'simple' awareness (e.g., Phoneme Segmentation) were more highly related to reading ability than 'compound' tasks (e.g., Phoneme Deletion), the present results show the opposite to be true for the present sample: whilst Phoneme Segmentation becomes less and less correlated with reading, Phoneme Deletion consistently shows a stronger correlation with reading than any of the other tasks.

The second type of theory discussed proposed that Phonological Awareness should be viewed as a continuum. Stanovich (1992) proposes that awareness develops along a continuum from shallow to deep sensitivity. If this were the case we should see a changing pattern of relationship to reading, with the more shallow tasks being most strongly related to reading but with deeper tasks holding this position as time goes on. In fact, the most shallow task, Odd Word Out, shows performance so poor that it was discounted from analysis. The intermediate level task, Phoneme Deletion, shows the strongest correlations with reading throughout the study. Further, the Phoneme Segmentation task, which is the deepest test of sensitivity, shows less and less relationship with reading rather than becoming more strongly related to it. Another problem for the continuum idea is that some tasks (Rhyme Generation, Phoneme Segmentation) were not correlated with the other tasks throughout the study, while it would be expected that all of the tasks should remain closely related.

Similarly, Cataldo and Ellis (1990) would rank Phoneme Segmentation as the most explicit task used here. However, far from becoming more closely related to reading, this task becomes *un*related to reading in year 2. This theory also suggested that children arrive at school with a good deal of implicit awareness already developed, but in the present study performance on the most implicit task (Odd Word Out), was extremely poor. The factor analysis did fail to show two separate factors, but important tasks failed to load onto the Phonological Awareness factor. Structural equation modelling showed that in year one neither implicit or explicit tasks, contributed significantly to later reading ability, contrary to the results of Cataldo and Ellis. Also, there was a significant contribution made to reading by implicit tasks in year 2, which does not replicate Cataldo and Ellis' work. Another piece of evidence which does not agree with this theory is the evidence from tasks reported in chapter 3 which suggest evidence of alphabetic reading at an earlier stage than predicted.

Several variations of onset/rime theories were presented next. The first of these was that of Goswami and Bryant (1990) who envisage a role for rime awareness even before children begin learning to read. The present results do, indeed, show that Rhyme Generation performance was less closely related to the other tasks at time 3 than time 1, but the correlation with concurrent reading is actually stronger (though still non-significant) at the later stage. Also, the hypothesised interaction between reading and Phonological Awareness was not observed. Further, there was no interaction between Phonological Awareness and reading at block 1. The performance on the Odd Word Out task is a particular problem for Goswami and Bryant, who hold this test to be the best measure of onset/rime awareness; unlike the results reported in their book, the present sample seemed to find particular difficulty with this task until they had been at school for many months. The fact that many children in the study were able to perform phoneme-based tasks such as Phoneme Deletion and Phoneme Segmentation *at all* at block 1 is also in conflict with Goswami and Bryant's theory, since they argue that phonemic awareness can be achieved only once the child has developed their reading skills. Patterns of correlation show that Rhyme Generation correlates significantly only with *earlier* reading ability and not with concurrent or later reading performance, suggesting that reading may in fact be driving Rhyme Generation performance, rather than the other way around. Perhaps most importantly, factor analysis failed to support a distinction between onset/rime and phoneme awareness.

The lack of distinct onset/rime and phonemic awareness factors also causes problems for the theory of Bowey and Francis (1991). While the continuing development of rhyme skills does sit better with their theory than with that of Goswami and Bryant, the lack of a close relationship with reading does not. Indeed, as we have seen, the Rhyme Generation task becomes less correlated with all of the other tasks. The ability of some children to perform phoneme-based tasks at block 1 does not agree with Bowey and Francis' assertion that such skills are a consequence of reading instruction, nor does the finding of a significant contribution of Phonological Awareness to reading in year 2 of the study.

The third theory based on onset/rime versus phonemic awareness was that of Muter (1994). The patterns of correlation between reading ability and rhyme, which suggest that reading skills make a contribution to rhyme skills more so than the other way round, along with the lack of any particular ability in or importance of early rhyme skills do support Muter's hypothesis that rhyme skills develop after a year or so of reading. In particular the patterns of performance in the Odd Word Out task, with scores only gradually rising above chance levels sit well with Muter's idea. However, no close relationship becomes apparent between rhyming skills and reading, and as has been pointed out already, only one factor emerged from the analysis and this involved both phonemic and rhyme-based tasks. Also the structural equation analysis failed to show the predicted interaction between initial reading and Phonological Awareness skills. Finally, other results (described in chapter 6) suggest that these children were reading at the phonemic level, rather than the onset/rime level, in year 2.

A slightly different type of theory was given by Wagner and Torgesen (1987) with their re-analysis of the data of Lundberg et al (1980). The present study did not include any measure analogous to Lundberg et al's concrete syllable segmentation task, but the data did demonstrate Rhyme Generation pulling away from the other Phonological Awareness tasks. However, the rhyme-based tasks in this study did not load onto a separate factor. Further, the Phoneme Segmentation task *also* showed a split away from the other Phonological Awareness tasks, which is not in keeping with Wagner and Torgesen's results. Also, Lundberg et al's subjects were at kindergarten, and so their performance ought to be more similar to the block 1 data. Clearly the present analyses do not support the predictions of this theory.

Morais' hypothesis regarding the nature of Phonological Awareness may fit rather better than most of the other theories with the lack of a clear cut pattern amongst the current data, since it might be possible to explain this as being due to the lack of a simple relationship between holistic and analytic awareness and Phonological Awareness tasks. The move away from other tasks of Rhyme Generation and Phoneme Segmentation might be explained in terms of one being a purely holistic and the other a purely analytic task, however the two tasks appear to be moving apart from reading ability too, which might not be expected according to Morais' theory. The poor performance on the Odd Word Out task at the early stages does not square with the predictions of Morais either, since these tasks should be easily accomplished using existing holistic awareness which does not require literacy skills. Further, the present results did not provide the dissociation between rhyme-based and phoneme-based tasks which would be expected; indeed Rhyme Generation was *more closely* related to the other Phonological Awareness tasks at the outset, rather than showing a dissociation with tasks like Phoneme Deletion and Phoneme Segmentation.

The final hypothesis introduced was that of Gombert (1992; 1999) and Seymour (1999). Contrary to the predictions of this theory, there was no clear distinction between those tasks considered epiphonological, and those which were metaphonological. In addition, the two epilinguistic tasks, Odd Word Out and Rhyme Generation, were not simple for the children to perform even though Gombert's theory would argue that by the time they reach school, children should possess sufficient epi-awareness in order to do well. Indeed scores for the rime experiment condition of the Odd Word Out task did not exceed chance levels until the beginning of primary 2. In contrast, scores for the onset experiment condition exceeded chance at the end of the first year. This may to some extent have been due to the emphasis on word-initial letters common in the children's classrooms, but the pattern remains contrary to that which was predicted. Also, early rime skills were not found to be predictive of later reading skills for the present sample.

The evidence for metalinguistic awareness was also unconvincing. Although Gombert (1999) suggests that meta-awareness for syllables may occur prior to any alphabetic instruction, it is apparent that the syllable deletion task was not easy - even by the end of year 2, the group's mean score was not at ceiling (14.83 out of 20). The two phonemic tasks were more difficult for the children, but were not closely related to each other as time went on. Whilst early reading was significantly correlated with later phoneme deletion, no such pattern was observed for the phoneme segmentation task. In all, the results of the present analyses did not fit well with the theories and predictions of Gombert (1992, 1999) and Seymour (1999).

Differences in subject ages, tasks (or stimuli) employed and sample sizes may all have played a part in causing the discrepancies with most of the previous research discussed in this chapter. Another, very important factor which most researchers fail to take into account, however, is the type of instruction which the children receive. If the suggestions of Duncan et al (1997, in press) are correct, then this single influence may account for much of the apparently contradictory findings in the literature.

There are also some ways in which the present study could have been improved, but because the study was set up in order to address several different questions regarding reading development these were either not recognised at the time or not practical. One problem which may have affected the results of the factor analysis was that only a few Phonological Awareness tasks were administered. This may have resulted in single factor solutions simply because there were not enough tasks to make a second factor. The number of tasks used was dictated by time factors and the large number of other tasks being used at each testing block. Another point which was less than ideal in hindsight, was that the Rhyme Generation task was only administered at blocks 1 and 3. It would have been valuable to follow the development of this skills throughout the study, in particular to see how the task related to the others and reading ability at time 4. A further improvement, and one which applies to almost all of the questions under consideration in this thesis, would have been to follow the children from the pre-school stage. This would have provided important information on the skills possessed by the children before they began receiving any literacy instruction. Unfortunately, this was not possible in the period of time available.

In order to further advance the study of Phonological Awareness and reading development, it is vital that further research such as this is done, so that the nature of Phonological Awareness may be clearly defined. As we have seen, there is little agreement in the literature in this area, and surprisingly little attempt to resolve the issue, which is often simply ignored. In order to progress in our understanding of the important role of Phonological Awareness in early reading development, it is vital that we first reach some understanding of the underlying nature of Phonological Awareness itself.

Chapter 3
The importance of phonemes and rimes in early reading

Introduction

It is clear from the introduction chapter that the issue of whether rhyme awareness or letter knowledge is more important for beginning readers has generated a great deal of research and debate.

In favour of alphabetic or phonemic knowledge comes evidence from a variety of sources. Longitudinal data suggests that letter knowledge is an important precursor to both reading and phonological awareness development (e.g., Stuart and Coltheart, 1988; Johnston, Anderson and Holligan, 1996). Studies from New Zealand indicate that even in the absence of explicit phonics training, children appear to generate grapheme-phoneme correspondences by themselves (Thompson, Cottrell and Fletcher-Flinn, 1996; Thompson and Johnston, 1993). Evidence of phonemic skills has been found even in pre-readers (Kirtley, Bryant, MacLean and Bradley, 1989) and it has also been shown that complex phonemic skills are easily acquired by young pre-readers with just a little training (Content, Kolinsky, Morais and Bertelson, 1986). Yet another source of evidence supporting the importance of alphabetic knowledge in early reading comes from data showing that letter knowledge is a very strong predictor of later reading success (Share, Jorm, MacLean and Matthews, 1984; Demont and Gombert, 1996; Cataldo and Ellis, 1990). Training studies, too, show that improving grapheme-phoneme knowledge skills leads to improved reading (Bradley, 1990; Treiman and Baron, 1983). Lastly, several studies have suggested that phonemic skills are necessary before orthographic analogies may be used (Nicholas, Kay and Mitchell, unpubd), and that such analogies may be based upon letter identity (Thompson and Fletcher-Flinn, 1993; Rack, Hulme, Snowling and Wightman, 1994).

There do also exist studies which argue that *rhyme* awareness is the most important skill for young readers, however. Most notable is the work of Goswami and Bryant (1990), who set out a theory of reading acquisition founded upon the importance of early rhyme awareness skills. Much of the evidence for rhyme importance is drawn from the work of Goswami (1986, 1988, 1990) who demonstrated that children can be trained to use rime-based analogies in their reading. Others have demonstrated a relationship between pre-school rhyme awareness and subsequent reading skill (Bryant, 1990; Bryant, Bradley, MacLean and Crossland, 1989; Bryant, MacLean, Bradley and Crossland, 1989; Cataldo and Ellis, 1990; Bowey and Francis, 1991). As was pointed out in chapter 1, though, some of these researchers' conclusions are not supported by their own data (e.g., Bradley and Bryant, 1983). Another major problem which has not been adequately answered by these theorists is that although phonemic knowledge is held to be of little importance, most onsets encountered by young children will be single phonemes. Some have dismissed this as pure coincidence (e.g., Bryant, 1990; Kirtley et al, 1989), though others have allowed that letter knowledge may have some limited importance (e.g., Bradley, 1990; Bruck and Treiman, 1992). Indeed, as discussed in the review of clue-word task research (chapters 1 and 5) much analogy data has indicated that grapheme-phoneme skills are *required* for the first stages of learning to read, with rhyme awareness and analogy use appearing at around year three of school (Muter, 1994; Muter, Snowling and Taylor, 1994; Nicholas, Kay and Mitchell, unpubd; Morais, 1991; Goswami, 1998).

A theory which has sought to encompass these various, and sometimes apparently contradictory, research findings is that of Seymour (1999) and Gombert (1992; 1999). This theory suggests that epiphonological awareness, available before literacy instruction commences, allows the child to be implicitly aware of first large and then smaller units of the language. Once instruction begins, an explicit metaphonological awareness develops, initially for individual phonemes but gradually encompassing larger structures such as rimes.

As has been shown, there are various different theories of whether and when awareness of phonemes and of onsets and rimes becomes the important focus of the young reader's phonological awareness and reading strategies. In this chapter the results from the longitudinal study will be discussed in terms of these different viewpoints, with the aim of investigating how the present sample's awareness of subsyllabic units relates to reading, and whether there is evidence of a shift in focus from small to large unit use (or vice versa).

Methods

Once again, this chapter draws data from all blocks of testing in the longitudinal study.

Alphabet Knowledge Task

A measure was taken at several points throughout the study of the ability of the children to give the names and sounds of the letters of the alphabet. In the test, all 26 letters of the alphabet appeared individually on the screen of a laptop computer. The stimuli were displayed in the centre of the screen in lower case, and were around 1-2 cms high. Each letter was preceded by a small asterisk, which served as a focus for the children's attention. When the experimenter pressed the spacebar, the asterisk disappeared and was replaced by a letter. The child's response spoken into a microphone triggered a voice-switch, removing the stimulus from the screen, displaying an asterisk ready for the next trial, and recording the reaction time data. The computer then waited for the experimenter to press the spacebar before proceeding to the next stimulus. No practice trials were given, though all children seemed to grasp what was required of them very rapidly.

During the first time through the task, the children were required to provide the *sounds* of the letters, and this was clarified by the experimenter before commencing testing. If, on any occasion, the child supplied the letter's *name* rather than its sound, the response was noted, and the experimenter would say, *"Now that's the letter's name. Can you tell me its sound?"*. This gave the child an opportunity to supply the correct answer. On occasions where the voice-switch was tripped early by accident (*e.g.*, if the child coughed or said, *"Ummm..."*), this was noted and the letter written down to give the child an opportunity to respond. Once all letters had been presented, the whole procedure was repeated and the children asked to give the letters' *names* rather than their sounds.

The number of names and sounds given correctly was calculated, with scores awarded even if the correct answer was given only in the wrong condition (*i.e.*, when the correct sound of a letter was only given during the *names* condition, or vice versa). The children were also given composite alphabet knowledge scores, reflecting the number of letters for which they were able to give the correct name *and/or* sound.

Where the children are split into high and low alphabet knowledge groups for analysis, this refers to their performance on the Alphabet Knowledge task at the first block of testing. A median split was performed on the composite scores (number of letters correctly sounded and/or named correctly), to give two equal groups of 24 children. The children remained in these high and low alphabet knowledge groupings for analysis regardless of subsequent performance on the task.

***Ready-to-Read Word Test* (Clay, 1979)**

At block 1, reading ability was measured using Clay's Ready-to-Read Word Test, in which the children were presented with a card which has 3 lists of high frequency words on it. Two words on the sheet, namely ***I*** and ***a***, were not included in scoring, because of their ambiguous status as words or letters leaving a total of 43 words. The children were asked to look carefully through the lists reading any words that they knew, and were encouraged to try to guess if they were unsure. Corrective feedback was given for the first word only, and no time limit was enforced. The number of words correctly read was then totalled to give a score out of a possible maximum of 43.

***British Ability Scales - Word Reading* (Elliot et al, 1983)**

After the first block of testing, reading ability was measured using the British Ability Scales Word Reading Test. In the task, the child was given a sheet, on which were 90 words progressing in difficulty. The child was then asked to read the words one at a time, and was encouraged to attempt to guess the identity of unfamiliar words. No corrective feedback was given during the test, and no examples preceded the test stimuli. Testing continued until the child made errors on 10 successive words. Responses were scored 1 point if correct, and the total raw scores were then converted into age-standardised scores and reading ages for each child.

***British Picture Vocabulary Scale** (Dunn & Dunn, 1982)*

The British Picture Vocabulary Scale (BPVS) was used in order to test the verbal I.Q. of the subjects. The materials consist of a book with four pictures on each page. The experimenter would say a word, *e.g.*, ***wooden***, and the child was then asked to choose which of the four pictures corresponded with this word, and to point to it. Four example trials were given, and then each child was tested until a ceiling level was reached. One point was awarded for each correct answer, and these scores were then transformed into age-standardised I.Q. scores with population mean of 100.

***Rhyme Generation Task** (Johnston, Anderson & Holligan, 1996)*

In order to test the children's awareness of rhymes and ability to generate rhyming words, the rhyme generation task devised by Johnston, Anderson and Holligan (1996) was employed. In this, the child was asked to give as many words as possible which 'sound like' or 'end the same way as' a stimulus word spoken by the experimenter. Three practice trials were given, in which the experimenter helped the child to think of rhyming words, and demonstrated what was required in the task. Twelve experimental stimuli were then given, and the children's correct responses noted. No corrective feedback was given, though rhyming words supplied by the children were used as a prompt. At block 1, testing was continued for each stimulus until the child could not think of any more rhymes. At block 3, the children's performance had improved so much that a maximum of 5 correctly rhyming responses for each stimulus word was introduced. This had the added benefit of equalising differences between extrovert children, who found it easy to give many answers, and introvert children, who were more reluctant to make responses.

Odd Word Out Task ***(Scott-Brown & Lee, unpubd)***

The Oddity task employed in the present study was a slightly modified version of that devised by Scott-Brown and Lee (unpubd), following the original task of Bradley and Bryant (1983). At block 1, when the children carried out the task for the first time, testing was preceded by an introduction to the concept of 'odd one out' using flashcards with pictures on them. This continued for several minutes until the child seemed to understand the concept clearly. At all testing blocks, the children were asked to repeat groups of three words (there were 3 such word triplets), simply to practice repeating the words. This was followed by the task itself. The experimental stimuli were split into 4 blocks, each with 2 practice and 6 experimental trials.

The 4 conditions were based on those proposed by Goswami and Bryant (1990, p21). According to these authors it should be easier for a child to detect the 'odd word out' when the distracter words share their rime than when they simply share the same coda (i.e. ***top rail hop*** should be easier than ***mop whip lead***). Further, it is predicted as a corollary to this, that in oddity trials concerning the beginning of the word, those in which the target differs in the body should be no easier than when it differs only in the onset, since, it is argued, the peak has nothing to do with the onset (i.e. ***peg pen car*** should be no easier than ***peg pin car***). It also follows that if the onset-rime hypothesis is correct, then oddity trials in which the target differs by only a single phoneme should be easier when this phoneme is the initial one (i.e. ***peg pin car*** should be easier than ***lip mop week***). Similarly, in oddity conditions where the target differs by a consonant plus vowel unit, it should be easier to detect the odd word out which differs by its final VC (rime) than by its initial CV unit (body; i.e. ***hip lip week*** should be easier than ***peg pen car***).

Testing blocks were as follows:

a) *Onset Experiment* In this condition the distracter items shared a common initial phoneme, which the target item did not, *e.g.*, ***peg pin car***. Since this corresponds with the word's onset, Goswami and Bryant would argue that this condition should be very easy for the children.

b) *Onset Control* As the name suggests, this condition was designed as a control for the Onset Experiment condition. The distracter items shared their final phoneme, but the target item did not, *e.g.*, ***lip mop week***. Thus, the items share the same number of phonemes as in the onset experiment condition (one), however this phoneme is no longer the onset and requires breaking up the rime unit in order to access it.

c) Rime Experiment In the Rime Experiment condition, the common unit shared by the distracter items was the rime, *e.g.*, ***hip lip week***, and so this condition argued to be very simple for children to respond to correctly (Goswami and Bryant, 1990).

d) Rime Control This condition may be considered a 'control' for the Rime Experiment condition because the distracter items shared the same number of phonemes as those in the Rime Experiment condition (two). Here, the distracter items shared their initial CV (body), which involves the onset, plus *part* of the rime, *e.g.*, ***peg pen car***.

Half of the children in any block of testing were randomly allocated to receive these 4 conditions in the order b, a, d, c, while the remainder of the children were tested in the order d, c, b, a. The experimenter would say 3 words, which the child was then asked to repeat. This ensured that errors did not occur due to the child mis-hearing the stimuli. The subject was then asked to choose *"Which word ends/starts differently?"* or *"Which word has a different sound at the start/end?"*. At the beginning of each condition, the experimenter would alert the child to which part of the word they should focus on by saying, *"Now it's the start/end of the word that's important"*. One point was awarded for each trial answered correctly, giving a maximum possible score of 6 for each condition (maximum total = 24).

Phoneme and Syllable Deletion Task

In this task children are asked to say how a word would sound if part of it were deleted. For example, a child might be asked to *"Say **pat** but don't say /p/"*, to which the correct response would be *"at"*. The original task of Rosner (1975) was expanded to contain 10 trials each of: initial syllable deletion, *e.g.*, ***hedgehog* → *hog***; final syllable deletion, *e.g.*, ***birthday* → *birth***; initial phoneme deletion, *e.g.*, ***pat* → *at***; final phoneme deletion, *e.g.*, ***book* → *boo***; initial blend-splitting deletion, *e.g.*, ***drive* → *dive***; final blend-splitting deletion, *e.g.*, ***damp* → *dap***. Also, testing was not discontinued, so that every child received all 60 words.

In testing blocks 1-3, the original 13 items were presented together during one test session, and the extra items were presented in a separate session. The extra items were split into two lists, each containing roughly similar numbers of each type of deletion. The children were randomly allocated list 1 or list 2 first. At block 4 all 60 deletion items were merged, and split into two lists of 30 items, each covering all types of deletion. These two lists were then presented as part of two separate testing sessions. All children received these lists in the same order.

For every presentation of the task, testing was preceded by two practice items (2 or 3 more were given if required at the first two blocks of testing). The children were awarded a score of 1 for each deletion performed correctly, giving a maximum of 10 points for each type.

Phoneme Segmentation Task *(Yopp, 1988)*

The Yopp-Singer test of phoneme segmentation ability was used in the present study. This consists of a list of 22 words, 10 of which contain 2 phonemes, with the remaining 12 words containing 3 phonemes. In the task, the children were asked to say, *e.g., "all the sounds in* ***go****"*, and correct responses were in the form of segmented phonemes, *e.g. "/g/ - /o/"*. Three practice items were given first, followed by the 22 test items, which were split into two lists of 11 words. Subjects were randomly allocated so that half of the children received list 1 first, and the other half received list 2 first. The 2- and 3-phoneme words were randomly mixed through the lists.

***Schonell Graded Word Spelling Test B** (Schonell & Schonell, 1960)*

This test is designed to provide a spelling age for each child. The experimenter read out a list of words of increasing complexity for the children to spell. Each word was presented on its own, then embedded within a simple explanatory sentence, and then repeated in isolation. The children were encouraged to guess how the words should be written down. Spelling items were repeated 2 or 3 times while the children were thinking and writing down their responses. The test was discontinued once all the children had made 7 or more consecutive errors in a group of 10 words. At the final block of testing there was a small number of children who were still able to spell words correctly when the other children had failed. These children were taken together as a group to continue testing with some more difficult items. There were 5 children at school 1, and 5 children at school 2 who fell into this category.

The children's responses were marked, and the number of words spelled correctly calculated. These scores were then converted into spelling ages using Schonell's formula of:

$$Spelling\ Age = \left\{ \frac{no.\,of\ words\,spelled\ correctly}{10} + 5 \right\} \quad years$$

Nonword Spelling Test

This test consisted of 26 orthographically legal nonsense words, *e.g.*, ***shart***. The children were told that they were going to be given a spelling test like the Schonell test with which they were familiar, but that this time it would not be real words they were asked to spell, but *"silly, made-up"* words instead. Each nonword was repeated 3 or 4 times for the children as they attempted to spell it. The children's responses were scored correct if they gave any reasonable phonetic representation of the nonword in question.

Results

Letter Name Knowledge

The mean number of letters correctly named by the children at each block was as follows: block 1, 5.25 (SD=7.79); block 2, 6.33 (SD=8.22); block 3, 13.85 (SD=8.72); block 4, 18.10 (SD=7.05).

Letter Sound Knowledge

Mean numbers of letters for which the children could give the correct sound were: block 1, 8.48 (SD=5.71); block 2, 20.35 (SD=4.42); block 3, 22.75 (SD=2.30); block 4, 22.40 (SD=0.42).

Reading Ability

The mean score on Clay's Ready-to-Read task (block 1) was 3.00 (Syllable Deletion=3.05). Reading Ages, as measured by the BAS Word Reading Test were converted into decimals for the purpose of analysis. Mean reading ages for the children at blocks 2-4 were: block 2, 5.79 (SD=0.52); block 3, 6.02 (SD=0.61); block 4, 6.88 (SD=0.80).

Phonological Awareness Tasks

For descriptive statistics of the Phonological Awareness tasks used in the present analyses, the reader is referred to table 2.1 (See Chapter 2)

Correlational Analyses

The correlations between knowledge of letter sounds and names, reading ability (Clay Ready-to-Read scores at block 1, and reading age at blocks 2,3 and 4) and the Phonological Awareness tasks were examined first. These analyses are reported in table 3.1.

From the table of correlations it is apparent that block 1 letter name and sound knowledge were significantly correlated to reading ability at all stages in the study. Block 1 Odd Word Out - Rime Experiment and Rhyme Generation, the early measures of rime awareness, did not relate as closely with reading, with Rhyme Generation correlations remaining poor throughout the study (block 1 rhyme generation and: block 1 reading, r=*.079*; block 2 reading, r=*.036*; block 3 reading, r=*.031*; block 4 reading, r=*.016*). Block 1 Rime Experiment correlations with reading did rise steadily during the 2 year period, however the relationship remained non-significant. Early reading and letter knowledge were quite consistently related to performance in the Phoneme Deletion and

Table 3.1 - *Table of correlations between block 1 vocabulary, reading, letter knowledge and rime awareness and other tasks (*p<.05 **p<.01 ***p<.001)*

Block 1 tasks → ↓	Letter sounds	Letter names	BPVS	Reading (Clay)	OWO - RE	Rhyme Gen
Letter names	.667***					
BPVS	.268	.262				
Reading	.531***	.704***	.363**			
OWO - RE	.154	.035	.130	.246		
Rhyme Gen	.175	.100	-.136	.079	.190	
OWO - OC	.295*	.232	.300*	.327*	.199	.078
OWO - OE	.243	.096	.227	.230	.273	.207
OWO - RC	.265	.324*	.383**	.593***	.323*	.093
Phon Seg	.533***	.269	.179	.371**	.057	.327*
Phon Del	.362**	.153	.220	.356**	.277	.304*

Block 1 tasks → *Block 2 tasks* ↓	Letter sounds	Letter names	BPVS	Reading (Clay)	OWO - RE	Rhyme Gen
Letter sounds	.570***	.302*	.099	.133	-.047	.058
Letter names	.553***	.868	.256	.773***	.053	.024
Reading age	.477***	.536***	.410**	.605***	.039	.036
OWO - OC	.162	.235	.164	.193	-.096	.058
OWO - OE	.351**	.402**	.380**	.298*	.165	.165
OWO - RC	.404**	.418**	.302*	.341*	.271	.267
OWO - RE	.354**	.285*	.381**	.368**	.203	.115
Phon Seg	.395**	.077	.278	.186	.014	.181
Phon Del	.429**	.407**	.342*	.470***	.049	.261

Block 1 tasks → / *Block 3 tasks* ↓	Letter sounds	Letter names	BPVS	Reading (Clay)	OWO - RE	Rhyme Gen
Letter sounds	.367**	.121	.006	.076	.064	.078
Letter names	.480***	.660***	.233	.606***	.131	.200
Reading age	.607***	.531***	.449***	.492***	.200	.031
OWO - OC	.108	.128	.348*	.335*	.118	.103
OWO - OE	.379**	.273	.332*	.382**	.139	.052
OWO - RC	.479***	.436**	.191	.441**	.431**	.202
OWO - RE	.387**	.345*	.319*	.300*	.099	.140
Phon Seg	.287*	-.066	.182	-.055	.115	.182
Phon Del	.457***	.398**	.306*	.454***	.123	.102
Rhyme Gen	.291*	.234	.176	.414**	.305*	.405**

Block 1 tasks → / *Block 4 tasks* ↓	Letter sounds	Letter names	BPVS	Reading (Clay)	OWO - RE	Rhyme Gen
Letter sounds	.200	.018	-.005	.065	.199	.093
Letter names	.540***	.520***	.242	.507***	.173	.221
Reading age	.495***	.373**	.369**	.328*	.246	.016
OWO - OC	.362**	.388**	.293*	.465***	.195	-.063
OWO - OE	.189	.186	.238	.415**	.274	.207
OWO - RC	.200	.408**	.223	.405**	.341*	.171
OWO - RE	.229	.147	.302*	.274	.386**	.100
Phon Seg	-.231	-.282*	-.087	-.162	-.100	.026
Phon Del	.329*	.237	.231	.280*	.034	.054

Phoneme Segmentation tasks, and BPVS also correlated significantly to Phoneme Deletion at blocks 2 and 3. BPVS, letter knowledge and reading (block 1) all correlated with Odd Word Out at blocks 1-3, with reading relating to all block 4 Odd Word Out conditions except Rime Experiment, and letter knowledge correlating significantly with onset control and rime control. Block 1 Rhyme Generation did not correlate with Odd Word Out at any point, and block 1 Rime Experiment scores correlated with very few Odd Word Out conditions during the remainder of the study - the only significant relationships were with Rime Control at blocks 1, 3 and 4 (*r=.323*, .431**, .341** respectively), along with the relationship to Rime Experiment at block 4(*r=.386***). Importantly , the relationship between block 1 Rime Experiment performance and Onset Experiment scores was not a very strong one, challenging the viewpoint that onsets and rimes are related units for the children at this stage.

It was also of interest in relation to the theories under discussion, to look at how Odd Word Out, alphabet knowledge and Rhyme Generation scores at later blocks correlated with reading ages. The results of these analyses are presented in table 3.2.

Table 3.2 *- tables of correlations between Odd Word Out, Rhyme Generation and letter knowledge with subsequent reading age (*p<.05 **p<.01 ***p<.001)*

	Reading Age - Block 3	*Reading Age - Block 4*
OWO Onset Exp - block 2	.524***	.569***
e.g. *peg, pin car*		
OWO Onset Con - block 2	.169	.290*
e.g. *lip, mop, week*		
OWO Rime Exp - block 2	.423**	.421**
e.g. *hip, lip, week*		
OWO Rime Con - block 2	.402**	.531***
e.g. *peg, pen, car*		
Letter sounds - block 2	.607***	.495***
Letter names - block 2	.531***	.373**

	Reading Age - Block 4
OWO Onset Exp - block 3	.629***
e.g. *peg, pin car*	
OWO Onset Con - block 3	.236
e.g. *lip, mop, week*	
OWO Rime Exp - block 3	.420**
e.g. *hip, lip, week*	
OWO Rime Con - block 3	.517***
e.g. *peg, pen, car*	
Letter sounds - block 3	.355**
Letter names - block 3	.449***
Rhyme Gen - block 3	.257

These correlations show that the relationship between letter knowledge and later reading ability remains strong. Odd Word Out scores at blocks 2 and 3 were significantly correlated with subsequent reading, unlike the block 1 Odd Word Out scores. However, the condition testing rime awareness (Rime Experiment) showed no special relationship to reading compared to the others. Indeed all Odd Word Out conditions at blocks 2 and 3 with the exception of Onset Control (a particularly difficult condition) correlated significantly with later reading age. This is not the pattern that might be expected if rimes were of particular importance to reading. The lack of any significant correlation between block 3 Rhyme Generation and block 4 reading age also runs counter to rime based theories of awareness (whether predicting early or late importance).

Multiple Regression Analyses

A series of fixed order multiple regression analyses were then carried out. The purpose of these was to compare the power of block 1 scores on alphabet knowledge, Clay reading test, and the four phonological awareness tasks to predict subsequent reading ability. For the analyses the Odd Word Out conditions were entered in 2 steps, one with the experimental conditions (Rime Experiment, e.g., *hip, lip, week*, and Onset Experiment, e.g., *peg, pin, car*) which aim to measure onset and rime awareness, and another with the two control conditions (Rime Control, e.g., *peg, pen, car*, and Onset Control, e.g., *lip, mop, week*). The dependent variables in the analyses were BAS Reading age at blocks 2, 3 and 4. BPVS scores taken at block 1 were entered as the first step in each analysis in order to control for differences in vocabulary knowledge at the start of schooling. Results of these analyses are given in table 3.4.

The results of the regression analyses showed that the best predictors of reading age at the end of primary 1 (block 2) were block 1 reading ability, and Phoneme Segmentation. Letter sound knowledge also contributed strongly, but only if entered into the regression before Phoneme Segmentation. The remaining tasks - Phoneme Deletion, Rhyme Generation and Odd Word Out - did not account for significant variance in block 2 reading, even when entered at step 2 after only BPVS.

The regressions from block 1 to reading age at the start of primary 2 (block 3) showed that Phoneme Segmentation was once again the strongest predictor of variance. This time, block 1 reading scores did not predict later reading ability when entered at the final step, though letter sound knowledge did. As in the first regression, Phoneme Deletion, Rhyme Generation and Odd Word Out scores at block 1 did not contribute to reading age even when entered at step 2 in the regression.

In the final set of regressions, the results showed that the only block 1 variable entered into the regression which continued to predict significant

Table 3.4 *- Results of stepwise multiple regression analyses. IVs measured at block 1. Values shown are percentage of variance accounted for, as indexed by r^2 change.*
(p<.05 **p<.01 ***p<.001)*

Reading Age at block 2												
a) BPVS	16.80**	a)	16.80**	a)	16.80**	a)	16.80**	a)	16.80**	a)	16.80**	a)	16.80**
b) alphabet knowledge - letter sounds	14.50**	c)	23.95***	d)	22.54***	e)	4.85	f)	0.86	g)	0.05	h)	5.15
c) Clay ready-to-read	12.17**	d)	10.92**	e)	0.00	f)	0.03	g)	0.12	h)	6.19	b)	11.68**
d) Phoneme Segmentation	8.28**	e)	0.45	f)	0.73	g)	1.38	h)	5.85	b)	12.59**	c)	10.42**
e) Phoneme Deletion	0.47	f)	0.63	g)	1.74	h)	3.59	b)	12.04**	c)	10.14**	d)	7.89**
f) Rhyme Generation	0.64	g)	2.23	h)	4.39	b)	10.24*	c)	10.20**	d)	9.06**	e)	0.33
g) Odd Word Out - Rime Exp, Onset Exp	2.26	h)	0.07	b)	1.70	c)	9.99**	d)	9.29**	e)	0.00	f)	0.63
h) Odd Word Out - Rime Cont, Onset Cont	0.06	b)	0.11	c)	7.27*	d)	8.28**	e)	0.00	f)	0.35	g)	2.26
Reading Age at block 3												
a) BPVS	20.20***	a)	20.20***	a)	20.20***	a)	20.20***	a)	20.20***	a)	20.20***	a)	20.20***
b) alphabet knowledge - letter sounds	25.51***	c)	12.46**	d)	27.08***	e)	4.32	f)	0.87	g)	3.14	h)	4.66
c) Clay ready-to-read	1.55	d)	18.25***	e)	0.18	f)	0.05	g)	2.47	h)	2.53	b)	22.86***
d) Phoneme Segmentation	8.56**	e)	0.60	f)	0.89	g)	0.93	h)	2.45	b)	22.20***	c)	0.72
e) Phoneme Deletion	0.76	f)	0.83	g)	2.59	h)	1.60	b)	22.24***	c)	0.71	d)	7.76**
f) Rhyme Generation	0.97	g)	1.60	h)	2.03	b)	21.15***	c)	0.69	d)	8.28**	e)	1.08
g) Odd Word Out - Rime Exp, Onset Exp	1.43	h)	0.38	b)	6.43*	c)	0.68	d)	9.80**	e)	1.08	f)	1.08
h) Odd Word Out - Rime Cont, Onset Cont	0.55	b)	5.20*	c)	0.11	d)	10.58**	e)	0.80	f)	1.37	g)	1.17
Reading Age at block 4												
a) BPVS	13.61**	a)	13.61**	a)	13.61**	a)	13.61**	a)	13.61**	a)	13.61**	a)	13.61**
b) alphabet knowledge - letter sounds	16.91**	c)	4.34	d)	14.01**	e)	3.27	f)	0.44	g)	10.74*	h)	3.17
c) Clay ready-to-read	0.01	d)	10.45**	e)	0.00	f)	0.00	g)	10.37	h)	1.52	b)	17.32**
d) Phoneme Segmentation	3.63	e)	0.01	f)	0.58	g)	7.69	h)	1.49	b)	14.47**	c)	0.01
e) Phoneme Deletion	0.05	f)	0.56	g)	8.05	h)	1.52	b)	15.08**	c)	0.00	d)	2.46
f) Rhyme Generation	0.68	g)	7.58	h)	0.59	b)	15.00**	c)	0.00	d)	1.43	e)	0.05
g) Odd Word Out - Rime Exp, Onset Exp	7.21	h)	0.71	b)	7.07*	c)	0.00	d)	2.28	e)	0.95	f)	0.56
h) Odd Word Out - Rime Cont, Onset Cont	1.88	b)	6.72*	c)	0.07	d)	2.88	e)	0.70	f)	1.26	g)	6.79

variance in reading age at the end of primary 2 (block 4) was letter sound knowledge. No variables predicted significant variance in reading age beyond that accounted for by letter sound knowledge. The only variables to predict significant variance before letter knowledge were Phoneme Segmentation and the experimental conditions of Odd Word Out, although they were only significant at step 2 of the analysis. In order to look at the significant step 2 contribution of the Odd Word Out experimental conditions further, two more regression analyses were carried out for block 4 reading age, with Onset Experiment and Rime Experiment each entered individually at step 2 after BPVS. These showed that while Onset Experiment accounted for significant variance in this position (r^2 change = 9.10%, p<.05), Rime Experiment did not (r^2 change = 3.99%, p=.147). Thus, rime awareness still fails to predict any significant variance in reading age.

Analyses of Variance and Covariance

For the purpose of these analyses, the group of subjects was split into high and low alphabet knowledge groups (see methods section above). Mean scores on composite alphabet knowledge for the two groups were: low alphabet knowledge, 5.04 (SD=2.56); high alphabet knowledge, 16.42 (SD=5.95). A one-way ANOVA on these scores showed that the two groups had significantly different levels of alphabet knowledge, $f(1,46)=74.03$, $p<.001$. The children were kept in these high and low alphabet knowledge groupings regardless of subsequent performance on the task.

A series of ANOVAs were carried out on reading ages, spelling skill and Phonological Awareness tasks with Alphabet Knowledge (low/high) as a between-subjects factor. The results of these are detailed below.

Clay Ready-To-Read

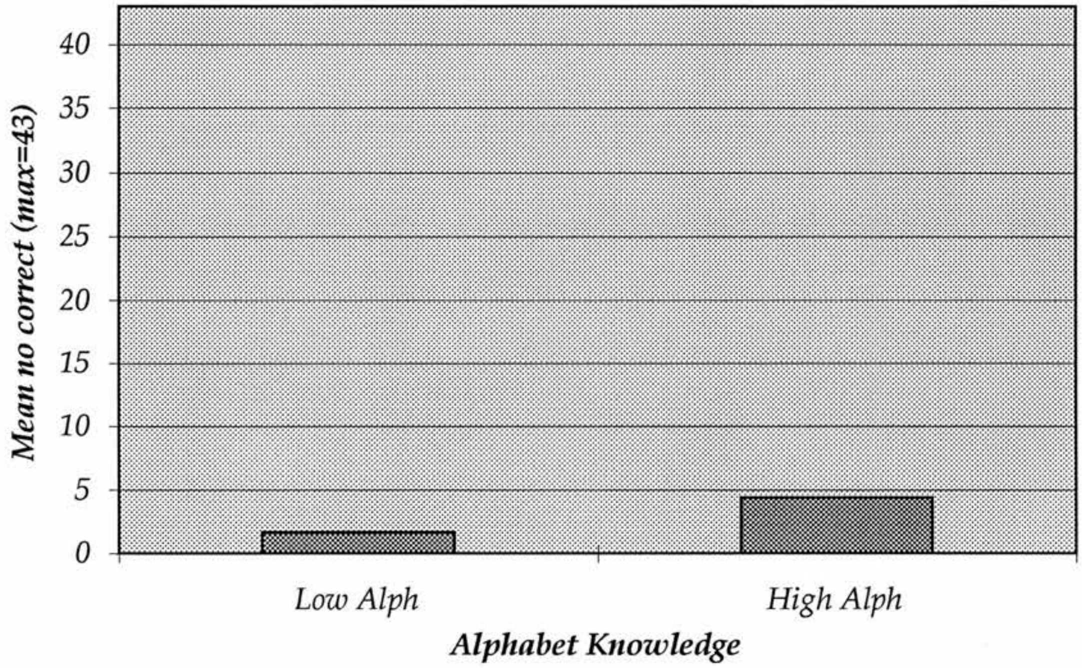
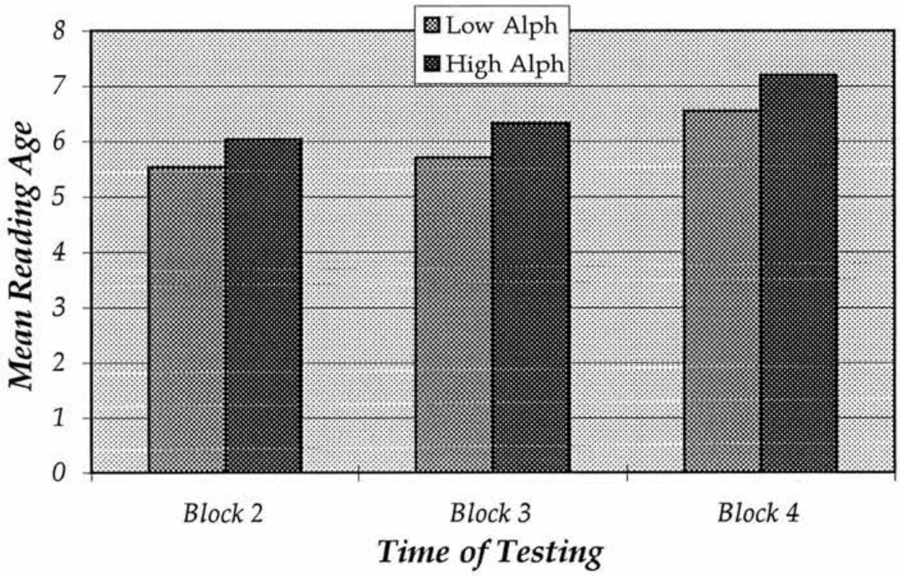


Figure 3.1 *- Graph showing mean scores on Clay Ready-To-Read task for high and low alphabet knowledge groups. (Maximum possible score = 43)*

A simple one-way ANOVA was carried out on the Clay Ready-To-Read scores, with one between subjects factor (Alphabet Knowledge). The results of the analysis showed a significant main effect of Alphabet Knowledge group, $f(1,46)=12.09$, $p<.001$, with the high alphabet knowledge group able to read more words than the low alphabet group. When the analysis was re-run with block 1 BPVS covaried out, the result did not change, and the f value for the covariate was not significant: BPVS $f(1,47)=2.266$, $p=.139$.

<u>Reading Age</u>

BAS reading ages measured at blocks 2, 3 and 4 were entered into a 2x3 (alphabet knowledge x time) ANOVA.



<u>Figure 3.2</u> *- Graph showing mean BAS reading ages for high and low alphabet groups*

The results of the analysis showed that the high alphabet knowledge group performed significantly better than the low alphabet knowledge group overall: main effect of alphabet knowledge group, *f(1,46)=17.10, p<.000*. The main effect of time was also significant, *f(2,92)=106.47, p<.000*, but the interaction of alphabet knowledge x time did not achieve significance: *f(2,92)=0.53, p=.588*. The main effect of time was then examined using a Newman-Keuls test, which showed that reading ages rose significantly at each testing block: i.e. reading age at block 2 < reading age at block 3 < reading age at block 4. When the analysis was re-run with BPVS as the covariate the results were not changed, though the covariate *f* value did reach significance: *f(1,45)=4.87, p<.05*.

Schonell Spelling Test

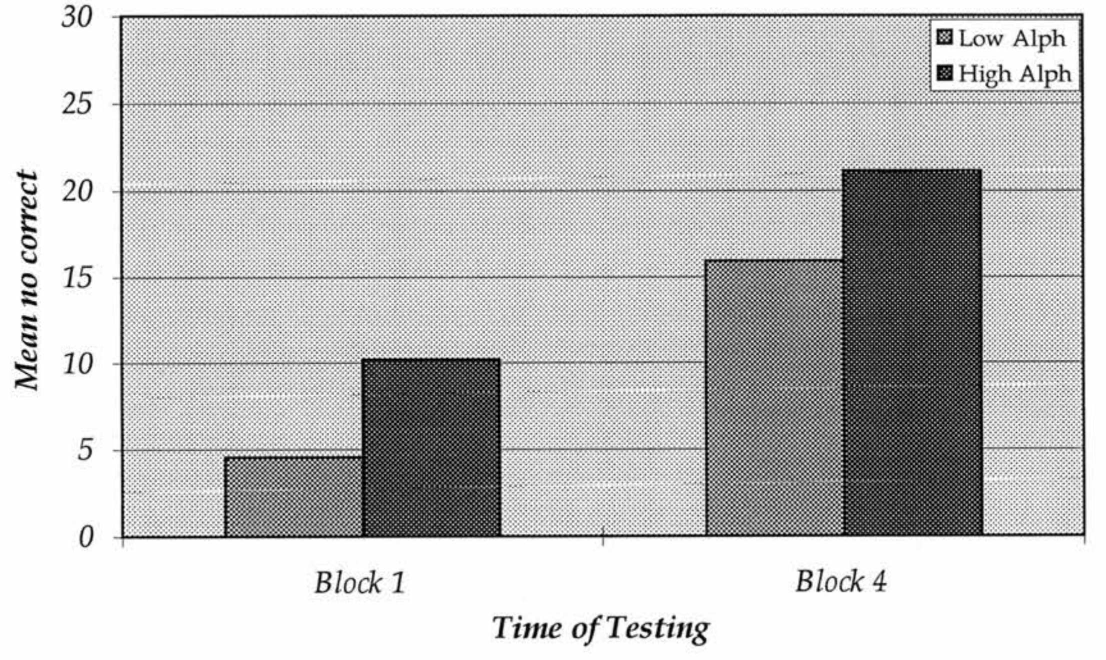
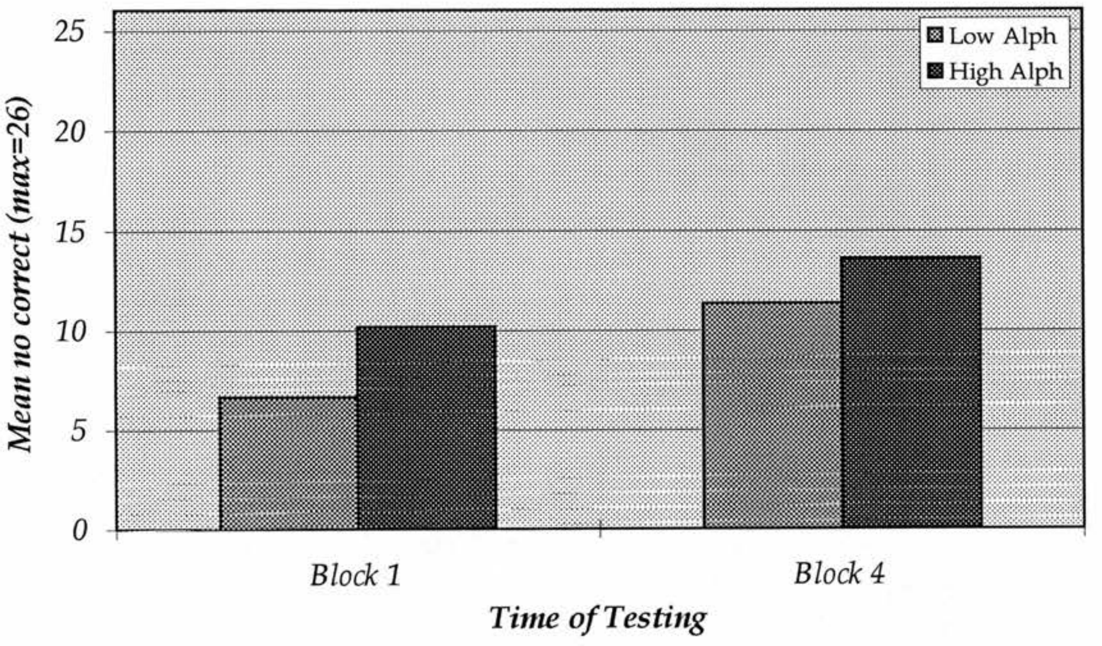


Figure 3.3 *- Graph showing mean scores for the Schonell Spelling Test for high and low alphabet knowledge groups.*

A 2x2 ANOVA of Time x Alphabet Knowledge was carried out on the scores for the Schonell Spelling Test. The analysis showed significant main effects of alphabet knowledge, $f(1,46)=13.05$, $p<.001$, and time, $f(1,46)=120.58$, $p<.001$. The interaction was not significant, $f(1,46)=0.06$, $p=.806$. We see, then that the children with high alphabet knowledge performed significantly better on the word spelling test than those with poorer alphabet knowledge. An analysis of covariance to control for the effects of block 1 vocabulary showed the same pattern of results; BPVS did not have a significant effect on the analysis, $f(1,45)=2.41$, $p=.128$.

<u>*Nonword Spelling Test*</u>



<u>Figure 3.4</u> *- Graph showing mean scores on Nonword Spelling Task for high and low alphabet knowledge groups. (Maximum possible score = 26)*

A 2x2 analysis of variance (Time x Alphabet Knowledge) on the nonword spelling test produced no significant main effect of alphabet knowledge group, $f(1,46)=2.80$, *n.s.*, though the main effect of time was significant, $f(1,46)=36.19$, $p<.001$, reflecting an improvement in performance across time. The interaction was not significant, $f(1,46)=0.91$, *n.s.* This analysis shows that the high alphabet group showed no advantage over the low alphabet group for nonword spelling. This pattern of results was unaffected by covarying out vocabulary: ANCOVA effect of BPVS, $f(1,45)=1.19$, $p=.282$.

Rhyme Generation Task

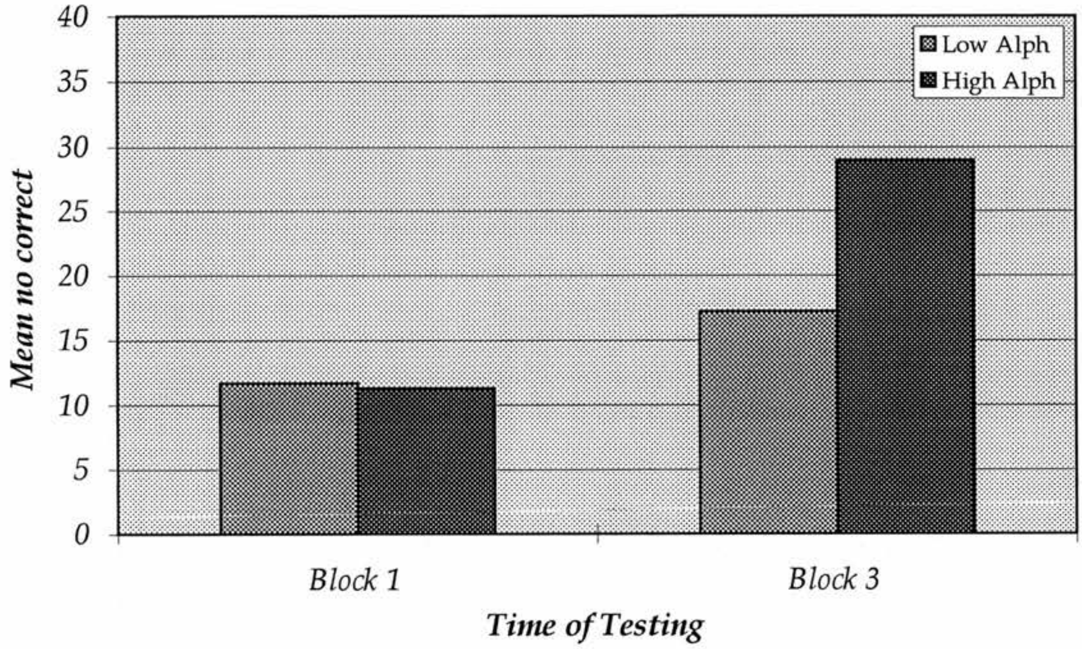


Figure 3.5 *- Graph showing mean scores on Rhyme Generation task (number of rhyming responses produced) for high and low alphabet knowledge groups.*

Scores for number of rhyming words produced were used in the analysis for Rhyme Generation. An analysis of Time x Alphabet Knowledge (2x2) showed that there was no significant main effect of alphabet knowledge, $f(1,46)=2.32$, *n.s.*, but that the effect of time was significant, $f(1,46)=25.08$, $p<.001$. The interaction was significant, $f(1,46)=6.75$, $p<.01$, and Newman-Keuls showed that the difference between high and low alphabet knowledge groups was significant at block 3, but not at block 1. Further, the low alphabet knowledge group did not improve significantly across time, but the high alphabet knowledge group did. A second analysis with vocabulary as the covariate did not alter these results, and the coefficient for BPVS was not significant: $f(1,45)=0.15$, $p=.701$.

Odd Word Out Task

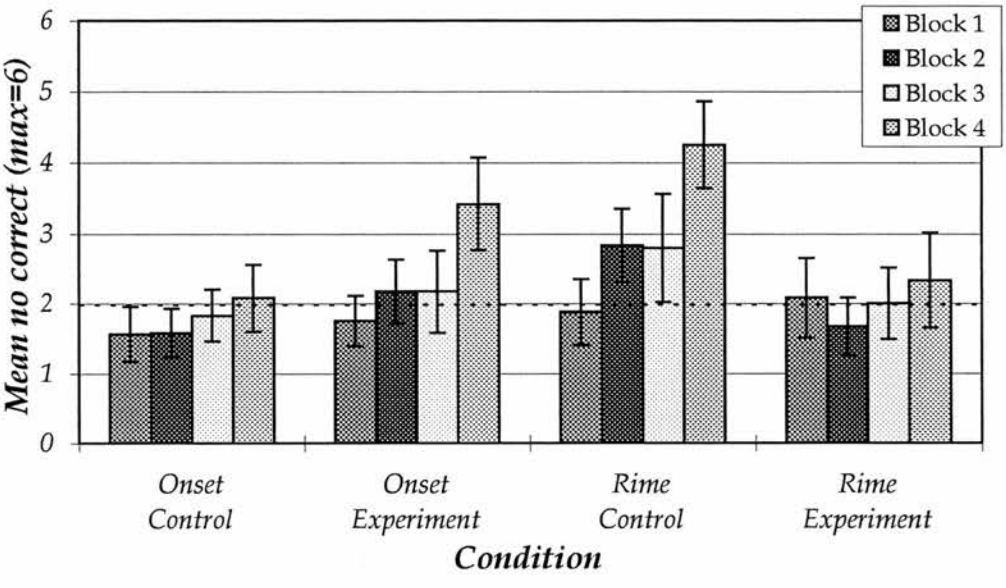


Figure 3.6a *- Graph showing mean scores on Odd Word Out task for the low alphabet knowledge group. Error bars represent 95% confidence intervals. The chance level of 2 correct is shown.*

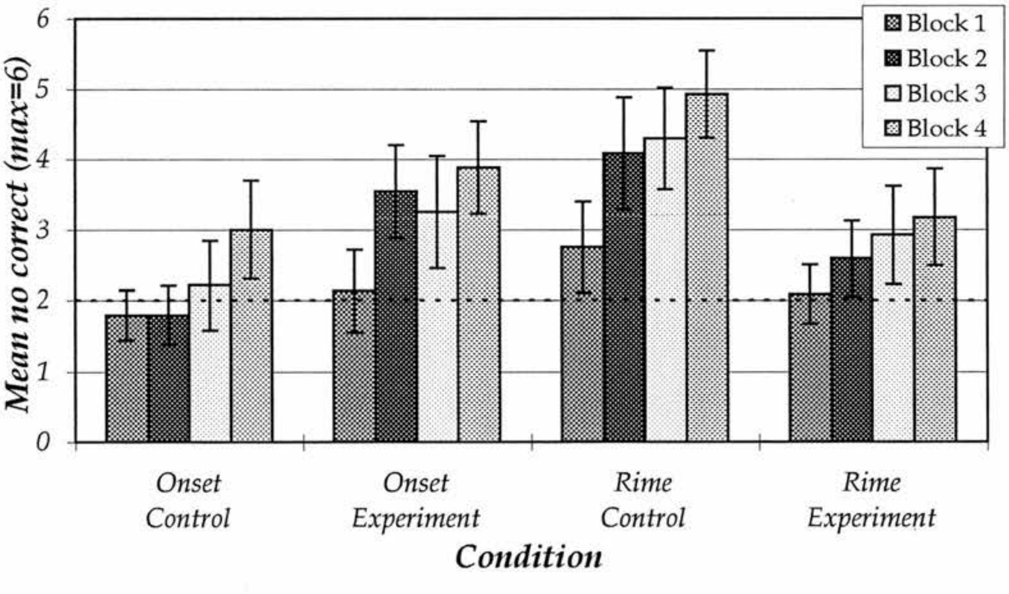


Figure 3.6b *- Graph showing mean scores on Odd Word Out task for the high alphabet knowledge group. Error bars represent 95% confidence intervals. The chance level of 2 correct is shown.*

In order to test the predictions of Goswami and Bryant (1990) concerning the Odd Word Out task, a 4x2x2x2 ANOVA was carried out on the children's scores: Time (1,2,3,4) x Experiment/Control condition x Onset/Rime condition[1] x Alphabet Knowledge (low/high). The main effect of alphabet knowledge was significant, *f(1,46)=10.87, p<.01*, though none of the other interactions involving alphabet knowledge reached significance: alphabet knowledge x time, *f(3,138)=1.88, p=.135*; alphabet knowledge x onset/rime, *f(1,46)=1.34, p=.253*; alphabet knowledge x experiment/control, *f(1,46)=.05, p=.821*; alphabet knowledge x time x onset/rime, *f(3,138)=.49, p=.687*; alphabet knowledge x time x experiment/control, *f(3,138)=2.15, p=.097*; alphabet knowledge x onset/rime x experiment/control, *f(2.68)=2.68, p=.108*; alphabet knowledge x time x onset/rime x experiment/control, *f(3,138)=1.85, p=.142*. The main effect of time was significant, *f(3,138)=40.34, p<.000*, as was the main effect of onset/rime, *f(1,46)=34.83, p<.000*. The main effect of experiment/control was not significant, *f(1,46)=3.20, p=.080*. The two-way interactions involving time were not significant: time x onset/rime, *f(3,138)=.27, p=.844*; time x experiment/control, *f(3,138)=2.08, p=.106*. The interaction of onset/rime x experiment/control was significant, *f(1,46)=74.86, p<.000*, as was the three-way interaction of time x onset/rime x experiment/control, *f(3,138)=8.39, p<.000*. Newman-Keuls testing was carried out on this interaction, and was investigated in terms of the predictions of Goswami and Bryant (see discussion). The post-hoc test showed that the predictions of Goswami and Bryant were not supported well. Firstly, they predicted that onsets would be easier to detect than final phonemes (Onset Experiment > Onset Control) - this finding was supported at blocks 2 and 4 only. Secondly, rimes were not easier to predict than bodies at *any* point in the study (the prediction was that Rime Experiment > Rime Control). Thirdly the difference

[1] It should be noted that here the terms 'Rime' and 'Onset' refer to conditions, rather than the unit involved; for example 'Onset' includes the Onset Control condition which requires detection

between final phonemes (Onset Control) and rimes (Rime Experiment) did not reach significance at any point, rather the two conditions remained statistically similar. Finally, Goswami and Bryant's prediction that the addition of a vowel to the onset should not affect performance (i.e. Rime Control ≈ Onset Experiment) was only upheld at block 1, when all conditions were quite similar.

The alternative predictions were that Rime Control would be the easiest condition - this was observed at blocks 2, 3, and 4. Apart from this, alphabetic theories did not predict much difference between the other conditions, since all could be performed analytically, and so the Odd Word Out results may be interpreted well in terms of such theories.

An analysis of covariance controlling for block 1 BPVS scores showed the same results as the ANOVA, though the coefficient for BPVS was significant: $f(1,45)=5.75$, $p<.05$.

However, some caution should be taken in interpreting the results of the Odd Word Out analyses, since (as can be seen from figures 3.6a and b) performance on the task was extremely poor for the sample. For the low alphabet knowledge group, performance on the Onset Control and (importantly) Rime Experiment conditions did not exceed chance levels, even by the end of the study. Onset Experiment scores did rise above chance for this group at block 4. The best performance was for Rime Control, whose scores rose above chance by the end of the first year at school. The high alphabet knowledge group showed better performance, though Onset Control performance did not exceed chance levels until block 4. Scores for Rime Experiment and Onset Experiment were higher than chance from the end of year 1. As for the low alphabet knowledge group performance was best on the

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of the final phoneme (coda).

Rime Control condition, which exceeded chance levels from the very beginning of schooling.

Phoneme Deletion Task

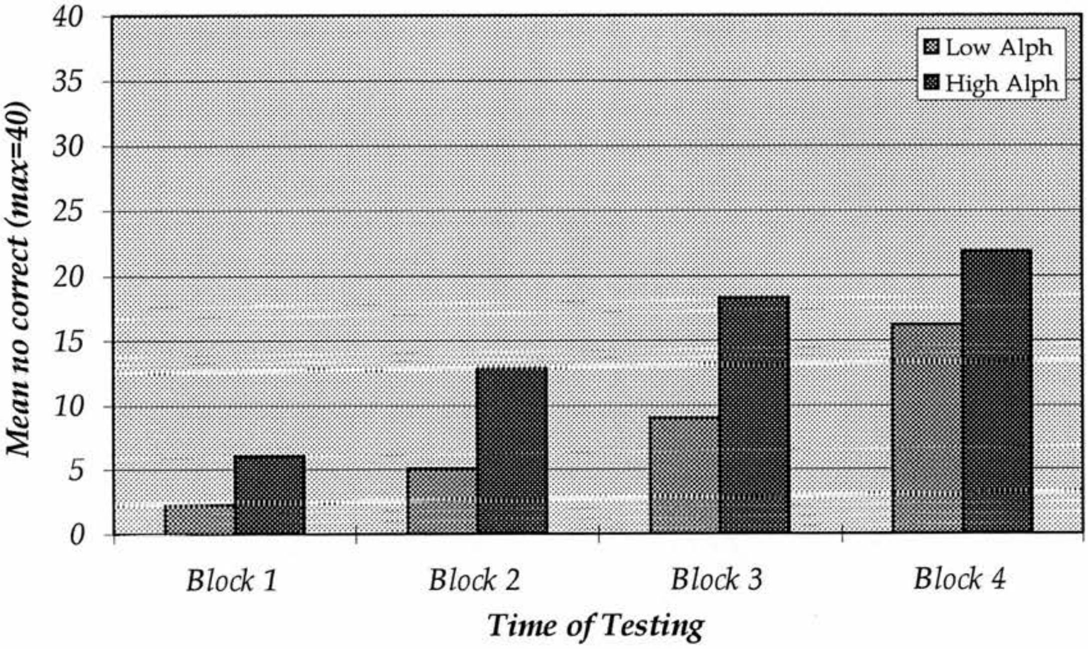


Figure 3.7 *- Graph showing mean scores on Phoneme Deletion task for high and low alphabet knowledge groups. (Maximum possible score = 40)*

Data from the Phoneme Deletion task were entered into a 4x2 ANOVA (Time x Alphabet Knowledge). Both main effects were significant: alphabet knowledge group, $f(1,46)=15.07$, $p<.001$; time, $f(3,138)=77.18$, $p<.001$. The interaction was also significant, $f(3,138)=2.79$, $p<.05$. A Scheffe test was required to resolve this interaction, and it showed that the high alphabet knowledge group showed significantly better performance than the low alphabet group at blocks 2 and 3 only, with the performance of the two groups being statistically similar at blocks 1 and 4. An ANCOVA covarying out block 1 vocabulary from the analysis showed the same pattern of results. BPVS did not show a significant effect on these results when covaried out, *f(1,45)=1.14, p=.292.*

Syllable Deletion Task

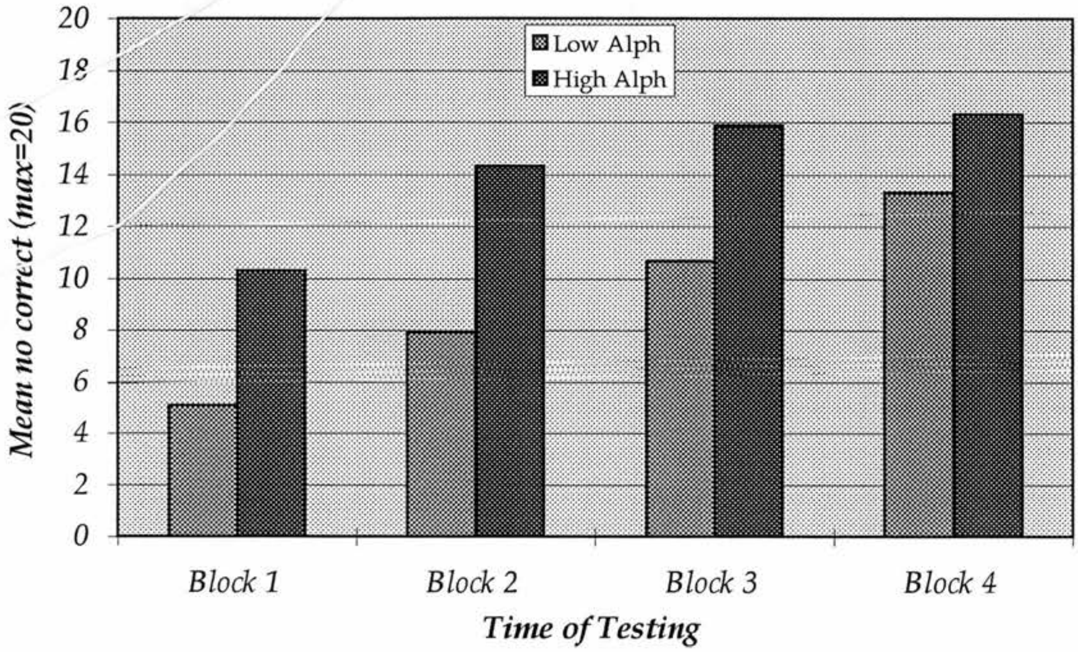


Figure 3.8 - Graph showing mean scores on Syllable Deletion task for high and low alphabet knowledge groups. (Maximum possible score = 20)

A 4x2 ANOVA produced significant main effects of alphabet knowledge and time: alphabet knowledge, $f(1,46)=17.39$, $p<.001$; time, $f(3,138)=42.56$, $p<.001$. Newman-Keuls for the effect of time showed that all differences were significant, i.e. performance improved significantly at every block. The interaction was not significant, $f(3,138)=2.26$, *n.s.* Once again, covarying out BPVS showed that it had no effect on the results: BPVS $f(1,45)=0.21$, $p=.650$.

Phoneme Segmentation Task

Number of Phonemes Correctly Segmented

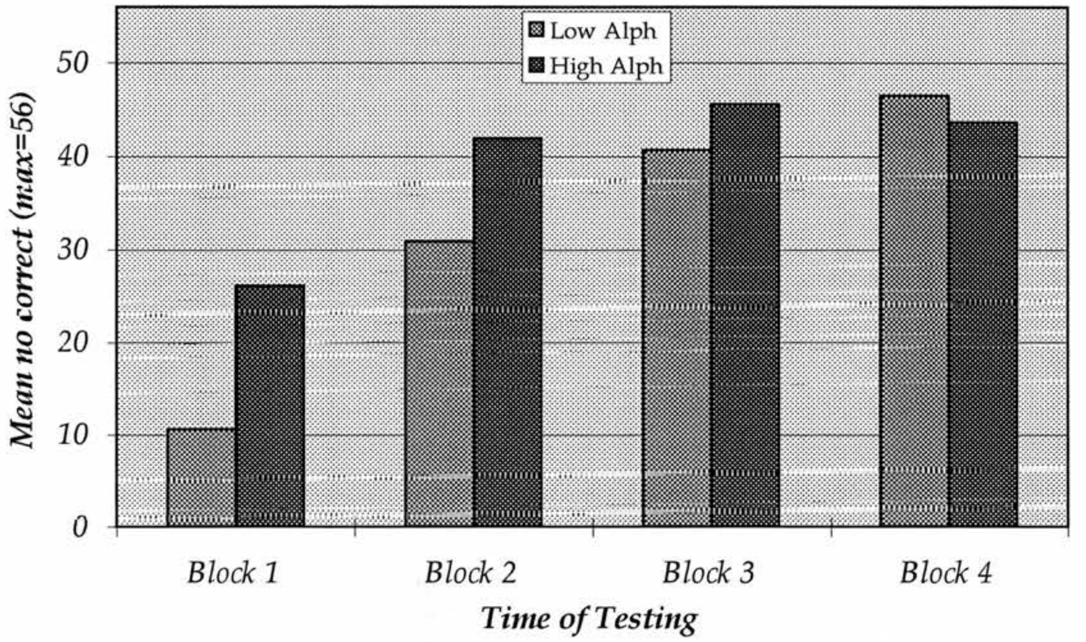
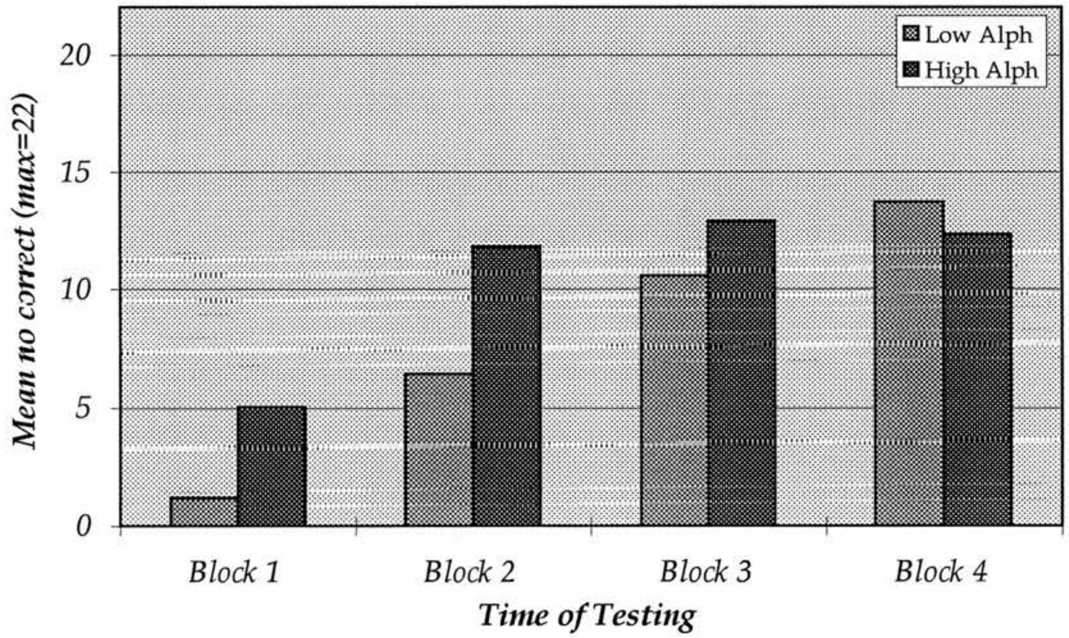


Figure 3.9 - Graph showing mean scores on Phoneme Segmentation task (number of phonemes correctly segmented for high and low alphabet knowledge groups. (Maximum possible score = 56)

The number of phonemes correctly segmented was used in the first analysis of the Phoneme Segmentation task (e.g. for the stimulus ***dog***, the response '*/d/ - /og/*' would count as one phoneme correct). The 4x2 ANOVA (Time x Alphabet Knowledge) produced significant main effects of alphabet knowledge, $f(1,46)=8.79$, $p<.01$, and time, $f(3,138)=83.55$, $p<.001$. The interaction was also significant, $f(3,138)=9.00$, $p<.001$, and post-hoc testing with Newman-Keuls showed that the high alphabet knowledge group's performance was significantly better than the low alphabet knowledge group at blocks 1 and 2, but that there was no significant difference between the groups performance at blocks 3 and 4. In addition, the low alphabet knowledge group showed significant improvements from block 1 to 2, and from block 2 to 3, while there was no significant improvement from block 3 to block 4. The high alphabet knowledge group, on the other hand, showed significant improvement only from block 1 to block 2, after which there was no significant gain in score. BPVS had no effect on these results when covaried out of the analysis: *f(1,45)=0.24, p=.629.*

<u>*Number of Words Correctly Segmented*</u>



<u>Figure 3.10</u> *- Graph showing mean scores on Phoneme Segmentation task (number of words correctly segmented) for high and low alphabet knowledge groups. (Maximum possible score = 22)*

Next the more conservative measure of Phoneme Segmentation ability, number of words segmented correctly was investigated (e.g. for the stimulus ***dog***, the correct response would be *'/d/ - /o/ - /g/'*). Results were almost identical to those in the previous analysis (number of phonemes correct). The 4x2 ANOVA produced significant main effects of time, *f(1,46)=4.51, p<.05,* and alphabet knowledge, *f(3,138)=41.05, p<.001.* Once again the interaction was significant, *f(3,138)=4.48, p<.01,* and a Newman-Keuls test showed an advantage for the high alphabet knowledge group at blocks 1 and 2 only. The low alphabet knowledge group showed significant performance gains from block 1 to 2, and from 2 to 3, but not from block 3 to block 4; the high alphabet knowledge group improved from block 1 to block 2, but performance at subsequent blocks was not significantly better than at block 2. Covarying out BPVS had no effect on the analysis, and the coefficient for the covariate was non-significant: $f(1,45)=1.04$, $p=.312$.

A summary of the results of these analyses with regards to the difference between high and low alphabet knowledge groups is given in table 3.3.

	High Alph > Low Alph	High Alph ≈ Low Alph
Clay Reading task (block 1)	✓	
Reading Age (blocks 2,3,4)	✓	
Schonell Spelling (block 1,4)	✓	
Nonword Spelling (blocks 1,4)		✓
Rhyme Generation (blocks 1,3)	✓ (3)	✓ (1)
Odd Word Out (blocks 1,2,3,4)	✓	
Phoneme Deletion (blocks 1,2,3,4)	✓ (2,3)	✓ (1,4)
Syllable Deletion (blocks 1,2,3,4)	✓	
Phoneme Seg(phon, blocks 1,2,3,4)	✓ (1,2)	✓ (3,4)
Phoneme Seg(trials, blocks 1,2,3,4)	✓ (1,2)	✓ (3,4)

Table 3.3 *- Summary of results for Alphabet Knowledge ANOVAs. Numbers in brackets refer to testing blocks.*

Discussion

The results of the analyses showed a very clear pattern of importance for phonemic awareness. The correlations showed that while the relationship between early alphabet knowledge (for both sounds and names) and reading ability remained highly significant across time, the early rime awareness measures (Odd Word Out Rime Experiment and Rhyme Generation) failed to correlate significantly with reading ability at *any* point in the study. Clearly this result does not fit with those theories which argue that rime awareness is important to the child from the very beginning of learning to read. The relationship between the Rime condition of Odd Word Out and reading, did rise over the course of the 2 years of the study, however, and so it is conceivable that during the 3rd year of school the correlation between these variables might become significant, in keeping with those theories which predict that rime awareness becomes important only at a later stage in learning to read (e.g. Muter, 1994). A further result which may be evidence of this viewpoint is the fact that early reading ability did not correlate significantly with the Onset Experiment or Rime Experiment conditions of Odd Word Out at block 1, but was correlated with later performance in all conditions of the Odd Word Out task - thus it may be that rime awareness is growing from reading skills rather than the other way around. However, block 1 scores on the Rhyme Generation task remained very poorly related to reading performance even at block 4, which is not in keeping with late rime-use predictions.

Another problem for rime-based theories was the lack of a significant correlation between detection of onsets and detection of rimes at the beginning of schooling, failing to support an expected close relationship between awareness of these units. The correlations between block 2 and 3 Odd Word

Out, alphabet knowledge and Rhyme Generation scores with reading also failed to support rime-based theories. Letter knowledge remained closely related to reading, and Rhyme Generation at block 3 still failed to correlate with later reading. Although the Odd Word Out condition correlations were significant, there was no special relationship between Rime Experiment scores and subsequent reading performance as rime-based theories would predict.

The analyses of variance and covariance demonstrated that children who started school with good knowledge of letter names and sounds performed better than children with poor letter knowledge on tests of reading and phonological awareness (both for phonemes and for larger units). The high alphabet knowledge group did not perform significantly better for nonword spelling, though at block 1 both groups performed poorly, and by block 4 all of the children had ceiling levels of alphabet knowledge which would allow them to perform similarly on the task. At block 1 there was no group difference for Rhyme Generation and Phoneme Deletion, though in both cases this may be explained by both groups performing very badly. The other points at which there were no group differences may be explained by the low alphabet knowledge group 'catching up' with the high alphabet knowledge group whose performance had leveled off. This can be seen for Phoneme Deletion at block 4 and Phoneme Segmentation during the 2nd year (blocks 3 and 4). The advantage gained from good alphabet knowledge in all these tasks remained even once vocabulary had been controlled for, showing that the effects were independent of this factor.

Importantly for the theories under discussion, alphabet knowledge gave children a significant advantage in all conditions of the Odd Word Out task, throughout the two years of testing. In addition those children with good alphabet knowledge at the start of school developed better Rhyme Generation skills in year two than the poor alphabet knowledge group. The analysis for this task shows that the low alphabet knowledge group actually failed to show *any* significant improvement on this task between block 1 and block 3. Taken together, the ANCOVA results for Odd Word Out and Rhyme Generation appear to be showing that awareness of larger units such as rimes is dependent upon knowledge at the grapheme-phoneme level.

These two sets of analyses, then, correlations and ANCOVAs, converge in demonstrating the importance of alphabet knowledge, rather than rhyme skills, in beginning to read. It might have been argued that these effects of alphabet knowledge on phonological awareness and reading skills are actually due to the superior reading skills which the high alphabet knowledge group possessed at block 1, however this challenge is answered by the results of the multiple regressions.

The regressions gave a very clear pattern of results, as the other analyses had done. Throughout the first two years of schooling, initial levels of letter knowledge and the ability to segment phonemes were the best predictors of reading age. Block 1 reading ability (as measured by Clay) did predict reading at the end of the first year, but made no unique contribution beyond this stage. This demonstrates that alphabet knowledge makes an important contribution independently of early reading skill. In year two the ability of early letter knowledge to predict reading performance grew stronger, and it became the only block 1 task to predict unique variance in reading age at the end of the second year.

The two block 1 tasks assessing rhyme awareness (Rhyme Generation and Odd Word Out) did not account for *any* significant variance in reading skill, even when entered into the regression before all the other tasks. The only exception to this was that the Onset Control condition did predict block 4 reading significantly if entered first; however, the relationship vanished once any other task was entered into the analysis before it. These results provide strong evidence that it is early letter sound knowledge and ability to access the phonemic level of the word which predict reading ability through the first two years of learning to read rather than early rime awareness.

Taken together, then, the results do not favour theories which argue that early rime awareness is important to reading development. Indeed the children's performance on rime measures was very poor at their entry to school. Block 1 rime measures did not correlate with, or predict, later reading skills, and superior block 1 alphabet knowledge enhanced performance on the Odd Word Out and Rhyme Generation tasks.

The finding that early alphabet knowledge is more important than early rime awareness does not contradict those who have argued that rime awareness develops in importance only after phonemic awareness has developed. However, the lack of a significant correlation between block 3 Rhyme Generation scores and block 4 reading age is not in keeping with late rime use theories. Also, the fact that *all* conditions of Odd Word Out at block 3 except Onset Control correlate significantly with later reading, rather than just (or particularly) the Rime Experiment condition, is contrary to the predictions of late rime use theories.

The results presented here *do* agree with theories which propose that phonemic knowledge is important for young readers, and that knowledge of larger word units (though not necessarily rimes) develops as the child's lexicon grows. It is clear from the data that it is the children's level of alphabet knowledge upon beginning school which is affecting their reading and phonological awareness throughout the first two years at school.

The final type of theory discussed in the introduction (Gombert, 1992, 1999; Seymour, 1999), which emphasised a different pattern of development for implicit and explicit phonological awareness could also be argued to account for the data. Not all of the results are as predicted by this theory, however. This viewpoint argues that before learning to read children already possess sufficient epiphonological awareness of rime units to allow good performance on tasks such as Odd Word Out and Rhyme Generation. For the present sample, though, performance on measures of such awareness was extremely poor at the start of year one. Also, the significant correlation between early rime awareness and later reading predicted by the theory was not observed in the present study.

Summary

The longitudinal data on alphabetic and rime awareness from correlations, ANCOVAs and multiple regressions converged well. It was demonstrated that whereas levels of letter knowledge at the start of primary one had an important impact on the children's development in reading and phonological awareness, their level of rime awareness at the start of schooling made no significant independent contribution to their development during the first two years of school. On the basis of the data, theories based upon the importance of rime knowledge were rejected in favour of theories stressing the importance of letter awareness.

Chapter 4

Visual Skills and Reading Development

Introduction

The role of visual skills in reading development has received surprisingly little attention in recent years. As the overview in chapter 1 has discussed, while some researchers have found evidence in *favour* of a strong relationship between visual skills and reading (e.g., Cataldo and Ellis, 1990; Ellis and Large, 1988; Johnston, Anderson, Perrett and Holligan, unpubd; Gattuso, Smith and Treiman, 1991; Johnston and Anderson, submitted), others have found no such link (e.g., Huang and Hanley, 1994) and have challenged the view that children use a visual 'logographic' strategy at the first stages of learning to read (e.g., Byrne, 1992; Sprenger-Charolles and Bonnet, 1996).

The bulk of literature relating to visual skills and reading development has been concerned with the nature of the deficit in children with reading problems. Once again, though, the picture from these studies is not clear cut. Some studies apparently show a visual deficit in poor readers (e.g., Fox, 1994), whilst others have found visual perception and visual-orthographic skills to be equal or even *superior* to reading age controls (e.g., Vellutino, 1979; Siegel, Share and Geva, 1995; Johnston, Anderson and Duncan, 1991; Johnston and Anderson, submitted). Research reviewed by Stanovich (1992), however, suggests that visual deficits may only be found in certain experimental conditions, such as very brief displays (Badcock and Lovegrove, 1981; DiLollo, Hanson, and McIntyre, 1983; Solman and May, 1990).

An interesting suggestion regarding this issue of visual skills and reading has been given by Johnston and colleagues (Johnston, Anderson and Duncan, 1991; Johnston and Anderson, submitted). The results of research with poor readers suggested to them that rather than *absolute* levels of visual skill being important in explaining the reading deficit, a measure which took into account *relative* visual and phonological skills seemed to account for the patterns of performance more closely (this was termed the 'visual advantage index'). It was suggested that children with very strong visual relative to phonological skills may become poor readers because of their over-reliance on these skills. This may relate to the Chinese/Phoenician continuum of reading style observed by Baron and Strawson (1976; see also Baron, 1979; Boder, 1973; Davidson, Olson and Kliegl, 1982). Indeed Baron (1979) has suggested that some poor readers may be viewed as extreme Chinese readers, overly-reliant on a visual approach to reading.

The 'reading style index' of Beech and Harding (1984) and Harding, Beech and Sneddon (1985) also demonstrated a range of reading styles within populations of normal readers, with the style of reading strategy becoming more visual as the children developed. This would seem to support the view of developmental models such as those of Frith (1985) and Marsh et al (1981) which envisage a visual-orthographic strategy being used by advanced readers.

In the present study, then there are several related questions which will be investigated as far as possible. The main question is whether there is a relationship between visual skills and reading ability in the present sample, and whether the visual tasks have any predictive relationship with reading ability.

It is also hoped to investigate whether there is evidence of a range of reading styles amongst the group, and whether visual skills relate to the strategies children adopt. Related to these questions is that of whether it is *relative* levels of visual and phonological awareness skills which determine the child's route to reading, rather than their absolute levels of visual skill.

Performance on several tasks will be investigated in order to answer these questions. Two tests of visual skill were administered during the study: the Frostig Test of Visual Perception (block 1); and the Children's Embedded Figures Test (blocks 1 and 3). In addition performance on tests of reading may provide clues as to the strategies which the children employ. Finally the reading style index task of Beech and Harding (1984) was administered at block 4, and it is hoped this will show the style of reading which the children are employing by the end of their first two years at school.

Methods

Ready-to-Read Word Test *(Clay, 1979)*

At block 1, reading ability was measured using Clay's Ready-to-Read Word Test, in which the children were presented with a card which has 3 lists of high frequency words on it. Two words on the sheet, namely ***I*** and ***a***, were not included in scoring, because of their ambiguous status as words or letters leaving a total of 43 words. The children were asked to look carefully through the lists reading any words that they knew, and were encouraged to try to guess if they were unsure. Corrective feedback was given for the first word only, and no time limit was enforced. The number of words correctly read was then totalled to give a score out of a possible maximum of 43.

***British Ability Scales - Word Reading* (Elliot et al, 1983)**

After the first block of testing, reading ability was measured using the British Ability Scales Word Reading Test. In the task, the child was given a sheet of paper, on which were 90 words progressing in difficulty. The child was then asked to read the words one at a time, and was encouraged to attempt to guess the identity of unfamiliar words. No corrective feedback was given during the test, and no examples preceded the test stimuli. Testing continued until the child made errors on 10 successive words. Responses were scored 1 point if correct, and the total raw scores were then converted into age-standardised scores and reading ages for each child.

***British Picture Vocabulary Scale* (Dunn & Dunn, 1982)**

The British Picture Vocabulary Scale (BPVS) was used in order to test the verbal I.Q. of the subjects. The materials consist of a book with four pictures on each page. The experimenter would say a word, *e.g.*, ***wooden***, and the child was then asked to choose which of the four pictures corresponded with this word, and to point to it. Four example trials were given, and then each child was tested until a ceiling level was reached. One point was awarded for each correct answer, and these scores were then transformed into age-standardised I.Q. scores with population mean of 100.

***Developmental Test of Visual Perception* (Frostig, 1966)**

Part IV of Frostig's Test of Visual Perception was used in the present study. In the first part of the test, the child is shown a row of 5 simple drawings, and their task is to find the picture which is *different* from the others; for example, it may be upside-down or reversed. One practice trial was given, with corrective feedback, followed by 4 experimental trials. The children marked their chosen picture with a pen. In the second part of the test, the child was again shown a row of pictures. This time the figure on the left was in a box, and the child had to choose which of the 4 other pictures was the *same* as the one in the box. Again, there was 1 practice trial followed by 4 experimental trials, and responses were marked or circled with a pen. One point was awarded for each correct response, giving a maximum possible score of 8.

Children's Embedded Figures Test ***(Witkin, Oltman, Raskin & Karp, 1971)***

In this test, the child must find a simple geometric shape which is embedded into various pictures, *e.g.*, a triangle disguised as a clown's nose. The children were first shown a small cardboard triangle, and the experimenter pointed out its similarity to a tent standing on the ground. The children were then shown a series of 4 cards, each with the 'tent' shape plus 3 other triangles of slightly different size, shape or orientation (or a combination of these feature differences) compared to the 'tent', and their task was to find the 'tent'. For each of these trials, the child was allowed to check their response using the cardboard shape. Regardless of whether they were correct, the experimenter then helped them to look at each of the 3 wrong triangles, and decide in what way it differed from the tent (*e.g.*, too big; upside-down). Next a series of 3 pictures demonstrated how the triangle could be built upon to form part of a picture. Two practice pictures then followed to familiarise the child with finding the tent shape embedded within a picture and then drawing round the tent's edges with their finger. Then the child proceeded to the test pictures, which embedded the tent shape in increasingly subtle ways. The child then proceeded through the 11 test items. If the child failed to find the 'tent' correctly in *all* of the 5 final pictures, testing was discontinued. If, however, the child managed to get any of these 5 trials correct, the test continued with a 'house' shape. Again, 4 cards were shown in which the 'house' shape had to be picked from 4 possible alternatives. There was then one practice picture with an embedded 'house', followed by a maximum of 14 experimental trials. On this series, testing was discontinued after the child responded incorrectly to 3 consecutive trials.

The experimental trials for both the 'tent' and 'house' series were scored 1 point for each correct response, giving a maximum possible score of 25.

Reading Style Index ***(Beech and Harding, 1984)***

This task was designed to assess whether a child tends to follow a phonics or a whole-word approach to reading words. Words were displayed one at a time on the screen of a laptop computer, and the child was asked to read them quickly and accurately. A small asterisk, acting as a fixation point, was displayed on the computer screen for a short time, followed by a word which the child was required to read. The child's response triggered a voice-switch, recording the response time and changing the display back to an asterisk and then the next word. Ten practice trials were given at the start of the test, followed by 3 blocks of words: 18 regular words; 18 irregular words; and 18 nonsense words. Each *irregular* word contained a spelling pattern in common with one of the *regular* words, but pronounced differently, *e.g.*, ***home***, ***come***. In turn, this spelling pattern was contained in one of the *nonsense* words, *e.g.*, ***bome***. Any legal pronunciation of the nonsense words was counted as correct. Median reaction times for each type of word and mean overall reaction times were calculated for correctly read words for each child individually.

These times were then used to calculate a reading style index score, though only for those children who had managed to read at least 5 of each type of word correctly. The formula for the reading style index is as follows:

$$\frac{|N-R|-|R-E|}{N+R+E}$$

The difference between median reaction times for regular (*R*) and exception (*E*) words was subtracted from the difference in median reaction times for nonsense (*N*) and regular words. This number was then divided by the mean reaction time for all words. The reasoning behind the formula is that those children using a phonics approach should find *regular* and *nonsense* words easiest to read, and so the index score will be negative. Conversely, a whole-word reader should find *regular* and *exception* words easier to read than nonsense words, resulting in an index score greater than zero.

Results

Descriptive statistics for the tasks are presented in table 4.1.

Task	*Mean*	*SD*
Clay Ready-to-Read (block 1)	3.00	3.05
BAS Reading Age (block 2)	5.79	0.52
BAS Reading Age (block 3)	6.02	0.61
BAS Reading Age (block 4)	6.88	0.80
Children's Embedded Figures Test - % (block 1)	15.00	8.79
Children's Embedded Figures Test - % (block 3)	22.58	12.50
Frostig Test of Visual Perception - % (block 1)	65.63	17.77
Reading Style - Regular words (max=18) (block 4)	8.27	5.77
Reading Style - Exception words (max=18) (block 4)	6.58	5.52
Reading Style - Nonsense words (max=18) (block 4)	4.81	4.01

Table 4.1 - *Table of descriptive statistics for tasks analysed in this chapter*

Correlational and Regression Analyses

In order to investigate whether there was any relationship between the measures of visual skill and reading ability, correlations between the measures were calculated. A table of correlation coefficients is given in table 4.2 [for a full set of correlations, see appendix 4]. It can be seen that the embedded figures task (CEFT) scores taken at the start of Primary 1 correlate significantly with reading age at the end of Primary 1 (block 2; r=.3881, $p<.01$) and the start of Primary 2 (block 3; r=.2896, $p<.05$). The relationship to block 4 reading age was not significant (r=.1063, $p=.472$). CEFT ability as measured at block 3 was also significantly correlated to reading at blocks 2 (r=.3039, $p<.05$) and 3 (r=.3036, $p<.05$), and the correlation with block 4 reading age only just failed to reach significance (r=.2720, $p=.061$). This suggests that visual segmentation skills are most important to reading at the end of Primary 1 and start of Primary 2, but that they then become less important towards the end of Primary 2. The Frostig Test of Visual Perception administered at block 1, showed a different pattern of relationship to reading age, becoming more highly correlated with later reading - the task narrowly missed being significantly correlated to reading age at block 3 (r=.2749, $p=.059$), and was significantly correlated with reading age at block 4 (end of Primary 2; r=.3072, $p<.05$). These correlation patterns suggest that the two visual tasks may be tapping different aspects of visual ability, each relating to different points in the development of the children's reading. The results do show that block 1 visual skills are related to reading at each of the subsequent blocks.

	CEFT1	CEFT3	Frostig	Clay	RA2	RA3	RA4
CEFT1	-	.4639***	.4290**	.2289	.3881**	.2896*	.1063
CEFT3		-	.4226**	.1386	.3039*	.3036*	.2720
Frostig			-	.1572	.1782	.2749	.3072*

Table 4.2 *- Correlation coefficients between visual tasks and reading ability. CEFT(1,3) = Children's Embedded Figures Task, blocks 1 and 3 (percentage correct); Frostig = Frostig Test of Visual Perception, block 1 (percentage correct); Clay = reading skill block 1; RA(2,3,4) = BAS reading age, blocks 2 (end primary 1), 3 (start p2) and 4 (end p2/start p3).*
** $p<.05$; ** $p<.01$; *** $p<.001$*

To test the relationships more closely, regression analyses were then carried out. The significant relationships between the visual tasks and reading were tested with and without first controlling for BPVS (block 1) and Clay reading (block 1). As can be seen from the summary in table 4.3, when entered as the first step the block 1 embedded figures task predicted a significant amount of variance in reading ages at blocks 2 and 3 (block 2: r^2 change=15.07, $p<.01$; block 3: r^2 change=8.39, $p<.05$) , while the block 3 scores on this task also predicted significant variance in block 3 reading when entered at step 1: r^2 change=9.21, $p<.05$. Once reading and vocabulary had been controlled for, the variance predicted by the variables was reduced to non-significant levels with the exception of block 1 CEFT, which continued to predict a small but significant amount of variance in block 2 reading ability: r^2 change=5.68, $p<.05$. Frostig's visual perception test accounted for a significant amount of variance in block 4 reading (r^2 change=9.44, $p<.05$), but this was removed once earlier reading and vocabulary skills had been controlled for (r^2 change=3.25, $p=.185$). The relationship between the tasks and reading in Primary 2 was a weak one, then, which was destroyed when entered last in the regressions analyses. CEFT performance at block 1, however, did survive to the final step in one of the regressions.

Table 4.3 *- Summary of stepwise regression analyses. Figures in brackets after variable names indicate the block of testing at which the measure was taken. (***p<.001 **p<.01 *p<.05)*

Dependent Variable - BAS Reading Age, block 2

	r^2 change		r^2 change
step 1: BPVS (1)	16.80**	*step 1:* CEFT (1)	15.07**
step 2: Clay (1)	23.95***		
step 3: CEFT (1)	5.68*		

Dependent Variable - BAS Reading Age, block 3

	r^2 change		r^2 change
step 1: BPVS (1)	20.20***	*step 1:* BPVS (1)	20.20***
step 2: Clay (1)	12.46**	*step 2:* Clay (1)	12.46**
step 3: CEFT (3)	3.06	*step 3:* CEFT (1)	2.41
step 4: CEFT (1)	0.76	*step 4:* CEFT (3)	1.41
	r^2 change		r^2 change
step 1: CEFT (1)	8.39*	*step 1:* CEFT (3)	9.21*

Dependent Variable - BAS Reading Age, block 4

	r^2 change		r^2 change
step 1: BPVS (1)	13.61**	*step 1:* Frostig (1)	9.44*
step 2: Clay (1)	4.34		
step 2: Frostig (1)	3.25		

Measures of Reading Style

Beech and Harding's Reading Style task had been employed at block 4 in an effort to calculate an index of style for the sample, and see how much this varied from child to child. In practice, however, the task proved problematical for several reasons. Firstly the children found the words difficult to read (mean scores (out of 18): regular = 8.27, exception = 6.58, nonsense = 4.81), with only 5 of the 48 children able to read more than half of the nonwords correctly. A second problem was that of obtaining reaction times for the children's responses since the voice switch was very easily triggered too soon by the child making a noise (for example, tapping the table, saying 'ummm...' or sounding out words aloud). In order to calculate the index a minimum of 5 correct words *with* RTs in all 3 conditions was required, but because of the problems mentioned, only 18 of the 48 children had sufficient data to calculate an index.

Apart from the data *collection* problems, the very small proportion of valid data demonstrates flaws in the index as a measure, at least for this age group. One problem was that because the children found the task difficult, only those children who were advanced readers could have had an index calculated, denying a proper investigation of how reading style relates to reading ability. Secondly, and perhaps more fundamentally, the equation used to calculate the index relies solely on response times, ignoring actual accuracy levels completely as well as equating speed with superior skill - an assumption which does not necessarily hold true. For instance, the index cannot make the distinction between a careful or shy child who reads cautiously but accurately - RT data would presume this child is having problems with the words - and a more extrovert child who races through the words, but manages to read only a few words correctly - this child's RT data will presume that they are reading the words with ease. For these reasons the Reading Style Index was not calculated for the present sample.

In order to make use of the accuracy data from this task, and to address the question of how the children were reading, it was decided to adopt a comparison of the correlations between scores for each type of word. This technique was suggested by Baron (1979) as a way of distinguishing whether children are reading as Phoenicians, Chinese readers or whether there are a variety of styles being employed by the children. Briefly, the predictions are that if $r_{NR} > r_{NE}$ then spelling to sound rules are important for reading regular (R) words; if $r_{NR} \approx r_{NE}$ then rules are not being used much to read the regular words. Secondly, if $r_{RE} > r_{NE}$ then word-specific associations are important for reading regular words; if $r_{RE} \approx r_{NE}$ then word-specific knowledge is not being employed in reading the regular words. In addition, r_{NE} being weaker than either of the other two correlations indicates that use of spelling-to-sound rules and word specific associations tend to be strategies employed by different types of children. The final set of predictions are that if $r_{NR} > r_{RE}$ then rules are the most important strategy in being able to read regular words (for these children), whilst if $r_{NR} < r_{RE}$ then this indicates that word-specific knowledge is the most important strategy for regular word reading.

	Regular	*Exception*	*Nonsense*
Regular	-	.9301***	.8288***
Exception		-	.7864***
Nonsense			-

Table 4.4 *- Table of correlations between mean scores for regular, exception and nonsense words. (*p<.05 **p<.01 ***p<.001)*

The correlations between nonsense (N), Exception (E) and Regular (R) words are shown in table 4.4. Pairs of correlations were compared using the formula:

$$t = \frac{(r_{XY} - r_{VY})\sqrt{(n-3)(1+r_{XV})}}{\sqrt{2\left(1 - r_{XY}^{2} - r_{VY}^{2} - r_{XV}^{2} + 2r_{XY}\, r_{VY}\, r_{XV}\right)}}$$

to compare r_{XY} and r_{VY} (two-tailed test with *d.f.* = *(n-3)*; Cohen and Cohen, 1975). The results showed firstly that $r_{NR} \approx r_{NE}$, indicating that rules were not being used to any great extent in order to read the regular words. Secondly, $r_{RE} > r_{NE}$ ($p<.001$) indicating that word-specific associations were being used to read the regular words. Although r_{NE} was only significantly lower than one of the other two correlations, this is evidence that rules and word-specific associations are being used by different children to some extent. Finally $r_{NR} < r_{RE}$ ($p<.01$), demonstrating that for these children ability to use word-specific rules was more important than spelling-to-sound rules when reading regular words. Thus these correlations suggest that when presented with words which could be read by either a visual or a phonological approach the majority of the children adopted a visual or 'Chinese' style of reading. There was also some evidence, though not as strong as might be expected, that rules and word-specific knowledge characterise the reading of different types of children.

Reading Error Analysis

As an estimate of how the children were approaching reading words, an error analysis was carried out on the British Abilities Scales task responses for blocks 2, 3 and 4. Since the aim was to look at relative levels of visually and phonologically based errors, the responses were classified simply as 'visual', 'phonological' or 'other'. Errors were judged as 'visual' if the target and response shared similar length or visual features such as ascenders or descenders, e.g., ship → 'stop'. 'Phonological' errors were those which resulted from incomplete sounding out of the target, e.g., window → 'win', or were the result of sounding words which could not be read accurately in this way, e.g., one → 'on-eh'. 'Other' errors were mostly unrelated to the target, e.g. money → 'you', or were responses where it was difficult to tell whether the response was the result of a visual or phonological error, e.g., sport → 'support'. Errors were classified into these categories for each child and were then expressed as a percentage of the total number of errors made by the child for each block. Mean percentages of each type of error are presented in figure 4.1.

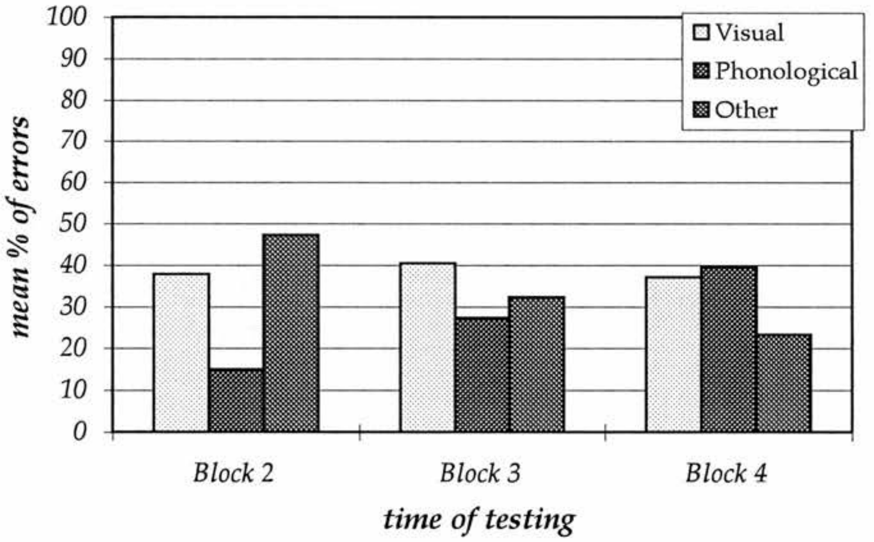


Figure 4.1 *- Mean percentage of 'visual', 'phonological' and 'other' errors on the BAS reading test*

A 2x3 (type of error(visual/phonological) x time(2/3/4)) repeated-measures ANOVA was then conducted on the error data. This produced a significant main effect of type (*f(1,47)=9.84, p<.01*), and of time (*f(2,94)=28.51, p<.001*). The interaction of type x time was also significant (*f(2,94)=12.19, p<.001*) and a Newman-Keuls post-hoc test was used to analyse it. It emerged that the proportion of 'visual' errors did not change significantly across time, but that 'phonological' errors increased significantly at each block. There were significantly more visual than phonological errors at blocks 2 and 3, but at block 4 the difference between the categories was not significant. The pattern suggests that the children rely more on visual cues in the first year (and into the second year) of learning to read, but that as their phonological skills increase the children are beginning to use a phonological approach more often in order to read difficult words.

Relative Importance of Visual Skills

The final analysis carried out on the data, was to test whether *relative* visual skills (as compared to phonological skills) were more important to reading than absolute levels, as suggested by Johnston, Anderson and Duncan (1991) and Johnston and Anderson (submitted). In order to do this, a 'visual advantage index' score was calculated by subtracting each child's standardised phoneme segmentation score from their standardised visual segmentation score (CEFT). Scores at block 1 were used to calculate the index. Thus, a child with better phonological than visual segmentation skills would have an index score less than zero, while greater visual than phonological segmentation skills would produce a positive index value. Correlations between this index and reading ages at blocks 2, 3 and 4 were then calculated (see table 4.5). These showed a clear pattern of increasing strength across time, with relationship between block 1 visual advantage index and reading age becoming significant at block 4 ($r=-.2808$, $p<.05$). The correlation is negative, indicating that it was those children who started out with better phonological than visual segmentation skills who became better readers. Children with better visual than phonological skills, on the other hand, had lower reading ages.

	Reading Age 2	*Reading Age 3*	*Reading Age 4*
Visual Advantage	-.1304	-.2593	-.2808*

Table 4.5 *- Correlations between Visual Advantage Index (block 1) and BAS reading age (*p<.05 **p<.01 ***p<.001)*

Discussion

The results of the correlational and regression analyses looking at the relationship between visual skills and reading did not reveal a strong link between the two. While the relationship between block 1 visual segmentation and block 2 reading age remained significant even at the final step in regression, the other relationships were not strong enough to cope with this demand. This result is in line with researchers such as Gough, Juel and Griffith (1992) and Byrne (1992) who have argued that young readers do not use visual 'logographic' strategies to read words. However, the other analyses suggest that this is an over-simplification of the issue.

A particularly important result was that obtained by comparing visual skills relative to phonological skills, as suggested by Johnston, Anderson and Duncan (1991) and Johnston and Anderson (submitted). When the visual advantage index (which gave a measure of how good the child's visual segmentation skills were in comparison to their phonological segmentation skills at block 1) was calculated, it was found that the relationship between this and later reading actually became stronger across the period of the study. The significant negative correlation between the visual advantage index at block 1 and reading age at block 4 demonstrates that where children began school with visual skills which outstripped their phonological their reading was poorer at the end of Primary 2. Children whose phonological skills outstripped their visual skills, on the other hand, became better readers at the end of their second year at school. The fact that this relationship between poor reading and a strong visual advantage increases in strength across the period studied indicates that the difference between the two types of children is widening. This seems to link with Boder's (1973) suggestion that some poor readers may be viewed as extreme 'Chinese' or visual, readers.

Although some researchers have argued that superior visual skills observed in dyslexic children have developed as a mechanism to *compensate* for poor phonological skills (e.g., Olson, Kliegl, Davidson and Foltz, 1985), the present result provides good support to the alternative view of Johnston and colleagues (Johnston, Anderson and Duncan, 1991; Johnston and Anderson, submitted). Johnston et al have argued that the superior visual relative to phonological skills observed in some poor readers stem from them possessing this pattern of performance from the early stages of reading. Children with better visual skills are likely to rely on them in order to read, however, an over-reliance on such a strategy will ultimately lead to difficulties as the visual route becomes inadequate to cope with the demands of an ever-expanding lexicon. Importantly this study shows possible evidence of such a pattern emerging within a population of normal young readers.

The attempt to employ the reading style index (Beech and Harding, 1984) as a measure of the way in which the children were reading proved problematical as discussed in the results section above. Not only was it difficult to obtain sufficient data, but the way in which the index itself was calculated did not seem to reflect the children's performance well. Instead the accuracy data from the task was used to attempt a correlational comparison of the type employed by Baron (1979). These results indicated that there was some variety in the strategies employed by the children, but that overall they seemed to favour a 'Chinese' or visual approach when reading regular words. This result demonstrates that visual skills do play an important role in the children's reading, and can be employed in reading regular as well as exception words.

Some caution must be applied in interpreting the results however. The lack of great variety in reading styles is unusual (c.f., Baron, 1979; Baron and Treiman, 1980b), and may in part be due to the fact that these words were read in a situation where the children had been encouraged to read the words quickly, and had a limited period in which to read them. This factor alone could have induced a fast, visual style of reading in the children regardless of the way in which they might have read the words in a situation with no time constraints, and might also explain why mean scores on the task were low.

The results of the error analysis, though, do also show that the children sometimes employ a visual strategy in reading new words. The proportion of visually based errors did not change significantly over time, suggesting that this strategy remained important even while phonological skills were increasing (as indicated by the rising levels of phonologically based errors). The pattern of falling errors in the 'other' category must also reflect increasing competence in using visual and especially phonological strategies in order to read the words, and fewer wild guesses unrelated to the words or perhaps based on just one letter.

Overall then, the picture painted by the analyses is that visual skills do play a role in reading, and that recognising words or parts of words based on visual features was a strategy consistently employed by the children in their reading throughout the study. The direct relationship between the measures of visual skill and reading was not a strong one as previous studies have also shown (e.g., Cataldo and Ellis, 1990; Ellis and Large, 1988).

Taking account of visual ability relative to phonological skills *did* provide some interesting results, though, indicating that having good visual skills but poorer phonological skills may actually lead to poorer reading development. Perhaps such a comparative index could usefully be used as a diagnostic tool for detecting potential reading problems, so that children who are developing a reading style which is too strongly visual can be given extra help to develop a phonological strategy for decoding new words (as suggested by Johnston, Anderson and Duncan, 1991). Further longitudinal data would be valuable in order to trace the long-term effects of having a high visual phonological advantage, and to test whether this leads to over-reliance on a visual approach to reading ultimately resulting in problems.

Chapter 5

Use of Analogy Strategies in Young Readers: The Clue-Word Task

Introduction

Throughout this thesis, the debate over the role of alphabet knowledge and onsets and rimes in early reading is a theme which recurs frequently. In this chapter, one technique for investigating the role of rimes is explored more closely. This is the 'clue-word' technique developed by Goswami (1986, 1988). This procedure involves three main stages which are common to almost all of the studies mentioned here (for a more detailed discussion see chapter 1). These stages are: firstly *pre-training*, during which a baseline measure of the children's familiarity and accuracy with the experimental items is taken; secondly, a *training* stage, in which the children are trained in orthographic analogy skills or with a 'clue word' which they become familiar with; and finally the *post-training* stage, in which the children's ability to use the training or clue words in order to read new words by analogy is tested. Of course, these words have usually been seen already at the *pre-training* stage, but the idea is that it is *improvement* in accuracy which demonstrates that the children have managed to read by analogy.

In her initial clue-word studies (1986, 1988a), Goswami was able to demonstrate that improvement at post-training was greatest for words sharing a rime segment with 'clue' words (which were usually visible during the post-training phase). Importantly, in an experiment looking at analogy improvement for *prose* passages (1988a, expt 3) it was shown that even without any clue, 7 year old children appeared able to use orthographic analogies based upon the *beginnings* (bodies) of words (improvement for rime-based analogy words was only seen in conditions *with* clue words available).

Whilst no measure was taken in these studies of the children's grapheme-phoneme skills, the results of the other papers employing the clue word task reviewed in chapter 1, indicate that this may play a crucial role in the development of orthographic analogies. Some studies found, for instance, that only children with good grapheme-phoneme skills were able to be trained to use analogies (e.g., Ehri and Robbins, 1992; Peterson and Haines, 1992), whilst other studies found a strong *predictive* relationship between early phonemic skills and later analogy use (e.g., Walton, 1995).[1] The results of other studies indicated that children are not fully able to use analogy strategies until they have been at school for 2-3 years developing a large enough lexicon upon which to base analogies and further that once these skills do develop, the analogies made are not necessary based upon rime units (Nicholas, Kay and Mitchell, unpubd; Bruck and Treiman, 1992; Savage and Stuart, 1998; also Goswami, 1988)

The present study employs and extends the clue-word technique as used by Muter, Snowling and Taylor (1994, expt 1). Muter et al's study investigated

[1] In fact this paper (Walton, 1995) also found no significant predictive relationship between pre-

whether analogy use is spontaneous in young readers by testing whether the improvements in analogy reading found by Goswami (1986, 1988a, 1990) were facilitated by the presence of the clue word during the testing phase. A group of 36 children with mean chronological age of 6.3 years were first asked to read a list containing all of the experimental items, and were then taught to read a set of five clue words. In the post-training phase, five lists of eight words (one list for each clue word) were presented to the children for reading. In each list, half of the words could be read by rime-based analogy with a clue word, while the others simply shared letters (in a different order) with the target. For half of the children the relevant clue word was visible alongside its own list during testing, whilst the remainder of the children did not see the clue words at this stage. It was found that an advantage for analogy words over control words was evident only for the children who had the clue word present at post-test, indicating that the children had not spontaneously used an analogy strategy.

In the present experiment, the technique of Muter et al was employed with a larger sample of children (48), who were slightly older than the original group (mean CA = 7y 1m). This sample were at the beginning of their third year at school. The procedure was extended to include a third, 'control' group who received no training with the clue words, and instead simply read the pre- and post-training lists. This extra condition allows a test of the possibility that simply seeing the words more than once may improve reading performance, regardless of the strategy used to read them.

The experiment aims to investigate whether the children are able to use the

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school rhyme skills and analogy use, contrary to the predictions of Goswami and Bryant (1990).

clue words in order to make rime-based analogies to read the words, in which case we would expect performance to be best for the analogy words, particularly for the 'clue present' group. Secondly, comparison of the groups should reveal whether ability to use analogies is spontaneous in which case all three groups should find the analogy words easier to read than control words. If training is required in order to use such a strategy, a clear ranking of order would be expected with the 'clue present' group showing a greater analogy word advantage than the 'clue absent' group, and the 'no training' group showing no preference between the two types of word.

In light of the other studies reported here, the relationship between the children's early letter knowledge and performance on the analogy task will also be compared. The studies reported above all point to the importance of grapheme-phoneme skills as a precursor to being able to make analogies.

Methods

Alphabet Knowledge Task

A measure was taken of the ability of the children to give the names and sounds of the letters of the alphabet. In the test, all 26 letters of the alphabet appeared individually on the screen of a laptop computer. During the first time through the task, the children were required to provide the *sounds* of the letters, and this was clarified by the experimenter before commencing testing. If, on any occasion, the child supplied the letter's *name* rather than its sound, the response was noted, and the experimenter would say, *"Now that's the letter's name. Can you tell me its sound?"*. This gave the child an opportunity to supply the correct answer. Once all letters had been presented, the whole procedure was repeated and the children asked to give the letters' *names* rather than their sounds. The children were given composite alphabet knowledge scores, reflecting the number of letters for which they were able to give the correct name *and/or* sound.

Where the children are split into high and low alphabet knowledge groups for analysis, this refers to their performance on the Alphabet Knowledge task at the first block of testing (beginning of Primary 1). A median split was performed on the composite scores to give two equal groups.

Analogy Task

This task was designed to assess the extent to which the children were able to use rime-based analogy strategies in order to read words. The task was based on that of Muter, Snowling and Taylor (1994), but with the addition of a control condition.

The experiment was designed so that of the 48 children tested, 24 received stimulus list A, and 24 received stimulus list B. The children in these 2 groups were then assigned randomly to one of 3 conditions: Clue Present; Clue Absent; and Control. This gave 8 children in each condition for each list. The 2 lists, A and B, consisted of 5 groups of 8 words, each group based on a target word. For every target word there were 4 *analogy* words, which shared their rime unit with the target, and 4 *control* words, which shared the same number of letters with the target word as did the analogy words, but could not be read by rime-based analogy with the target. So, for example, the target word ***ring*** had analogy words: ***king sing wing ping***; and control words: ***gain sign rink rang***.

Testing proceeded through 3 stages. At the first stage - the *pre-training* stage - the children were shown a list containing all 40 of the testing stimuli randomly ordered. These were printed in 24 pt Arial font, in 8 rows of 5 words. The words were covered with a piece of paper, and revealed one row at a time in order to aid the children's concentration and avoid overwhelming them with so many words. The children were simply asked to read the words, and were encouraged to guess at those words of which they were unsure.

Following the *pre-training* phase, children in the Clue Absent and Clue Present conditions were given a *training* phase. Here the children were shown the 5 target words upon which the stimuli analogy and control words were based, printed in 48 pt Arial font on separate index cards. First the experimenter went through the words one at a time, reading them for the child, and then the child was asked to read each card. If errors were made, the child was reminded of what the word actually said. After reading through all 5 cards twice, they were shuffled in order to prevent the children from simply learning a *sequence* of words. The training continued in this way until the child had read all 5 words without errors on two consecutive occasions. In the original study by Muter et al, training was continued until the children read through the words correctly on 3 consecutive showings, however the vast majority of children in the present study seemed to find little difficulty in learning the words, and became weary if forced to read them 3 times correctly.

The final phase of the task, administered to all 3 groups of children, was the *post-training* phase. In this the 40 stimulus words were split according to the 5 target words upon which they were based. The 4 analogy and 4 control words were randomly mixed (though the order remained identical for lists A and B). The 5 lists of words were each printed in 24 pt Arial font on separate sheets of paper, which were presented one at a time, and the children asked to read the them. The lists were shuffled between subjects to randomise their order of presentation.

The children in each condition were given slightly different instructions at the beginning of the *post-training* phase. Sixteen children formed the Clue Present group. These subjects were told that the words they had just been reading (in the *training* phase) could help them to read these new lists of words. In this condition, the relevant target word card was placed beside each list while the children were reading. No specific attention was drawn to the target word. Children in the Clue Absent condition (of whom there were also 16) were told that the words they had just been reading could help them to read other words (as in the Clue Present condition above). This time, however, the target words were not visible as the children were reading the lists. Finally, the third group of 16 children were used as a Control condition. These children did not receive any training with the target words. Instead they went straight from the *pre-training* to the *post-training* phase, and were simply told that they were going to see some more lists of words which they were to read. The children in all 3 conditions were shown the same post-training reading lists. Scores were calculated for the numbers of analogy and control words read correctly at *pre-* and *post-training* by each child.

Results

A comparison was made firstly of the mean scores for all words in the two word lists. These were 36.54 for list A and 32.38 for list B. A one-way ANOVA showed that there was no significant difference between the two groups ($f(1,46)=.362$, $p=.550$), and so the scores for the lists were combined for the remainder of the analyses. In order to ensure that there were no differences in reading age between the three groups, t-tests were carried out comparing BAS reading ability. These found no significant differences, suggesting that the groups were well matched for reading ability: clue present v control, $t(23.66) = .44$, $p=.664$; clue present v clue absent, $t(27.58) = -.28$, $p=.784$; clue absent v control, $t(28.08) = .92$, $p=.368$.

A graph of mean scores on the analogy task for the three groups is given in figure 5.1. In order to investigate the data, a 2x2x3 (word type x time (pre/post training) x condition (clue present, clue absent, control)) repeated measures ANOVA was carried out. This revealed no significant effect of condition ($f(2,45) = 1.67$, $p=.200$) nor any main effect of time ($f(1,45) = 3.82$, $p=.057$) though this was close to significance. The main effect of word type was significant ($f(1,45) = 27.20$, $p<.001$), showing that overall analogy words were read more accurately than control words. The two-way interactions of condition x word type and condition x time were non-significant: condition x word type, $f(2,45) = 0.20$, $p=.821$; condition x time, $f(2,45) = 1.73$, $p=.189$. The interaction of word type x time was significant, $f(1,45) = 6.93$, $p<.01$. The three-way interaction of condition x word type x time failed to achieve significance, $f(2,45) = 1.40$, $p=.258$. The significant two-way interaction of word type x time was analysed using a Newman-Keuls post-hoc

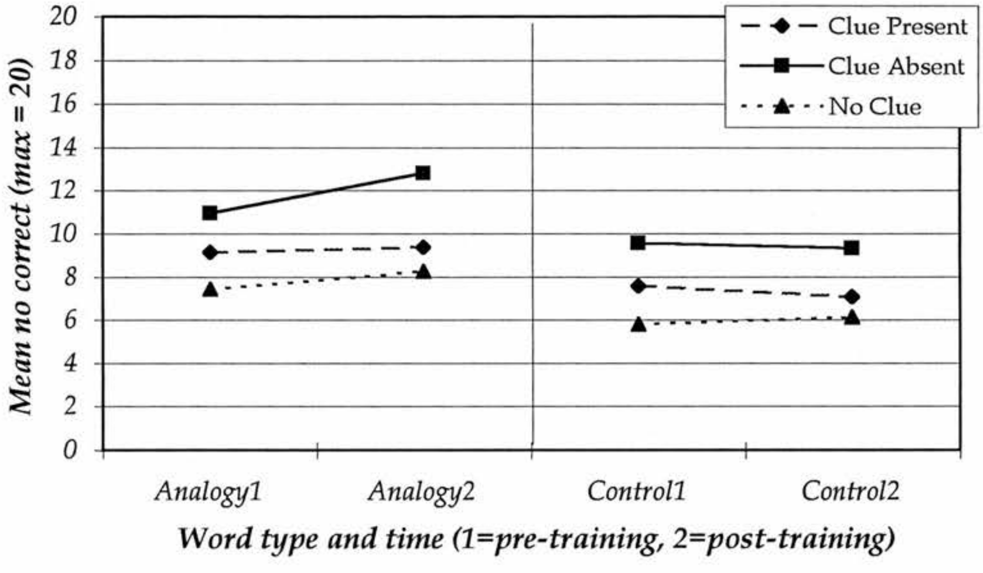

Figure 5.1 *- Mean number of words read correctly for each word type at time 1 (pre-training) and time 2 (post-training) by condition*

test, which showed that on average analogy words were read more accurately than control words at both pre and post-training phases. Further, it was found that the mean number of control words read accurately did not improve significantly from time 1 to time 2, whereas analogy words had improved significantly at the post-training phase.

In order to check whether the superior performance for analogy words even at the first stage of the experiment had influenced the outcome of the analysis, a second analysis compared the *change* in score from pre- to post-training. Improvement scores were calculated for analogy and for control words by subtracting each child's pre-training score from their post-training score, thus creating two new variables:

$$\Delta analogy = (\text{post-training analogy score - pre-training analogy score})$$
$$\Delta control = (\text{post-training control score - pre-training control score})$$

Means for these scores by group are shown graphically in figure 5.2.

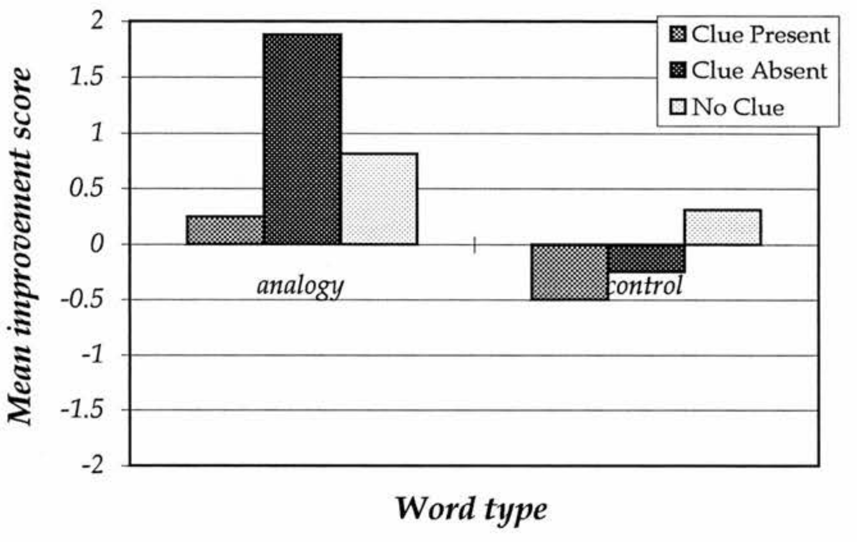

Figure 5.2 - *Mean improvement scores for each word type (Δanalogy, Δcontrol) by group*

A 2x3 (word type (Δanalogy, Δcontrol) x condition (clue present, clue absent, control)) repeated measures ANOVA was then carried out using the improvement scores, and this found no significant main effect of condition ($f(2,45) = 1.73$, $p=.189$) and no significant interaction of condition x word type, $f(2,45) = 1.40$, $p=.258$. There was a significant main effect of word type, however ($f(1,45) = 6.93$, $p<.01$), indicating that on average analogy words improved significantly more than control words. This result confirms those from the first ANOVA, and suggests that the pre-training differences between analogy and control words had not affected the pattern of performance across time.

The analyses show, then, that there were no significant differences in performance between the three groups of subjects. On average analogy words were easier to read than control words, and only the analogy words showed improved performance during the final stage of the experiment. Importantly, the presence or absence of training and presence or absence of a 'clue word' at stage 3, did not have a significant impact on the performance of the children in the task.

Since the children had been classified as having good or poor alphabet knowledge at the start of primary 1 (see methods section), this variable provided a good way in which to test how the children's early awareness of letters and their sounds affected their ability to read analogy-based words, or be trained to use analogies at the start of primary 3. Two ANOVAs (condition x word type x time) were carried out then, once for 'low-alphabet knowledge' children and then for 'high alphabet knowledge' children.

low alphabet knowledge group

The 24 low alphabet knowledge children were randomly spread between the experimental groups, with 6 children in the clue present condition and 9 children each in the clue absent and control conditions. Mean scores for the children are shown in figure 5.3a. The only significant result of the ANOVA was the main effect of word type, $f(1,21) = 5.00$, $p<.05$, again showing superior overall performance for analogy rather than control words. All other effects and interactions were non-significant: main effect of condition, $f(2,21) = 2.52$, $p=.104$; main effect of time, $f(1,21) = 3.24$, $p=.086$; condition x word type, $f(2,21) = 0.45$, $p=.644$; condition x time, $f(2,21) = 0.58$, $p=.566$; word type x time, $f(1,21) = 1.05$, $p=.317$; condition x word type x time, $f(2,21) = 1.98$, $p=.163$. The pattern of results for children who started primary 1 with poor awareness of letters and letter sounds shows that there were no effects of condition or training in the task. Nor were there any significant improvements from the pre- to post-training stage for either type of word. The children did show the pattern found in earlier analyses, though, of generally reading analogy words more easily than control words.

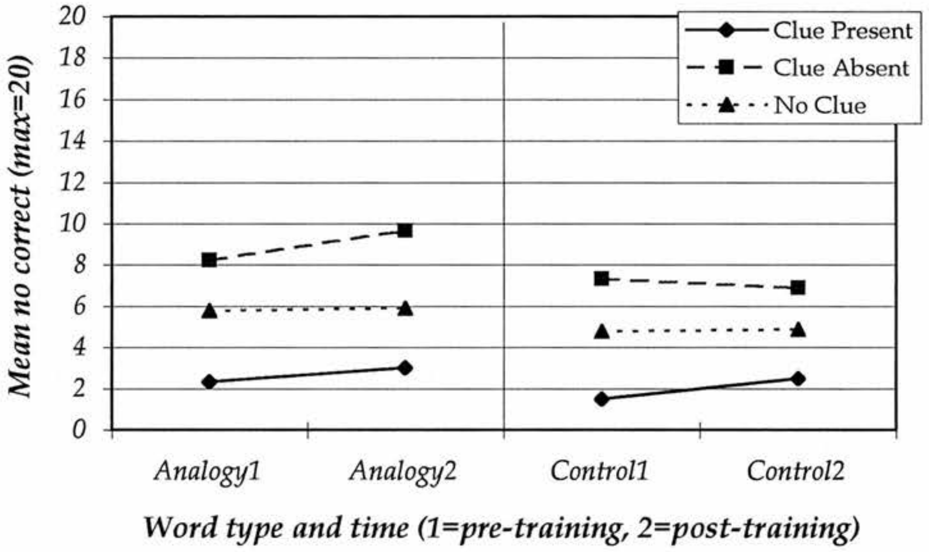

Figure 5.3a *- Mean number of words read correctly for each word type at time 1 (pre-training) and time 2 (post-training) by condition - low alphabet knowledge group*

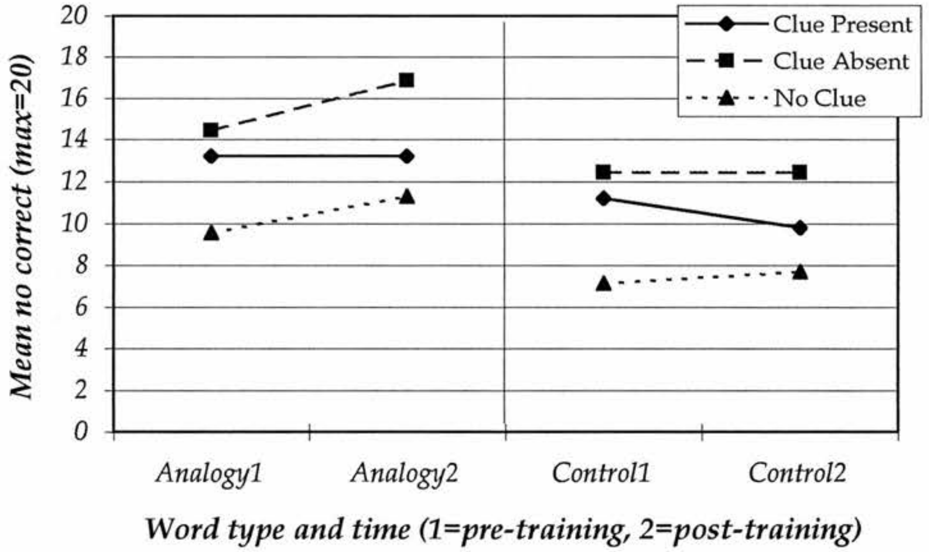

Figure 5.3b *- Mean number of words read correctly for each word type at time 1 (pre-training) and time 2 (post-training) by condition - high alphabet knowledge group*

high alphabet knowledge group

Of the 24 'high alphabet knowledge' children in the sample, 10 were in the clue present groups and there were 7 each in the clue absent and control conditions. Mean scores for the groups can be seen in figure 5.3b. The ANOVA for this group once again showed no main effects of condition ($f(2,21) = 1.83$, $p=.186$) or time ($f(1,21) = 3.09$, $p=.093$), but did show a significant effect of word type such that analogy words were read more accurately than control words on average ($f(1,21) = 24.93$, $p<.001$). Again there was no interaction of condition x word type ($f(2,21) = 0.07$, $p=.934$) nor of condition x word type x time ($f(2,21) = 0.28$, $p=.761$) showing that the training had not had a significant impact on the children's preference for one type of word rather than the other. The remaining interactions were significant, however: condition x time, $f(2,21) = 4.47$, $p<.05$; word type x time, $f(1,21) = 5.32$, $p<.05$. These were investigated using post-hoc tests (Newman-Keuls). It was revealed that the condition x time interaction was due to the fact that while the clue absent and control groups read significantly more words on average at post-training than pre-training, the clue present group showed no significant improvement across time. The second interaction (word type x time) was shown to be due to a significant improvement for analogy words across time for the sample as a whole, whereas there was no significant improvement for control words.

Thus, for the children who started out at school with good letter knowledge, training with 'clue words' did not produce any significant improvements - indeed the clue present group did not show any significant improvement at all. For the group as a whole, the mean number of analogy words read correctly improved from pre- to post-training while the scores for control words did not.

Discussion

What the analyses have shown is firstly that the analogy words were easier for the children to read even at the pre-training stage. Secondly, it was only performance on analogy words which increased significantly at the post-training phase. Thirdly, and most importantly, these results were true regardless of condition, and therefore were not due to training with clue words, or to the presence of a clue word to aid analogy use. The second ANOVA, which looked at the *change* in score from pre- to post-training rather than actual accuracy confirmed the initial findings that the improvement in accuracy was greatest for analogy words, irrespective of treatment group. Comparing the performance of children who started school with high or low levels of letter knowledge revealed that the 'low alphabet knowledge' group did not show significant improvements for either type of word in any group. The 'high alphabet knowledge' children, on the other hand did show improvement for analogy words, but this was not a result of training since the clue present group was the only one to show no significant improvement across time.

The finding that the children found analogy words easier to read than control words at pre-training might be taken as evidence that the children were already using analogy strategies in their reading. Although the two types of word were matched on their Kucera-Francis frequency, it may be that some other characteristics of the words, such as their frequency in the children's reading books, has made the analogy words easier to read. It may be, for instance, that these analogy words contain orthographic structures which are more frequent in the language, making them easier to identify. It has been shown that the frequency of rime segments and size of their orthographic neighbourhood can influence the ease with which words are read (Treiman, Goswami and Bruck, 1990; Leslie and Calhoon, 1995). It is interesting that a similar pre-test advantage has also been found in other analogy task studies (Goswami, 1988a; Muter et al, 1994; Savage and Stuart, 1998). This might be overcome by constructing the stimuli more carefully, and by asking trial samples of children to read the lists in order to balance the ease of reading both word types.

The main finding in the present study was the lack of any training effects. Indeed for the 'high alphabet knowledge' children, who showed more increase from pre- to post-training, the clue present group showed no significant improvement for analogy *or* control words. According to Goswami, children in this condition ought to have shown the greatest improvement since they had the advantage of being able to *see* the clue word which could help them. For the sample as a whole analogy words did show an increase in accuracy, however once again this was true for all three experimental groups, even for the children who received no clue-word training at all. Although this result alone may indicate that the children were employing analogy strategies spontaneously, it should be borne in mind that there are other factors which may have enhanced this effect. One such factor is increased familiarity from simply seeing the words for a second time. If the children are able to use analogies of any kind using experience with print there should be a particular advantage for analogy words, whose rime segments were repeated four times in each list. It might be expected, however, that familiarity should have some impact on the ease of reading control words too, though perhaps the larger variety of orthographic sequences in these words would not permit facilitation on any significant scale. Another possible explanation for improvements in analogy but not control word reading is the way in which the post-training lists are constructed. Although control and analogy words are mixed within each list, there are very few items (only 8). In practice this means that analogy words often appeared together in the lists, drawing the children's attention to the shared rime segment. Evidence for this facilitation was found in the responses of several children who would read the whole list (or a large part of it) as though the words all shared a rime (see figure 5.4 for examples). A side-effect of this focus on rhyming is that the control words (which do not rhyme) will be read incorrectly. This possibility is also pointed out by Savage and Stuart (1998), who

Example 1		*Example 2*		*Example 3*	
Word List	*Responses*	*Word List*	*Responses*	*Word List*	*Responses*
rink	ring	grand	grand	cold	cold
sing	sting	bald	band	bolt	bold
gain	ging	sand	sand	gold	gold
sign	rink	hand	hand	hold	hold
rang	ring	band	band	toad	told
wing	wing	lend	land	doll	doll
ping	ping	lean	lean	sold	sold
king	king	nail	nail	lost	lost

Figure 5.4 - *Examples of subject's responses to post-training lists, showing generalisation of rime units. This enhances scores for 'analogy' words, but hinders reading of 'control' words.*

felt that the high ratio of 'rime' to 'non-rime' words in Muter's lists may have led to overemphasis of the units. In their study, Savage and Stuart found no advantage for rime units when using lists which employed a much lower ratio of 'rime' to 'non-rime' words. It is possible that both of these factors contributed to the analogy improvement effect.

Another important finding was the demonstration that very early letter knowledge made a significant impact on whether the children were able to use the familiarity of the analogy words in order to increase accuracy in reading them. This finding confirms the results of the many studies reviewed in the introduction which showed that analogy use depended upon existing grapheme-phoneme awareness skills (e.g., Ehri and Robbins, 1992; Bruck and Treiman, 1992; Peterson and Haines, 1992; Nicholas, Kay and Mitchell, unpubd; Walton, 1995; Muter, Snowling and Taylor, 1994). What is perhaps most remarkable is that letter knowledge at the very start of schooling (*two years* prior to this experiment) should have such a marked influence on reading development at primary 3. [See also chapter 3]

The lack of a training effect in the present study does not replicate the results of Muter et al (1994) or the other studies who did find such an effect (e.g., Goswami, 1986, 1988a; Nicholas, Kay and Mitchell, unpubd). It might be that the children had not been trained for long enough, since very little training was given in the present study. Muter et al *did* find a training effect using a similar procedure, however, so this is unlikely to be the main reason that the training was not effective here. One important difference between the present sample and those in earlier studies, though, is that these children were 7.1 years old and just beginning their third year at school. This is older than the samples involved in most other studies, and it may be that these children have spontaneously begun to make use of orthographic experience in order to use analogy strategies. Muter and her colleagues (Muter, 1994; Muter, Snowling and Taylor, 1994) have actually proposed that it is at about this time that children will begin using analogy strategies spontaneously, and the present results may show some evidence for this, in particular for the high alphabet knowledge group.

The results of the present study do not accord with the conclusions and predictions of Goswami, who places a strong emphasis on the ability of very young children to use clue words in order to read new words and also upon the importance of *training* children in a way which emphasises use of rime-based analogies. Goswami's (1986) study suggested that even very young children were able to be trained to use clue words. However, a closer look at the data in the paper shows that the improvements made by the children were extremely small - mostly an increase of just one word on average for the children who could read - and for the non-readers the mean score for rime target words (which was the highest mean) is 0.89 out of a maximum possible score of 12 correct. A quick calculation reveals that Σx (the sum of all scores) for this condition is a very small 16 out of a possible total of 216. Goswami's 1988a paper also suggests that young children are able to use analogies, though it does find importance for the beginnings as well as the rimes of words. The data from this study seem more convincing than in the 1986 paper in showing an improvement in analogy use in response to training, however the results still fail to demonstrate that the children are using such a strategy spontaneously (i.e., without training) as Goswami argues.

The weight of evidence from other researchers such as those discussed in the introduction, suggests that analogies are not used by children until they possess some grapheme-phoneme skills and experience with orthography through reading and spelling.

It would be interesting to repeat the experiment with pre-training word lists which had been more carefully constructed in order to minimise differences, and using post-training lists with lower proportions of rime words. Using a similar age group to the present sample would also help to investigate whether the present results are in fact evidence that by this stage in learning to read children are beginning to use analogy strategies spontaneously. Another important aim would be to investigate analogies based on structures other than just the rime to investigate whether rime-based analogies really do have a special status. It is interesting to note that in Goswami's 1988a paper (expt 3) children of a similar age to the present sample showed spontaneous use of analogies based upon the *beginning* of words when reading prose, but not based upon rimes (for children who did not receive training with a clue word, beginning-based analogies improved significantly, but rime-based analogies did not.) Other studies, too, have indicated that analogies are not necessarily limited to being based upon rime units (e.g., Savage and Stuart, 1998; Nicholas, Kay and Mitchell, unpubd; Goswami, 1988a; Bruck and Treiman, 1992).

In summary, then, the present study agreed with the results of most of the studies reviewed above in demonstrating that the ability to make orthographic analogies depends upon early grapheme-phoneme awareness. No effects were found of training the children with clue words, though 'analogy' word reading improved significantly for all three groups. The pattern suggests the possibility that by the beginning of primary 3, children have begun to use orthographic analogies without having been specifically taught how to do so. Although Goswami (1993, 1994) has strongly advocated that children be *trained* to use rime-based analogies from the very start of schooling, the present results and a great deal of other research suggests that: a) analogies tend to be used only once the child has been at school for 2 - 3 years (e.g., Bruck and Treiman, 1992; Nicholas, Kay and Mitchell, unpubd; Muter, Snowling and Taylor, 1994; Muter, 1994); b) when analogies *are* used, they are not necessarily based upon rime units (e.g., Nicholas, Kay and Mitchell, unpubd; Goswami, 1988a; Bruck and Treiman, 1992; Savage and Stuart, 1998); and c) analogy use depends upon good grapheme-phoneme skills and phonological awareness (e.g., Peterson and Haines, 1992; Walton, 1995; Ehri and Robbins, 1992). Given these findings, it would seem more sensible to train children in letter-sound correspondences (i.e., phonics) and to build up their reading vocabularies, so that they are equipped to evolve an orthographic analogy strategy for reading unfamiliar words once their development reaches a level at which they can use such strategies spontaneously.

Chapter 6

Small and Large Units in Beginning Reading: Effects of Instructional Technique

Introduction

In chapter 1, the difference between 'small-unit' and 'large-unit' theories of reading acquisition were highlighted. Small unit theorists argue that phonemic awareness or letter knowledge is vital in the first few years of learning to read, and point to evidence of links between early phonemic awareness and subsequent reading skill (e.g., Byrne and Fielding-Barnsley, 1989; Stuart and Coltheart, 1988; Stanovich, Cunningham and Cramer, 1984; Rack, Hulme, Snowling and Wightman, 1994; Share, Jorm, MacLean and Matthews, 1984; Johnston, Anderson and Holligan, 1996). The relationship between these skills is commonly seen as a reciprocal one, with phonemic skills assisting reading as well as vice versa (e.g., Perfetti, Beck, Bell and Hughes, 1987; Morais, 1991; Bryant and Goswami, 1987). Rime awareness is seen to be of importance only at more advanced stages of reading development (perhaps after 2-3 years), and its use for analogy strategies appears to depend upon good grapheme-phoneme skills (e.g., Muter, 1994; Cataldo and Ellis, 1990; Ehri and

[1]Goswami has recently amended her viewpoint in support of late-rime use, as proposed by (for example) Muter (1994) and Bruck and Treiman (1992).

Robbins, 1992; Bruck and Treiman, 1992; Seymour, 1990, 1993, 1997, 1999; Duncan et al, 1997, in press).

At the opposite side of the debate are those who argue that phonemic skills are not available to beginning readers, and that instead it is awareness of onset and rime segments which children naturally use in their reading and phonological awareness (e.g., Goswami and Bryant, 1990; MacLean, Bryant and Bradley, 1987; Goswami, 1993, 1994; Goswami and Mead, 1992). In support of this viewpoint, large-unit theorists point to studies which appear to suggest a link between pre-school rhyme skills and subsequent reading achievement (e.g., Bradley and Bryant, 1983; Lundberg, Olofsson and Wall, 1980). It has also been argued that rime-based analogies are available from the very first stages of learning to read (Goswami and Bryant, 1990; Goswami, 1993, 1994).[1]

In order to test these viewpoints, Duncan, Seymour and Hill (1997) carried out a set of experiments designed to investigate the level (phoneme or onset/rime) at which young children's reading and phonological awareness is focused. The results indicate a clear preference for attending to the phonemic level of the word, as would be predicted by small-unit theories. A follow-up paper (Duncan et al, in press) involved the same sample of children in their second year at school. Results on the common unit task at this point indicated that the children's ability to detect rime units had begun to improve, but that their superior performance with small units remained. A third study, involving a new sample of primary 1 children from a similar instructional background, also found a preference for small units in the common unit task (Seymour, Duncan and Bolik, 1999).

However, as is pointed out by Duncan, Seymour and Hill (1997) these results may be interpreted "as a direct consequence of the teaching emphasis on the letters of the alphabet" which their subjects had received. The authors also propose that alternative teaching regimes emphasising units larger than the phoneme (e.g. syllables or rimes) might be expected to produce results more in keeping with large-unit theories (Duncan et al, 1997, p199; also Duncan et al, in press).

A small number of research papers have addressed the comparison of how children learn to read when they have received the input of phonics teaching (as in Scotland) as opposed to patterns of reading development in children in New Zealand who are taught by a whole-word approach, with no explicit training in letter-sound correspondences. The results of such studies have revealed some slight differences in the way in which the children approach tasks of reading and phonological awareness. Johnston and Thompson (1989) compared 8 year old readers in Scotland and New Zealand, and found that performance on a lexical decision task was affected by the instructional backgrounds of the samples. Whilst the New Zealand (non-phonics) sample were equally efficient in detecting nonsense words as they were at detecting pseudohomophones (e.g., ***blud***), the Scottish (phonics) group were poorer at detecting the latter type of nonword, presumably due to their use of a 'sounding out' strategy. Interestingly, when the nonsense words and pseudohomophones were presented within text (e.g., ***There was blud on the floor.***) both groups of children were poorer at correctly rejecting the pseudohomophones. This indicates that once the New Zealand children were reading text, they too had adopted a strategy which involved some phonological recoding (see also Thompson and Johnston, 1993).

Another comparative study by Connelly, Johnston and Thompson (unpubd), however, compared further the text-reading performance of 6 year old children from Scotland and New Zealand who had been carefully matched for word reading accuracy. This study showed that the New Zealand children did not employ phonological recoding as a reading strategy to the same extent as the Scottish children did. Also, although the Scottish children's strategy meant that they took longer to read the test passages, their comprehension of the text was better the that of the non-phonics children.

Thompson and Johnston (unpubd) compared the phonological awareness and nonword reading ability of children from Scotland and New Zealand. They found that on a task of phoneme deletion both groups of children performed equally well. On nonword reading, however, the non-phonics taught New Zealand children were not as successful as the Scottish, phonics-taught sample.

Present Study

The present study aims to replicate and extend the findings of Duncan et al (1997). Once again a sample of children were drawn from primary schools in Dundee. Like the sample studied by Duncan et al, these children received a 'mixed' approach to reading instruction; that is, a sight word vocabulary was developed alongside instruction in grapheme-phoneme correspondences and the way in which letters combine to form words. No training in sounding and blending had been given at this stage. A second sample of children were drawn from two schools in Fife, Scotland. These children had received a period of intensive training in phonics, emphasising awareness of sounding and blending, and the way in which words are composed of phonemes (Johnston and Watson, 1997). The third group of subjects was taken from two schools in

New Zealand where children are taught to read using a whole-word approach, without training in grapheme-phoneme rules.

Thus a comparison can be made between the three groups, each with a different background of reading instruction: 'mixed' instruction with some phonics, 'mixed' instruction with intensive phonics and whole word teaching without phonics. By comparing these groups we can test how the predictions of large and small unit theories hold up under different regimes, and whether in fact the focus of awareness is influenced by the type of instructional backgrounds which the children have experienced, as suggested by Duncan et al (1997, in press).

The different theories make quite distinct predictions about the patterns of results which would be expected for the various tasks. These will now be outlined for each of the Duncan et al tasks, and for the group of additional phonological awareness tasks which were administered.

Nonword Naming

This task aims to determine whether the children use small (phonemic) or large (body/rime) units in order to read novel words. The small-unit theories would predict that all of the children will decode the nonwords at the phonemic level which would lead to equal performance for the different conditions. The large-unit theories, on the other hand, would predict that the presence of familiar rime units in the body/rime and onset/rime conditions will lead to enhanced performance since these nonwords could be read by analogy. Neither of these viewpoints would predict group differences.

If, however, the results may be influenced by instructional technique as suggested by Duncan et al (1997) then it would be expected that the New

Zealand children might have poorer phonemic analysis ability, and thus that these children will be poor at reading nonwords in comparison with the Scottish children.

Orthographic Unit Identification

In this task, the children's ability to detect the various subsyllabic structures orthographically is investigated. Once again, neither small- nor large-unit theories would predict significant group differences in performance for this task. If the children's development naturally leads to awareness of the phonemic level of words as argued by small-unit theorists, then it would be expected that these units will be detected more readily than larger units such as bodies and rimes. Large-unit theories would predict superior detection for rime units in particular, with onsets also being relatively easy to detect. Other small units and bodies would not be expected to be detected well according to such theories. Instructional influences, if present, would once again predict poorer overall performance from the New Zealand children. However, the children's previous experience with the words in their written form, along with spelling experience, might lead to this group difference being less pronounced than in the phonological common unit task.

Phonological Common Unit Identification Task

The phonological common unit identification task is designed to examine the children's phonological awareness for different levels of the subsyllabic structure. For part A of this task, the predictions of the small-unit and large-unit theories would be similar to those for the orthographic common unit identification task, i.e., that the children should show superior detection for phonemes or for rimes and onsets respectively.

For part B, small-unit theories would predict a significant effect of complexity manipulation, with simple units (i.e., phonemes) easier to detect than complex ones. Large-unit theories would predict no effect of complexity in part B. An instructional effect may still lead to the New Zealand group performing less accurately than the Scottish children for all units. Further, the New Zealand children would be less likely to show an effect of complexity manipulation for onsets and codas, since their awareness is not expected to focus at a phonemic level.

Other Phonological Awareness Tasks

As for the Duncan et al tasks, these competing accounts of reading development make distinct predictions about performance on the four other phonological awareness tasks administered to the groups.

Two of these tasks, odd word out and rhyme generation, do not require the child to explicitly isolate or produce phonemes. For the odd word out task, large-unit theories would predict best performance for the onset experiment and rime experiment conditions, since these require detection of onset and rime units. Small unit theories would also predict that the onset experiment condition will be straightforward, but not the rime experiment condition. The rhyme generation task should be relatively simple according to large-unit theories, but not especially so according to small-unit accounts. Instructional differences would not be expected to produce significant group effects for either of these tasks, since neither of them require explicit phonemic analysis.

The second two phonological awareness tasks do require explicit phonemic analysis of words; these are the phoneme deletion and phoneme segmentation tasks. According to large unit accounts, these should be difficult for all the children to do, since it is argued that such awareness is not yet fully available to the children, while small unit theories would predict that all children would be able to perform reasonably well. Instructionally based accounts would predict a significant advantage for the Scottish children in these tasks, since their reading programs have equipped them with the phonemic awareness necessary to perform well.

A summary of the predictions for each task can be seen in figure 6.1.

	Small-unit Theories	*Large-unit Theories*	*Instructionally-based Theories*
Nonword Naming	All conditions equal; no group differences	Onset/rime and body/rime best; no group differences	New Zealand poorer than Scottish children
Orthogr. Unit i.d.	small units easier than large for all groups	onsets and rimes easiest for all groups	NZ < Scottish, but difference less than for Phon. i.d. task
Phon. Common Unit i.d.	small units easier than large for all groups; simple > complex	onsets and rimes easiest for all groups; no complexity effect	NZ < Scottish; NZ less likely to show complexity effect for onsets and codas
Rhyme Generation	able to perform, though not expert	good performance	No group differences
Odd Word Out	onset experiment and rime control easiest	onset experiment and rime experiment easiest	No group differences
Phon. Deletion	reasonably good performance	difficult task for all children	Scottish children better than New Zealand group
Phon. Segmentation	reasonably good performance	difficult task for all children	Scottish children better than New Zealand group

Figure 6.1 - summary of predictions from the 3 types of theory for each of the tasks used.

Methods

Subjects

For this study, data was collected from samples in Fife and New Zealand who were matched closely to a subsample of the Dundee children on reading age and chronological age. The Fife sample consisted of 25 children drawn from Primary 2 classes at two schools, who had received a period of intensive phonics training as part of another study (Johnston and Watson, 1997). This training involved accelerated training in letter-sound names, and in blending words together using plastic letters in order to emphasise the way in which phonemes join together to form words. This is a form of *synthetic* phonics. A further group of 25 children were drawn from a sample of 44 children from two schools in New Zealand. In New Zealand children begin school on their 5th birthday, and so the children had been at school for approximately one-and-a-half years. These children had received no training in phonics or letter sounds, but had been taught instead by a 'whole word' instructional technique which focuses on use of context in order to identify words. They were, however, taught letter names and did receive some teaching in letter sounds as part of spelling instruction. As mentioned above, the Dundee children had received a 'mixed' literacy instruction program in which children learned whole words, but also received teaching in letter-sound correspondences. When tested, the children had not begun training in sounding and blending words. All three samples drew children from mixed social backgrounds.

Children were matched to the Fife sample on both chronological age (population mean = 6y 6mth, SD=.220y) and reading age (population mean =

6y 7mth, SD=1.206y). These matches were confirmed using simple one-way ANOVAs: chronological age x group, $f(2,72) = 1.937, p=.152$; reading age x group, $f(2,72) = .660, p=.520$.

Materials and Procedure

Reading age was measured using the British Abilities Scales word reading test. The four tasks of Duncan et al (1997) were adapted for use with the present samples. These were: scheme word reading; nonword naming; orthographic unit identification; and phonological common unit identification (parts A and B). In addition the children were tested on their knowledge of letter sounds and names, and completed four phonological awareness tasks: odd word out, rhyme generation, phoneme deletion and phoneme segmentation.

British Ability Scales - Word Reading (Elliot et al, 1983)

Reading ability was measured using the British Ability Scales Word Reading Test. In the task, the child was given a sheet, on which were 90 words progressing in difficulty. The child was then asked to read the words one at a time, and was encouraged to attempt to guess the identity of unfamiliar words. No corrective feedback was given during the test, and no examples preceded the test stimuli. Testing continued until the child made errors on 10 successive words. Responses were scored 1 point if correct, and the total raw scores were then converted into age-standardised scores and reading ages for each child.

***British Picture Vocabulary Scale* (Dunn & Dunn, 1982)**

The British Picture Vocabulary Scale (BPVS) was used in order to test the verbal I.Q. of the subjects. The materials consist of a book with four pictures on each page. The experimenter would say a word, *e.g.*, ***wooden***, and the child was then asked to choose which of the four pictures corresponded with this word, and to point to it. Four example trials were given, and then each child was tested until a ceiling level was reached. One point was awarded for each correct answer, and these scores were then transformed into age-standardised I.Q. scores with population mean of 100.

Alphabet Knowledge Task

A measure was taken of the ability of the children to give the names and sounds of the letters of the alphabet. In the test, all 26 letters of the alphabet appeared individually on the screen of a laptop computer. During the first time through the task, the children were required to provide the *sounds* of the letters, and this was clarified by the experimenter before commencing testing. If, on any occasion, the child supplied the letter's *name* rather than its sound, the response was noted, and the experimenter would say, *"Now that's the letter's name. Can you tell me its sound?"*. This gave the child an opportunity to supply the correct answer. Once all letters had been presented, the whole procedure was repeated and the children asked to give the letters' *names* rather than their sounds.

The number of names and sounds given correctly was calculated, with scores awarded even if the correct answer was given only in the wrong condition (*i.e.*, when the correct sound of a letter was only given during the *names* condition, or vice versa). The children were also given composite alphabet knowledge scores, reflecting the number of letters for which they were able to give the correct name *and/or* sound.

Nonword Reading Task

This task was based on that used by Duncan et al (1997). Forty nonsense words were constructed using words drawn from the children's reading schemes. Thus, the Dundee schools each had their own set of nonsense words, whilst the Fife and New Zealand samples shared a third set of stimuli constructed using words from the Thompson 'Beginning Reading Vocabulary - first 150 words' list (this is a list of very common words, used as a guide by New Zealand teachers). Unlike the original study, the numbers of nonsense words in the present test was kept constant across conditions and schools[2]. There were 4 conditions, each with nonsense words built up from different word-units. There were 10 words in each of the 4 conditions, which were presented in the following order:

1) *body/rime* For this condition the reading words used were required to share their vowel sounds, *e.g.*, ***nop*** = *not* + *stop;*
2) *onset + rime* *e.g.*, **mot** = *mum* + *not;*
3) *body + coda* *e.g.*, ***rus*** = *run* + *yes;*
4) *onset + peak + coda* *e.g.*, **lem** = *look* + *help* + *mum*.

All four conditions were carried out in a single testing session. Each word was printed in 40 point Arial font onto one side of an index card. Picture

[2]However, for analysis one word had to be discarded from each condition in the Fife/New Zealand list because the stimuli 'cet' and 'loon' had both appeared in 2 conditions. This gave maximum totals of 9 for each condition for these children.

cards from the children's game of snap were attached to the reverse sides of the cards, so that each condition had 5 'pairs' on their cards. For each condition, the 10 cards were spread out on the floor in front of the child with the nonwords uppermost. It was explained that they were to try to read the 'funny words', and then once they had read a word they could turn the card over so they could play the game on the other side. The children were allowed to choose the words in any order they wished, and no corrective feedback was given. Once all 10 words had been read, and all the pairs of pictures matched, the cards were gathered up and the next set of cards spread out. Responses were scored correct if they were legal pronunciations of the nonwords, which meant that there was more than one correct answer for most stimuli, *e.g.*, ***mos***, could be correctly pronounced with a long or short vowel, and the 's' could be hard or soft: *i.e.*, /mos/, /moz/, /mɑs/, or /mɑz/. One point was awarded for each correct response, and totals calculated for each condition.

Orthographic Unit Identification Task

Once again this task was based on that used by Duncan et al (1997). The task is designed to test the children's knowledge of orthography, and to investigate which segments of words are most easily identified. The reading program words used to devise the stimuli for the nonword reading and phonological common unit identification tasks were used as stimuli for this task. The two Dundee schools each had their own set of words, and the Fife and New Zealand children had a third set based upon words from the Thompson 'Beginning Reading Vocabulary - first 150 words' list. For the New Zealand children, it was felt that the rimes of the words 'yes' (es) and 'car' (ar) might be confusable with the letter names of their codas (i.e., *s* and *r*), and so 2 extra words (*red* and *dog*) were added to the lists in case this were true. In the event, the New Zealand children had no problems in distinguishing the rimes of 'yes' and 'car' from their codas, and so responses to 'red' and 'dog' were discounted from the analyses.

Five lists of the 10 words (12 for the New Zealand sample) were generated, with the words randomly ordered in each. The first 2 words in each list were test items, and so were not scored. The 5 main subunits of the syllable were tested for each word, *i.e.*, onset, body, peak, rime and coda, with 2 of each type tested in every list. In this way, each unit had been tested for every word by the time all 5 lists were completed.

During the task, the child was given a pencil, and instructed that they were to draw a circle round the parts of the words the experimenter said. The list items were covered with a piece of paper, and revealed one at a time. The first word would be revealed, and read by the experimenter, who would then say, *e.g.*, (given the word ***yes***) *"Now can you draw a circle around the bit that says* ***/s/****?"*. On the practice items, corrective feedback was given, and if the child had made an error the experimenter would use the pencil to demonstrate the correct response. After this, no assistance was given. If it was not clear which letters had been circled, the experimenter asked the child which letters they had meant to choose.

One point was awarded for each correct response, giving a total of 10 maximum points for each of the 5 word units involved.

Phonological Common Unit Identification Task

This task again followed the example of that used by Duncan et al (1997), and tested the children's ability to detect shared phonological units in spoken word-pairs. The task is divided into two parts, and these will be described individually.

At the beginning of the first condition, the children were introduced to a toy rabbit which they could choose a name for. It was explained that the rabbit liked to *"say the bits of words which sound the same"* but that it needed the child to help it. The child then 'helped' the rabbit to play both parts of the phonological common unit identification task.

Part A

In part A, there were 5 conditions, each containing 3 practice, and 10 experimental trials. The 5 conditions were each carried out during a separate testing session, and were concerned with the following different units:

1) common onset, *e.g.* ***got game***;
2) common body, *e.g.* ***food full***;
3) common rime, *e.g.* ***got pot***;
4) common peak, *e.g.* ***jam had***;
5) common coda, *e.g.* ***put cat***.

Ten simple 3-phoneme words taken from reading scheme books which the children had read, were used as the first words in each pair. Because the schools in the study used different reading schemes, different sets of stimuli were created using the words used to form the Nonword Reading Task (see above). The 2 Dundee schools each had their own set of stimuli created from words in their own reading schemes, whilst the Fife and New Zealand groups both received a set of stimuli created using words from the Thompson 'Beginning Reading Vocabulary - first 150 words' list (this is a list of very common words, used as a guide by New Zealand teachers). Pronunciation differences led to one word-pair from the common body condition being changed for the New Zealand sample.

In the Duncan et al study, the words used for the second halves of the word-pairs were taken from *spoken* vocabularies of children of the appropriate age. This information was not available when the Dundee stimuli were created, and so a book of children's written vocabularies was used instead (Edwards and Gibbon, 1964)[3]. In doing this, an assumption was made that children use words from their spoken vocabularies when writing, which would make the stimuli comparable to those in the original study of Duncan et al. The list of spoken vocabulary was available when the stimuli for the Fife and New Zealand samples were constructed (Wepman and Hass, 1969).

At the beginning of each condition, the children were informed about which part of the words was important, and 3 practice items were administered with corrective feedback. The 10 experimental trials were then given, with no corrective feedback. During the task, the experimenter would say two words, *e.g.* ***pen pig***, and the child was asked what the rabbit would say; for example, in this instance the correct response would be ***/p/***.

Part B

In the second part of the phonological common unit identification task, the *complexity* of the shared units in the word pairs was manipulated as well as their position. Because of this, the peak could not be tested. The four conditions, presented over different sessions were:

[3] With the exception of 6 word-pairs for whom no suitable word could be found in the written vocabularies. Instead, simple words were chosen which were judged to be familiar to young children.

1) common onset, *e.g.*, ***dog down; green grow***;
2) common body, *e.g.*, ***mat man; cloth clock***;
3) common rime, *e.g.*, ***ball fall; paste waste***;
4) common coda, *e.g.*, ***him name; just last***.

The stimuli for the word pairs were this time drawn completely from written vocabulary lists for children of the appropriate age[4] for the Dundee children, and completely from spoken vocabularies for the Fife and New Zealand children. The Dundee schools both heard the same set of stimuli, whilst the Fife and New Zealand groups shared a different set. Pronunciation differences in New Zealand led to 4 word pairs being replaced for these children (1 complex coda pair, 1 simple body pair and 2 complex body pairs).

In each condition there were 8 items: 4 with 'simple' shared units; and 4 with 'complex' shared units. Four practice items were given at the start of each block, two of which were simple, and 2 of which were complex. In Duncan et al's study, the children were warned of the change from simple to complex units in each condition by extra practice items given at the point of change. Due to an oversight this clue was not given to the Dundee children, but was included in testing in Fife and New Zealand.

Testing procedure was the same as that for part A of the task, with the children 'helping' the rabbit to spot the shared units.

[4] In the original study of Duncan et al, words from *spoken* vocabularies were used to construct these stimuli. Once again, this resource was unavailable at the time the present stimuli were created.

<u>Scheme Word Reading</u>

As in the original study of Duncan et al, the children were tested on their ability to read the stimuli from which the nonword reading, phonological common unit and orthographic common unit tasks had been created (though due to lack of time this was not done with the Dundee sample). Although the lists differed very slightly, the maximum possible for both groups was 13. The children were shown the scheme words printed on a piece of card and simply asked to read through them. One point was awarded for each correct response.

<u>Rhyme Generation Task</u> (Johnston, Anderson & Holligan, 1996)

In order to test the children's awareness of rhymes and ability to generate rhyming words, the rhyme generation task devised by Johnston, Anderson and Holligan (1996) was employed. In this, the child was asked to give as many words as possible which 'sound like' or 'end the same way as' a stimulus word spoken by the experimenter. Three practice trials were given, in which the experimenter helped the child to think of rhyming words, and demonstrated what was required in the task. Twelve experimental stimuli were then given, and the children's correct responses noted. No corrective feedback was given, though rhyming words supplied by the children were used as a prompt. In order to equalise differences between extrovert children - who found it easy to give many answers - and introvert children - who were more reluctant to make responses - a maximum of 5 correctly rhyming responses for each stimulus word was employed.

Odd Word Out Task (Scott-Brown & Lee, unpubd)

The Oddity task employed in the present study was a slightly modified version of that devised by Scott-Brown and Lee (unpubd), following the original task of Bradley and Bryant (1983). At block 1, when the children carried out the task for the first time, testing was preceded by an introduction to the concept of 'odd one out' using flashcards with pictures on them. This continued for several minutes until the child seemed to understand the concept clearly. At all testing blocks, the children were asked to repeat groups of three words (there were 3 such word triplets), simply to practice repeating the words. This was followed by the task itself. The experimental stimuli were split into 4 blocks, each with 2 practice and 6 experimental trials. Testing blocks were based on those proposed by Kirtley, Bryant, MacLean and Bradley (1989) and Goswami and Bryant (1990), and were as follows:

a) *Onset Experiment* In this condition the distracter items shared a common initial phoneme (onset), which the target item did not, *e.g.*, ***peg pin car***.

b) *Onset Control* As the name suggests, this condition was designed as a control for the Onset Experiment condition. The distracter items shared their final phoneme (coda), but the target item did not, *e.g.*, ***lip mop week***. Thus, the items share the same number of phonemes as in the onset experiment condition (one), however this phoneme is no longer the onset and requires breaking up the rime unit in order to access it.

c) *Rime Experiment* In the Rime Experiment condition, the common unit shared by the distracter items was the rime, *e.g.*, ***hip lip week***.

d) *Rime Control* This condition may be considered a 'control' for the Rime Experiment condition because the distracter items shared the same number of phonemes as those in the Rime Experiment condition (two). Here, the distracter items shared their initial CV (body), which involves the onset, plus *part* of the rime, *e.g.*, ***peg pen car***.

Half of the children in any block of testing were randomly allocated to receive these 4 conditions in the order b, a, d, c, while the remainder of the children were tested in the order d, c, b, a. The experimenter would say 3 words, which the child was then asked to repeat. This ensured that errors did not occur due to the child mis-hearing the stimuli. The subject was then asked to choose *"Which word ends/starts differently?"* or *"Which word has a different sound at the start/end?"*. At the beginning of each condition, the experimenter would alert the child to which part of the word they should focus on by saying, *"Now it's the start/end of the word that's important"*. One point was awarded for each trial answered correctly, giving a maximum possible score of 6 for each condition (maximum total = 24).

Phoneme and Syllable Deletion Task

In this task children are asked to say how a word would sound if part of it were deleted. For example, a child might be asked to *"Say **pat** but don't say **/p/**"*, to which the correct response would be *"at"*. The original task of

Rosner (1975) was expanded to contain 10 trials each of: initial syllable deletion, *e.g.*, ***hedgehog* → *hog***; final syllable deletion, *e.g.*, ***birthday* → *birth***; initial phoneme deletion, *e.g.*, ***pat* → *at***; final phoneme deletion, *e.g.*, ***book* → *boo***; initial blend-splitting deletion, *e.g.*, ***drive* → *dive***; final blend-splitting deletion, *e.g.*, ***damp* → *dap***. Also, testing was not discontinued, so that every child received all 60 words. The original 13 items were presented together during one test session, and the extra items were presented in a separate session. The extra items were split into two lists, each containing roughly similar numbers of each type of deletion. The children were randomly allocated list 1 or list 2 first.

Testing was preceded by two practice items. The children were awarded a score of 1 for each deletion performed correctly, giving a maximum of 10 points for each type.

***Phoneme Segmentation Task** (Yopp, 1988)*

The Yopp-Singer test of phoneme segmentation ability was used in the present study. This consists of a list of 22 words, 10 of which contain 2 phonemes, with the remaining 12 words containing 3 phonemes. In the task, the children were asked to say, *e.g.*, *"all the sounds in **go**"*, and correct responses were in the form of segmented phonemes, *e.g.* *"/g/ - /o/"*. Three practice items were given first, followed by the 22 test items, which were split into two lists of 11 words. Subjects were randomly allocated so that half of the children received list 1 first, and the other half received list 2 first. The 2- and 3-phoneme words were randomly mixed through the lists.

Results

A table of chronological and reading ages along with means for the base knowledge tasks is given in figure 6.2.

Task	*Dundee*	*Fife*	*New Zealand*
Chronological age	6.41 (0.20)	6.50 (0.26)	6.53 (0.19)
Reading Age (BAS)	6.33 (0.43)	6.66 (1.50)	6.68 (1.40)
Letter sound knowledge	22.88 (2.29)	22.40 (4.22)	18.80 (4.90)
Letter name knowledge	18.72 (6.48)	14.04 (9.22)	24.28 (1.70)
BPVS standardised score	-	101.52 (18.95)	99.60 (13.52)

Figure 6.2 - mean scores for letter knowledge and British Picture Vocabulary Scale. Standard Deviations given in brackets.

Alphabet Knowledge

Letter sounds

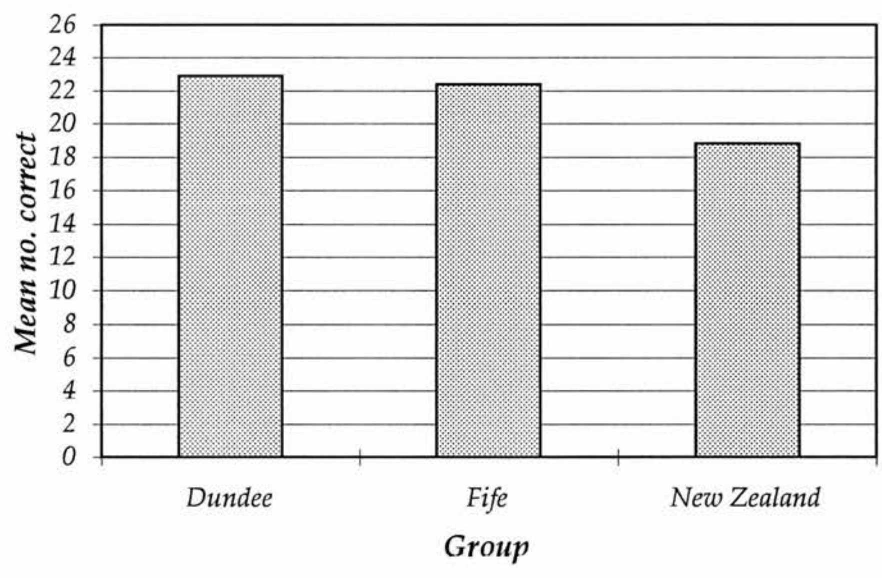

Figure 6.3 - Mean number of letter sounds correct (max = 26) for each group.

Knowledge of all 26 letter sounds was examined by group. A one-way ANOVA revealed a significant effect of group, *f(2,72) = 7.917, p<.001,* which was examined using a Newman-Keuls test. The results of this showed that the

Dundee and Fife groups had accurately identified the sounds of a similar number of letters, and that both knew significantly more sounds than the New Zealand group. This pattern was as expected since the two Scottish groups had received training in letter sounds, but the New Zealand children had not.

<u>Letter names</u>

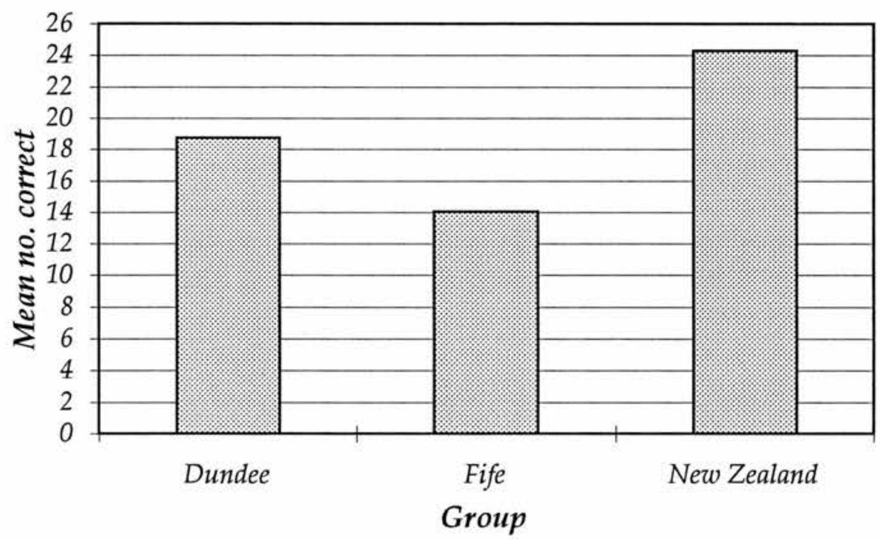

Figure 6.4 - Mean number of letter names correct (max = 26) for each group.

In a similar manner, knowledge of letter names was subjected to a one-way ANOVA with group as a between-subjects factor. The effect of group was significant, $f(2,72) = 15.185$, $p<.001$, and Newman-Keuls testing revealed that each group differed significantly from the others. The New Zealand children were able to supply the highest amount of names, followed by Dundee, and then Fife. The superior performance of the New Zealand sample was as expected since these children had received instruction on letter names, whereas the Scottish children had not. It is not entirely clear why the Dundee group's ability to provide letter names should be superior to that of the Fife group, however this may have been due to previous experience of the Dundee group on this task (such that they knew more clearly what was being asked of them), or even to slight differences in school policies on the point at which letter names are introduced to pupils.

British Picture Vocabulary Scale

The Fife and New Zealand children were tested on the British Picture Vocabulary Scales in order to check their vocabulary. Normed scores for this task were entered into a one-way analysis of variance with group as the between-subjects factor. No significant effect of group was found, $f(1,48) = .170$, $p=.682$, confirming again that the groups were well matched.

Duncan, Seymour and Hill (1997) Tasks

A table of mean scores for the Duncan et al tasks is given in Figure 6.5.

Task	*Dundee*	*Fife*	*New Zealand*
Reading Scheme Words	-	10.08 (4.43)	11.60 (2.12)
Nonwords: Onset/Rime %	60.40 (28.35)	50.22 (38.51)	35.56 (30.93)
Body/Coda %	58.40 (30.64)	50.67 (43.04)	41.33 (35.65)
Body/Rime %	58.40 (29.96)	68.00 (87.39)	40.89 (35.53)
Onset/Peak/Coda %	56.40 (28.85)	48.44 (39.01)	39.56 (32.25)
Orthographic Unit: Onset %	98.00 (4.68)	95.50 (11.34)	84.00 (22.10)
Peak %	91.50 (11.25)	93.50 (9.63)	80.00 (21.95)
Coda %	99.00 (5.00)	95.00 (13.50)	92.00 (21.31)
Body %	70.50 (24.71)	73.00 (35.48)	59.00 (32.98)
Rime %	73.00 (24.65)	72.00 (34.66)	74.50 (36.17)
Phon. Common unit A: Onset %	96.80 (5.57)	93.60 (11.14)	87.20 (21.89)
Peak %	73.20 (25.77)	74.40 (36.41)	68.80 (35.74)
Coda %	80.40 (26.53)	74.80 (35.25)	77.20 (27.47)
Body %	61.20 (31.66)	54.40 (44.35)	49.78 (40.72)
Rime %	30.80 (37.30)	44.80 (45.20)	51.60 (46.96)
Phon. Common unit B: simple onset %	93.00 (21.07)	89.00 (21.75)	75.00 (25.00)
complex onset %	41.00 (32.98)	49.00 (47.59)	71.00 (36.57)
simple coda %	65.00 (37.50)	74.00 (41.13)	77.00 (33.79)
complex coda %	1.00 (5.00)	25.00 (34.61)	15.00 (21.65)
simple rime %	57.00 (39.21)	43.00 (44.21)	57.00 (44.21)
complex rime %	38.00 (43.97)	41.00 (45.00)	56.00 (45.80)

Figure 6.5 - mean scores for Duncan et al tasks. Standard Deviations given in brackets.

Reading Scheme Words

A one-way ANOVA showed no significant difference between the two groups tested on their ability to read the scheme words used, $f(1,48) = 2.391$,

p=.129. Both samples performed well on the task, which was important, since the Duncan et al tasks depend on recognisable word units.

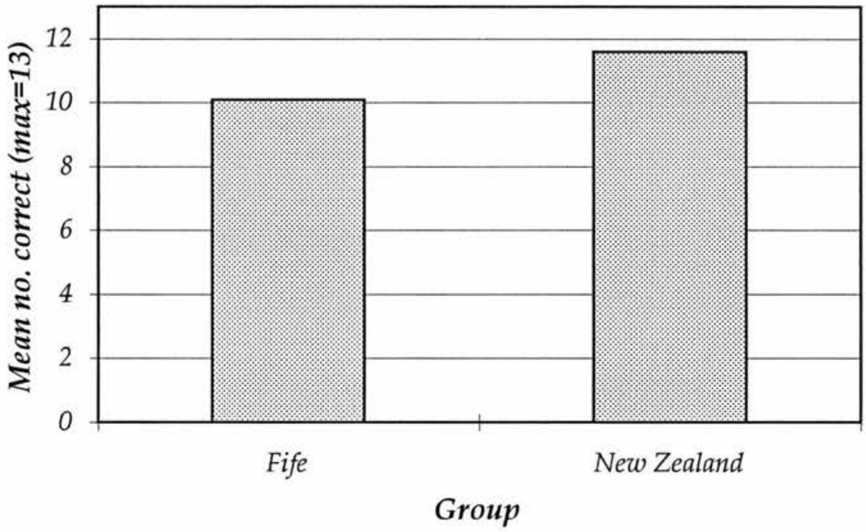

Figure 6.6 - Mean number of reading scheme words (from which stimuli were constructed) read correctly by group (max=13)

Nonword Naming

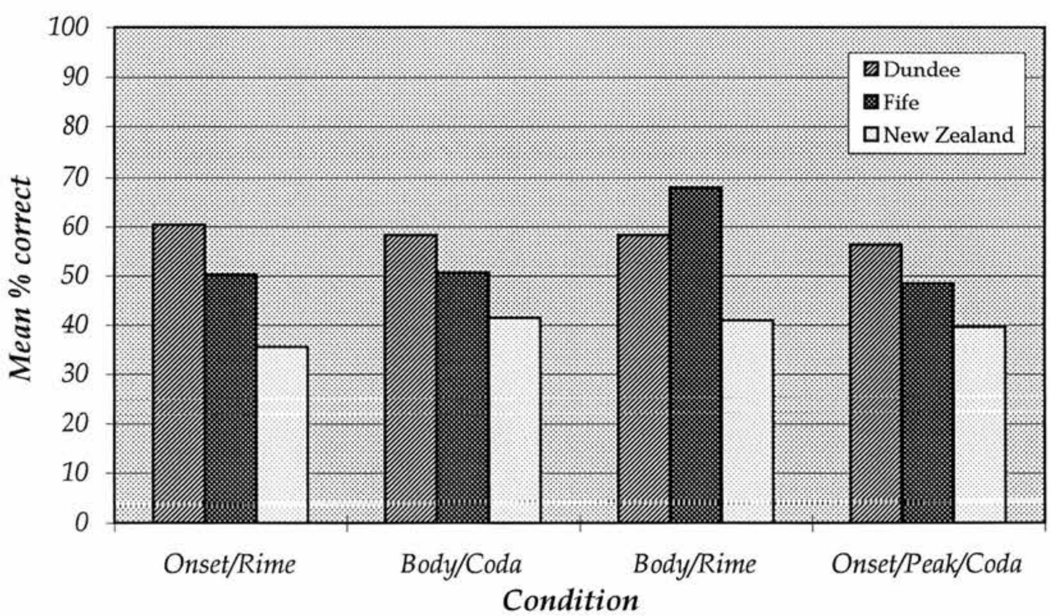

Figure 6.7 - Mean percentage of nonwords read correctly across groups.

Data for this task were transformed into percentages for each of the four conditions in order to control for the different number of stimuli between groups (10 per condition for Dundee, 9 per condition for Fife and New Zealand). A 4x3 analysis was then carried out, with condition as a within-subjects factor, and group a between-subjects factor. The main effect of group was not significant, $f(2,72) = 1.99$, $p=.144$, nor was the effect of condition, $f(3,216) = 1.54$, $p=.204$. The interaction of group x condition also failed to achieve significance, $f(6,216) = 1.21$, $p=.303$. These results are in keeping with small-unit theories which predicted no differences between conditions and no group differences, and indicates that the children were employing a grapheme-phoneme strategy in order to read the stimuli. The present study failed to find raised performance for the body + rime condition just as Duncan et al did.

Orthographic Unit Identification

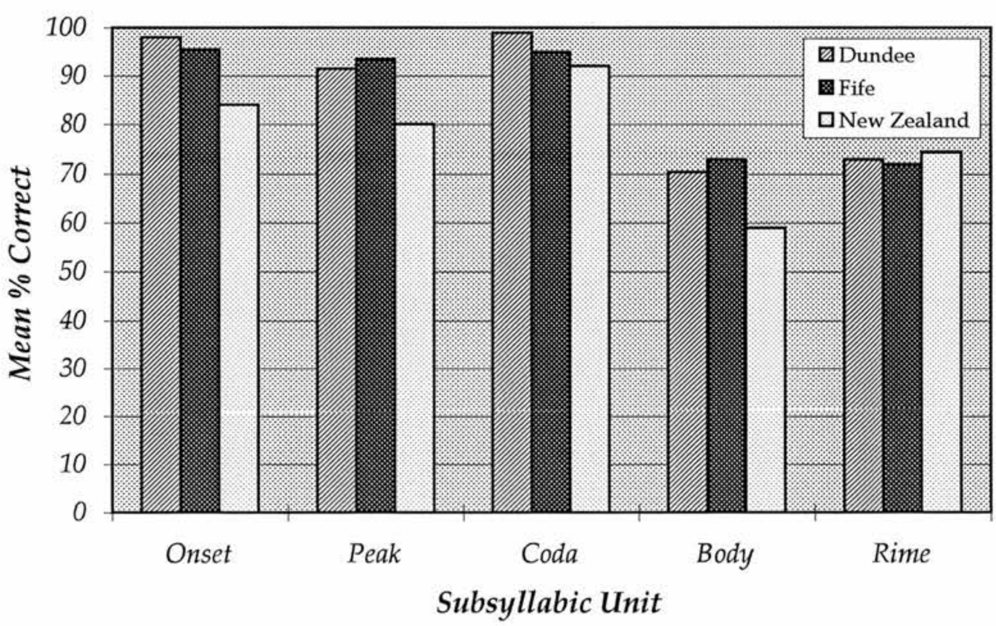

Figure 6.8 - Mean percentage of each type of unit detected correctly in the orthographic unit identification task across groups.

Percentage scores for each unit in the orthographic identification task were entered into a 5x3 (unit x group) ANOVA. The main effect of group was non-significant, $f(2, 72) = 1.88$, $p=.160$, though the effect of unit was, $f(4,288) = 38.07$, $p<.001$. The interaction of group x unit failed to reach significance, $f(8,288) = 1.38$, $p=.205$. Newman-Keuls testing was used to identify the pattern of performance across unit for the entire group. This showed that the level of onset detection was not significantly different to that for peaks or codas; all other comparisons were significant, such that codas were detected better than peaks, which in turn were easier than rime units, with detection of bodies the least accurate. There was, then, a clear order of preference regardless of group for this task, with small units more easily identified than larger ones. The results broadly replicate those of Duncan et al, though in the present study there *was* a significant advantage for rimes compared to bodies as predicted by large-unit theories. The other predictions of large-unit theories were not upheld, however.

Phonological Common Unit Identification - part A

The children's raw scores were converted into percentages before analysis. A 5x3 ANOVA was then performed. There was no significant effect of group, $f(2,72) = .03$, $p=.971$, but the effect of unit was significant, $f(4,288) = 49.62$, $p<.001$. The interaction of group x unit also achieved significance, $f(8,288) = 1.97$, $p<.05$, and it was at this level that post-hoc tests were carried out. Newman-Keuls revealed that the effect was due to Dundee performing worse than the others on rime units. There were also slightly different patterns of performance for the three groups. For Dundee, onsets were detected most easily and rimes were the hardest to detect; bodies, peaks and codas were not

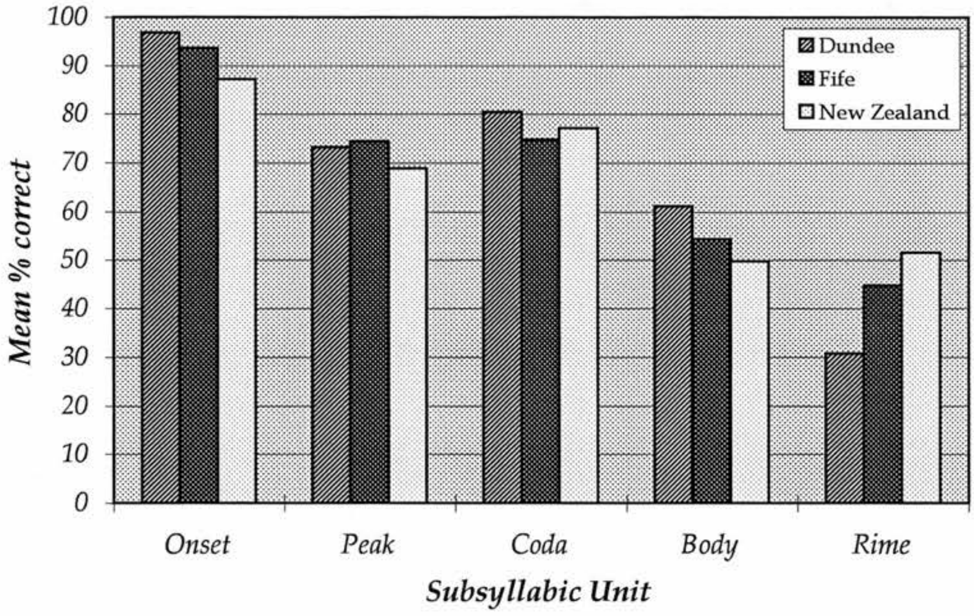

Figure 6.9 - Mean percentage correct for each subsyllabic unit in the phonological common unit task (part A) across groups.

significantly different from each other, with onsets and codas also being similar. In Fife there was a clear distinction between small and large units, with the three small units being detected similarly well, and all being detected better than bodies and rimes, whose scores were similar to each other. In New Zealand, bodies and rimes were again the hardest units for the children to detect, with onsets and codas detected most accurately; the score for peaks did not differ significantly from rimes and codas.

The results show, then, that for all three groups, onsets and codas were detected most accurately, with large units being harder to detect. The most clear cut split between large and small units was in Fife where the children had been exposed to intensive phonics instruction. Contrary to the predictions of those who might argue that such effects were due to phonics instruction, however, the New Zealand children also showed a bias towards initial and final units rather than bodies or rimes. In Dundee the results are less clear cut, but do show an advantage for onsets and a particular problem with rime units.

Phonological Common Unit Identification – part B

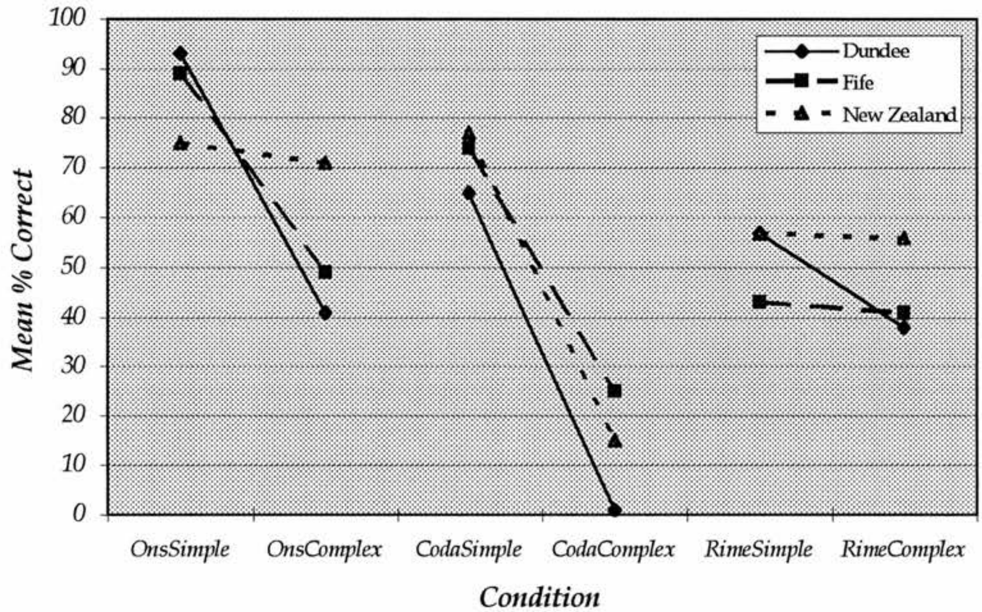

Figure 6.10 - Mean percentage correct in the phonological common unit identification task (part B) across groups.

Due to differences in pronunciation, problems arose with stimuli for the New Zealand common body condition. Because of this only the onset, rime and coda conditions were analysed. Again all scores were converted into percentages. With the complexity manipulation, this gave a 3x2x3 (unit x complexity x group) ANOVA. The main effect of group was not significant, $f(2,72) = .82$, $p=.444$, though the effects of unit and of complexity were: unit, $f(2,144) = 29.12$, $p<.001$; complexity, $f(1,72) = 152.85$, $p<.001$. The interaction of group x unit failed to achieve significance ($f(4,144) = 1.78$, $p=.136$), but the other two-way interactions were significant: group x complexity, $f(2,72) = 6.35$, $p<.01$;

unit x complexity, $f(2,144) = 45.66$, $p<.001$. The three-way interaction of group x unit x complexity was also significant, $f(4,144) = 4.64$, $p<.01$, and it was at this level that the effect was investigated. Using Newman-Keuls it was found that simple onsets were easier than complex items for the Scottish children only, with the New Zealand group showing no difference between the two. Dundee detected simple onsets significantly better than New Zealand, and New Zealand gained significantly higher scores than both Scottish groups for complex onsets. This would suggest that the complexity manipulation for onsets had no effect on the New Zealand group. All groups identified simple codas more easily than complex, and Dundee performed particularly badly on complex codas. For rime units all groups performed similarly, and showed no effect of the complexity manipulation; this was expected since complex and simple rimes require access to the same segment of the word, and do not distinguish between subsyllabic levels as the onset and coda conditions do.

Examining performance by group, for simple units Dundee were able to detect onsets significantly better than rimes or codas; Fife detected rimes worse than codas and onsets; and New Zealand found codas significantly easier than rimes, with onset performance not differing significantly from the other two units. Overall, then, rime units were detected most poorly for all groups, a finding hard to reconcile with large unit theories or with the suggestion that instruction has had a great influence. For complex units, codas were hardest to detect for all samples. The Dundee and New Zealand groups found complex onsets and rimes equally accessible. Meanwhile Fife showed a definite advantage for complex onsets over codas, but their rime detection was not significantly different to levels of performance for onsets or codas. Clearly, the complex coda condition was particularly difficult for the children. This was probably due to the fact that it is quite difficult to isolate and pronounce these segments (e.g. **'/rt/'** from ***hurt – part***). Complex onsets were detected at a similar level to complex rime units for all three groups, perhaps because ability to detect onsets (rather than simply initial phonemes) involves parsing at the onset/rime level. In support of this, complex onset scores were also statistically similar to simple rime scores for all three groups. This comparison of complex onset and rime unit detection is not mentioned in the original paper of Duncan, Seymour and Hill (1997). It does lend support to the reasoning behind the complexity manipulation, i.e. to distinguish the onset-rime level from the phoneme level.

Phonological Awareness Tasks

A table of means for the phonological awareness tasks is given in Figure 6.11.

Phoneme and Syllable Deletion

This task was analysed for phonemes and syllables separately. Since two items had to be removed from the New Zealand data due to problems of pronunciation, scores were converted to percentages for analysis. The data for one New Zealand child for this task was also dropped from the analyses, due to problems which arose during testing.

Task	*Dundee*	*Fife*	*New Zealand*
Initial Syllable Deletion %*	75.20 (24.85)	74.80 (32.68)	71.67 (26.48)
Final Syllable Deletion %*	79.20 (13.52)	73.60 (27.52)	79.58 (26.94)
Initial Phoneme Deletion %*	52.80 (40.67)	66.80 (39.97)	70.42 (33.42)
Final Phoneme Deletion %*	66.80 (26.88)	63.20 (40.49)	62.08 (32.30)
Initial Blend Deletion %*	24.40 (22.93)	34.40 (32.41)	32.50 (29.82)
Final Blend Deletion %*	35.20 (20.23)	47.60 (32.82)	54.17 (30.10)
Phon Seg: trials correct	14.44 (4.93)	10.96 (7.18)	9.76 (6.51)
phonemes correct	47.20 (8.25)	39.44 (12.75)	38.36 (13.21)
2-phoneme words, position 1	8.68 (1.44)	8.44 (1.42)	7.92 (2.81)
2-phoneme words, position 2	8.24 (2.05)	6.44 (3.43)	6.92 (3.34)
3-phoneme words, position 1	11.24 (1.20)	10.40 (1.94)	8.32 (2.85)
3-phoneme words, position 2	9.16 (2.84)	6.44 (3.94)	7.04 (3.27)
3-phoneme words, position 3	9.88 (2.54)	7.72 (4.24)	8.16 (3.64)
Odd Word Out: Onset Experiment	3.32 (1.63)	3.92 (1.50)	3.52 (1.92)
Onset Control	2.04 (1.24)	3.04 (1.57)	2.56 (1.47)
Rime Experiment	2.68 (1.68)	3.28 (1.70)	3.64 (1.91)
Rime Control	4.40 (1.58)	4.68 (1.49)	4.72 (1.90)
Rhyme Generation: total	24.52 (15.60)	46.76 (16.18)	40.80 (18.44)
rhyming words	16.52 (9.54)	32.12 (11.20)	25.60 (11.48)
rhyming nonwords	8.00 (6.86)	14.64 (6.07)	15.20 (7.84)

*Figure 6.11 - mean scores for phonological awareness tasks. Standard Deviations given in brackets. (*There were only 24 children in the New Zealand group for this task.)*

<u>Syllable Deletion</u>

A 2x3 ANOVA (initial/final x group) was carried out on the syllable deletion scores. There was no significant main effect of group, f(2,71) = .09, p=.910, or position, f(1,71) = 2.93, p=.091. The interaction also failed to achieve significance, f(2,71) = 1.59, p=.210.

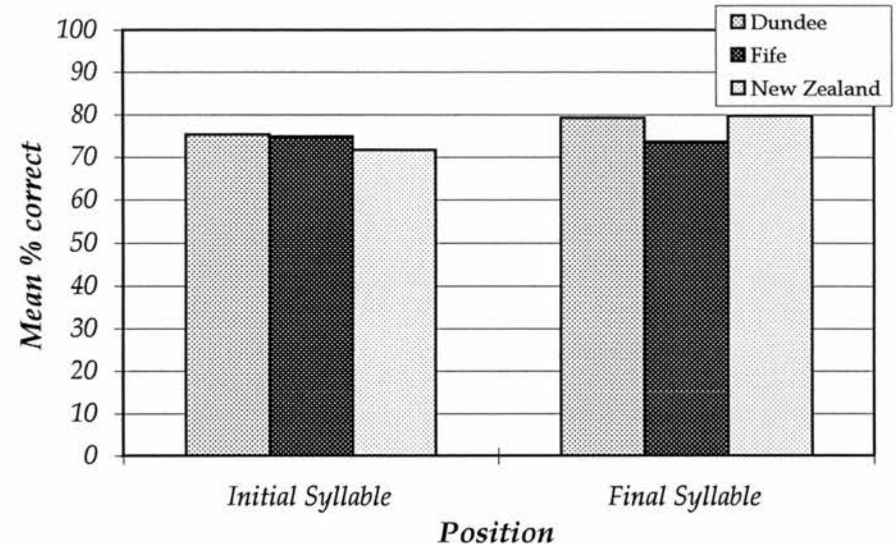

Figure 6.12 - Mean percentage of syllables correctly deleted across groups.

<u>Phoneme Deletion</u>

A 2x2x3 ANOVA (position x phoneme/blend x group was carried out on the phoneme deletion data. The main effect of group was not significant, $f(2,71) = .90, p=.410$, but the main effects of position and phoneme/blend were significant: position, $f(1,71) = 16.14, p<.001$; phoneme/blend, $f(1,71) = 97.85$, $p<.001$. The two-way interaction of group x position was not significant ($f(2,71) = 1.35, p=.266$), nor was the interaction of group x phoneme/blend ($f(2,71) = .72$, $p=.488$). The interaction position x type was significant, $f(1,71) = 12.38, p<.001$, as was the three-way interaction of group x position x type, $f(2,71) = 5.44, p<.01$. Newman-Keuls revealed that for each group, initial and final phonemes were deleted equally well. Initial and final blends were deleted equally in Dundee, but final blends were easier than initial in Fife and New Zealand. Blend-splitting deletions (initial and final) were performed less well than phoneme deletions (initial and final) for the two Scottish groups, whereas final phonemes were performed at a similar level to final blends in New Zealand.

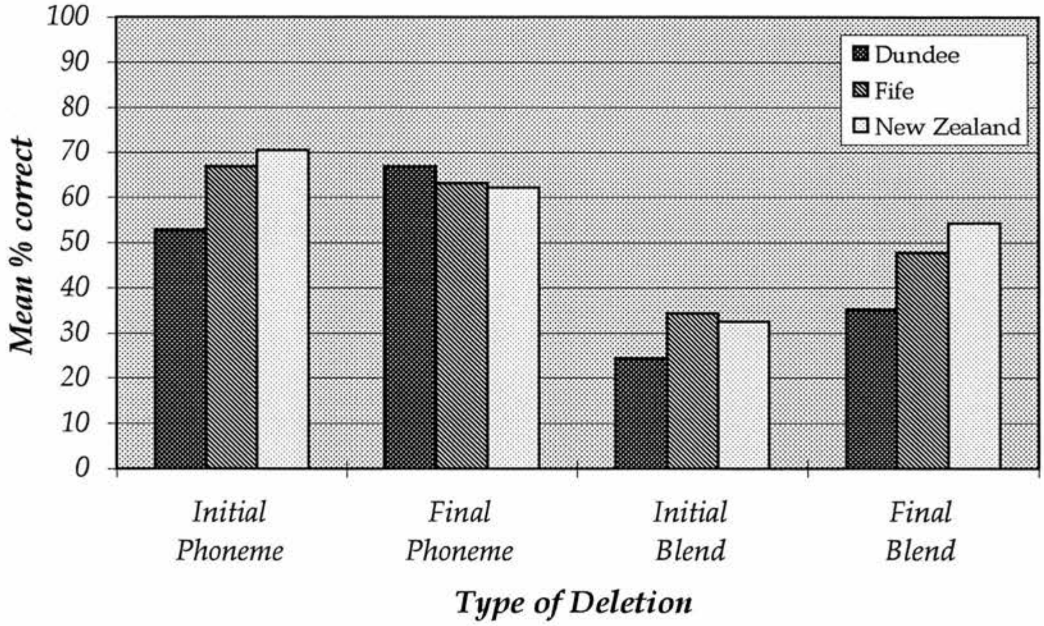

Figure 6.13 - Mean percentage of phonemes deleted correctly across groups.

Phoneme Segmentation

This task was analysed in three different ways. Firstly the number of trials in which the child segmented all phonemes correctly were analysed (max=22). Then the total number of phonemes correctly segmented were analysed (max=56). Analyses were then conducted for 2- and 3-phoneme words separately, investigating the number of phonemes correctly segmented in each word position.

Trials correct

The mean number of trials correct was analysed across groups in a one-way ANOVA. The effect of group was significant, $f(2,72) = 3.75$, $p<.05$, and

Newman-Keuls revealed that Dundee performed significantly better than New Zealand, but that Fife's performance did not differ from either of the others. It is possible that the Dundee children had benefited from experience with this task because they had been asked to complete it on previous occasions as part of the longitudinal study.

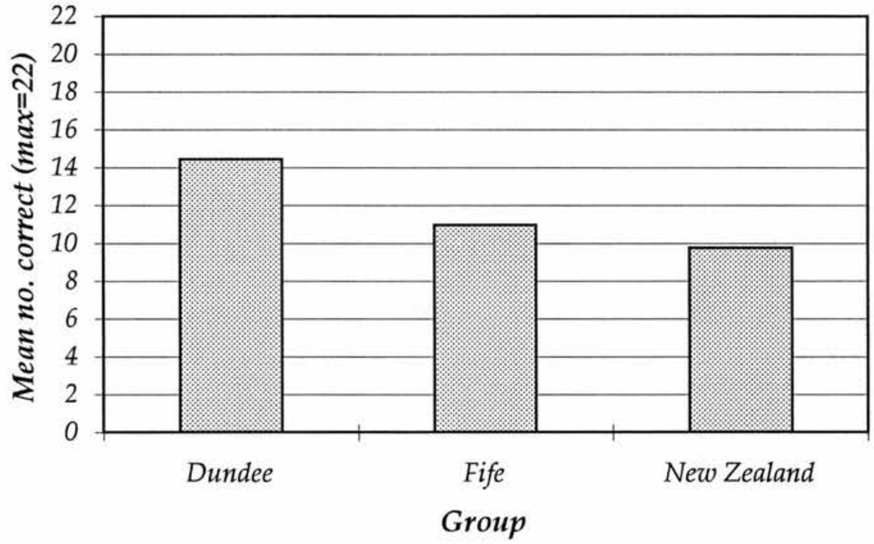

Figure 6.14 - Mean number of trials segmented correctly (max=22).

<u>Total number of phonemes correct</u>

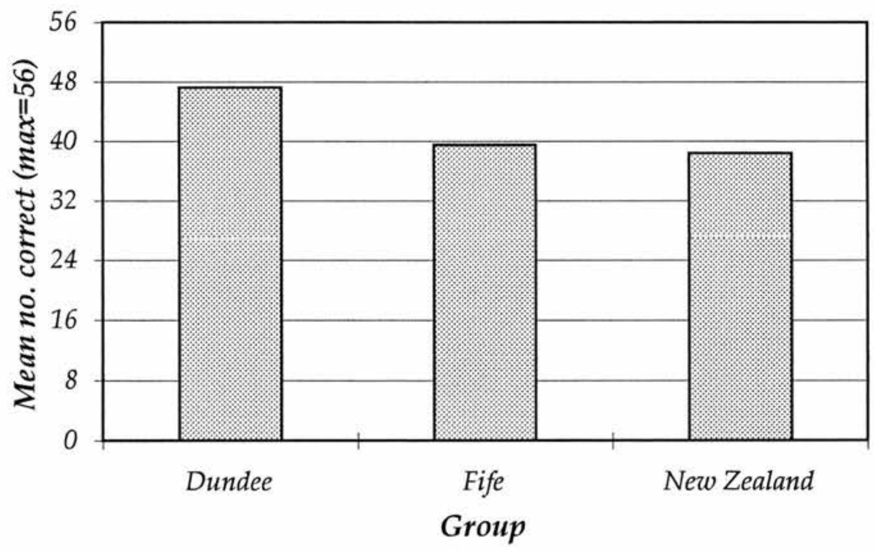

Figure 6.15 - Mean number of phonemes correctly segmented (total for all words; max=56).

A one-way ANOVA across groups revealed a significant main effect, *f(2,72) = 4.31, p<.05*. Newman-Keuls showed that Dundee performed better than Fife and New Zealand who segmented similar numbers of phonemes.

2-phoneme words

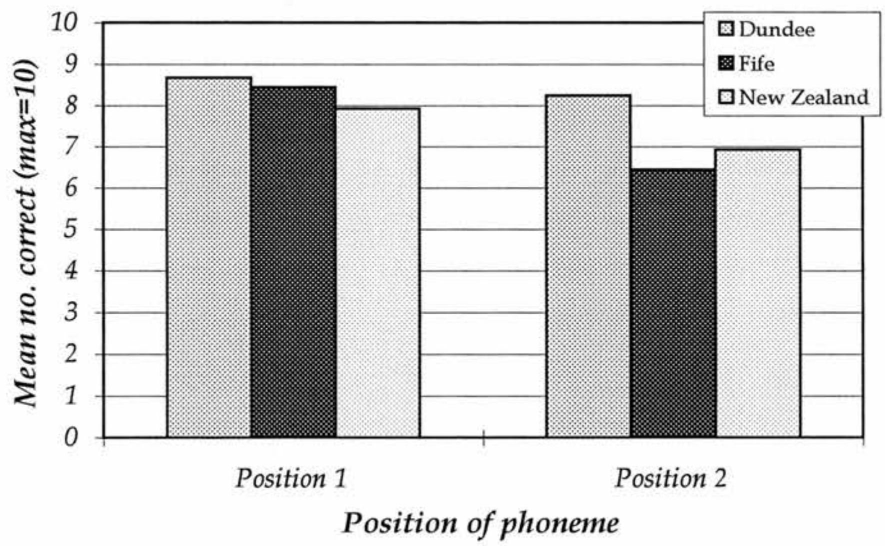

Figure 6.16 - Mean number of phonemes correctly segmented for 2-phoneme stimuli by position (max = 10 for each position).

Numbers of initial and final position phonemes (maximum of 10 for each position) in 2-phoneme words were analysed in a 2x3 (position x group) ANOVA. The main effect of position was significant, *f(1,72) = 14.85, p<.001*. This was due to better performance for initial rather than final phonemes. The effect of group was non-significant, *f(2,72) = 1.82, p=.169*, as was the interaction of group x position, *f(2,72) = 2.35, p=.103*.

3-phoneme words

Initial, middle and final phonemes correctly segmented in 3-phoneme words were analysed next. There was a possible maximum of 12 phonemes correct for each position. A 3x3 ANOVA was carried out, and produced significant main effects of group, $f(2,72) = 5.07$, $p<.01$, and of position, $f(2,144) = 33.99$, $p<.001$. The interaction of group x position was also significant, $f(4,144) = 4.49$, $p<.01$, and this was resolved using a Newman-Keuls test. For initial position phonemes, Dundee and Fife performed significantly better than New Zealand, while middle and final position phonemes were segmented significantly better by the Dundee children than the Fife and New Zealand children.

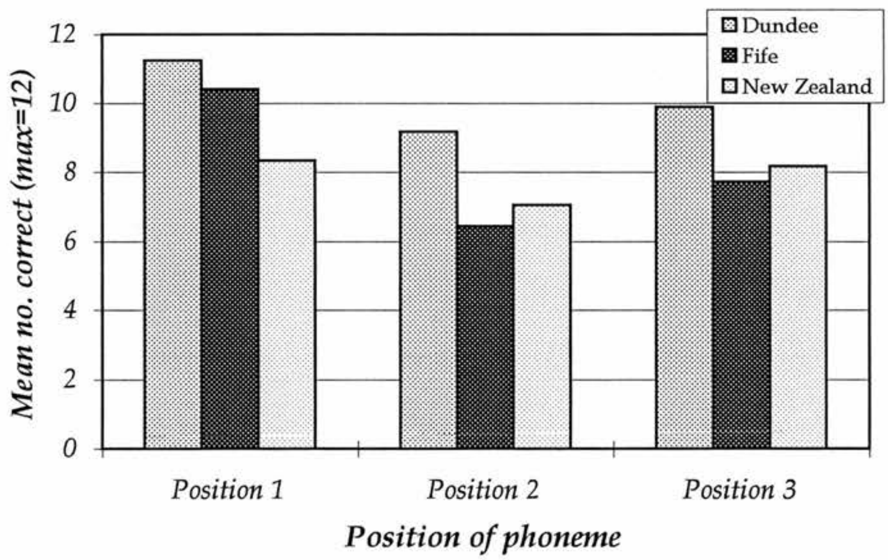

Figure 6.17 - Mean number of phonemes correctly segmented for 3-phoneme stimuli across position (max = 12 per position).

The three groups performed slightly differently across positions also: Dundee segmented initial phonemes better than middle or final phonemes; the Fife children segmented initial phonemes more easily than final phonemes which in turn were segmented more accurately than middle position phonemes; the New Zealand group did not show any significant differences in performance for the three positions. Dundee and Fife's advantage for initial phonemes may be the result of their instructional programs, which encourage children to think about initial sounds. It is unclear why Fife were poor at segmenting middle, compared to final, phonemes. Overall scores were good for all three groups, though, in keeping with predictions of small unit theories.

Odd Word Out

Mean scores for each of the four odd word out conditions (max = 6 per condition) were analysed in a 2x2x3 ANOVA (onset/rime x experiment/control x group). There were no significant main effects for group, $f(2,72) = 1.54$, $p=.222$, or exper/control, $f(1,72) = 1.83$, $p=.181$. The main effect of onset/rime was significant, however: $f(1,72) = 47.16$, $p<.001$. The 2-way interaction of onset/rime x exper/control also achieved significance, $f(1,72) = 83.72$, $p<.001$. Newman-Keuls analysis showed that for the onset conditions, the experiment condition was easier than the control condition, i.e. initial phoneme (onset) differences were detected more easily than final phoneme (coda) differences. Meanwhile, for the rime conditions the children found the control condition to be easier than the experiment condition; that is, they found it easier to detect differences in word bodies rather than word rimes. Indeed, the rime control condition scores were significantly better than for any other condition.

None of the other interactions were significant: group x onset/rime, $f(2,72) = 2.33$, $p=.105$; group x exper/control, $f(2,72) = .21$, $p=.811$; group x onset/rime x exper/control, $f(2,72) = 1.17$, $p=.316$.

Inspection of the 95% confidence intervals for each group at each condition showed that Dundee and New Zealand were not significantly different from the chance level of 2 correct in the onset control condition. This condition was performed more poorly than any of the others. The other score which failed to exceed chance levels was Dundee's rime experiment score.

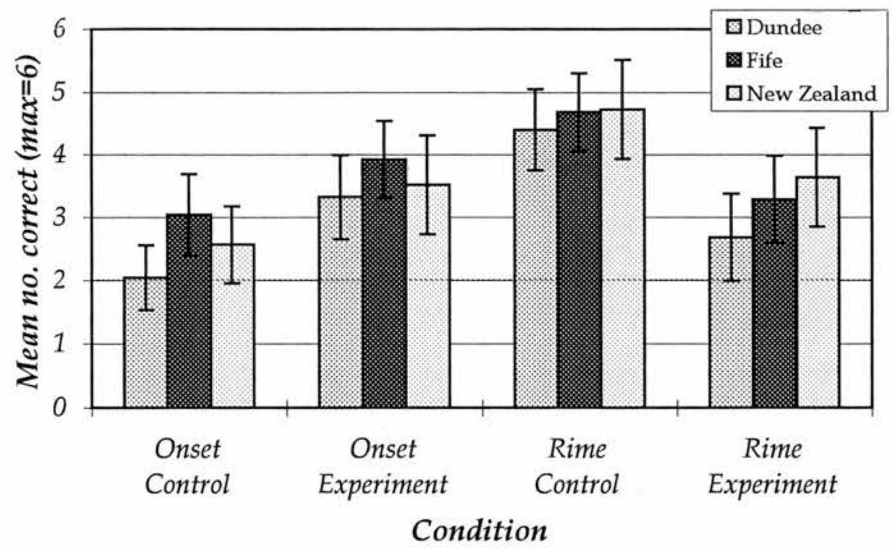

Figure 6.18 - Mean number of trials correct for each condition in the odd word out task (max = 6 per condition). Bars represent 95% confidence intervals. The chance level of 2 correct is also indicated.

In the odd word out task, the children seemed to find it easiest to compare and detect the odd word out when it differed at the start of the word, and this was heightened when the word-initial unit involved the peak as well as the onset (rime control condition).

Rhyme Generation

Mean numbers of rhyming words and nonwords produced in the rhyme generation task were analysed across group in a 2x3 ANOVA. The main effect of group was significant, $f(2,72) = 11.76$, $p<.001$, and this was analysed using Newman-Keuls in order to show how the children's total number of rhyming responses differed. This showed that Dundee performed worse than both Fife and New Zealand. The main effect of type (word/nonword) was significant, $f(2,72) = 232.69$, $p<.001$, as was the interaction of group x type, $f(2,72) = 11.76$, $p<.001$. The interaction was resolved using a Newman-Keuls

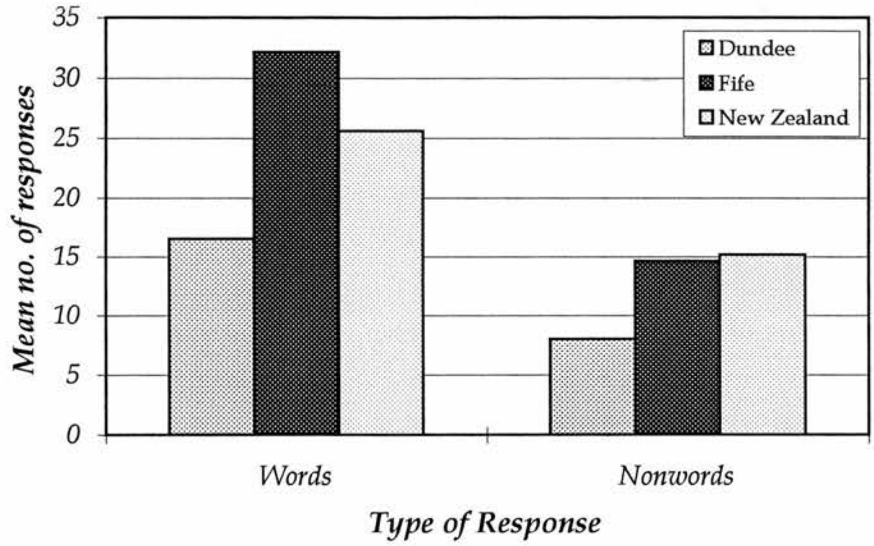

Figure 6.19 - Mean number of correctly rhyming responses. Possible total maximum (words+nonwords) = 60

test which showed that Fife produced more words than New Zealand, but similar numbers of nonwords to them; also Fife and New Zealand produced more of both types of response than Dundee. It is unclear why Dundee showed such poor performance relative to the other groups, but this may have been due in part to experimenter differences. The results are not in keeping with an instructionally based viewpoint, and performance was not as high as might be predicted by large-unit theories. Rather, the results fit more easily with small-unit theories of development.

Discussion

The results from the tasks give no support to large unit theories, which would have predicted clear advantages and preferences for detection and manipulation of large units, in particular the rime. The children were able to produce rhyming words in the rhyme generation task, but performance was not exceptional. Detection of rime units was difficult for the children even in the odd word out task, traditionally considered to be a good test of this skill (Bradley and Bryant, 1983; Kirtley, Bryant, MacLean and Bradley, 1989).

Similarly, the results give little support to the suggestion that Duncan et al's results may simply have been due to the instructional background of their subjects. The New Zealand children did not appear to perform very differently to the Scottish children in the tests, showing superior detection for smaller rather than large units in the phonological common unit and orthographic unit identification tasks. On two tasks, though, there were differences in performance between New Zealand and the Scottish children which may at first glance indicate some instructional influences. The first of these was the observation that in the phonological common unit task (part B), the New Zealand children showed no effect of the complexity manipulation for onsets, indicating that their ability was in detecting *onset* units as opposed to simply detecting initial phonemes. However, the fact that the New Zealand group's performance for simple codas was superior to their detection of simple rime units runs counter to the pattern expected if the children's awareness was focused mostly at the onset and rime level.

For the phoneme segmentation task, an effect of group was observed for both the number of trials correct and number of phonemes correct. In these analyses, Dundee performed significantly better than New Zealand, however the fact that the Fife group's performance did not differ significantly from New Zealand's suggests that Dundee's advantage may be due to other factors such as their relative experience with the task (these children had performed the task before as part of the longitudinal study), or it may even have been due to the effects of having different experimenters collecting data in the groups. Certainly, the fact that the Fife group performed similarly to the New Zealand children argues against an effect of literacy instruction. A similar pattern of results also arose in the analysis for three-phoneme words in the phoneme segmentation task, though here Dundee showed an advantage over the other children only for middle and final position phonemes. For word-initial phonemes the two Scottish groups *did* show an advantage over the New Zealand children, though as suggested above this may have been due to a focus on word-initial sounds in the Scottish children's reading instruction. While the New Zealand children's instruction had also placed some focus on the beginnings of words, the emphasis on word onsets was not as strong.

The results for the tasks *do* accord well with the predictions of small-unit theories in showing that even during the second year at school, children from very different educational backgrounds all showed a preference for - and ability to detect and manipulate - phonemes within words.

The results obtained in the present study for the tasks drawn from the Duncan et al (1997) study, do seem to replicate their general findings. For the nonword reading task the present results actually match small-unit theory predictions even more closely than in the original study: whilst Duncan et al found a significantly lower response for the body/rime nonwords, the results presented here showed no effect of nonword type. As Duncan et al did, we found a significant advantage for small units over large in the orthographic unit identification task, and similar patterns for the phonological common unit identification task. What the current study adds to the original is in demonstrating that such results are not simply the product of a 'mixed' or phonics teaching regime, but that even children taught by a whole-word method demonstrate superior awareness for small units.

The tasks developed by Duncan et al do seem to be an excellent method for allowing a controlled comparison of awareness for *all* subsyllabic units. In particular, part B of the phonological common unit task seemed capable of picking up on onset/rime level, as opposed to phoneme level, parsing. As mentioned in the methods section, the stimuli in the present study improved on those used by Duncan et al, in that the number of stimuli was better standardised across conditions, and that (with the obvious exception of the 'complex' stimuli in the common unit task) care was taken to avoid using words containing consonant clusters.

The phonological common unit task has been recently criticised on two points. One query was with the instructions given to the children. By telling the children that it was the 'beginning' or 'end' of the word that was important, it is suggested that the child's attention was being drawn only to the initial and final phonemes of the words which would lead to a disadvantage in the rime and body conditions. However, the statement on whether the 'beginning' or 'end' of the words was important was mentioned only briefly, and was followed up by 3-4 practice items during which it was made very clear which unit of the stimuli was important. The present study also used more practice items than Duncan et al's original tasks which only contained one or two practice trials in each condition. In addition it would be difficult to think of another way in which to focus the child's attention on the correct part of the word in a way that is simple enough for young children to grasp.

A second criticism levelled at the task was that by not randomising the order of presentations for each condition, the children may have been biased from the first condition (common onset) to focus on small units. It was not practical in the present study to randomise the order of testing for the children, and also the order was maintained in order to make the replication as close as possible to the original study. The short space of time available did lead to parts A and B of the task being combined into each session, though. This meant that the children were tested on bodies then onsets (session 5), rimes then bodies (session 6), and peaks then rimes (session 7). This ought to have given some level of mixing of the task orders, and yet the results still closely match the patterns found by Duncan et al. Also, the time between conditions was felt to be sufficient that there should be no order effects.

The effects of instruction wording and order of blocks does deserve further investigation, though, in order to maximise the potential of these important new tasks. One study has attempted to address these criticisms by using randomised block orders and less explicit instructions, and the results from this confirm the findings of the present study and of Duncan et al (1997) in demonstrating a preferential awareness for small units (Seymour, Duncan and Bolik, 1999).

It seems from the present results that different instructional regimes for reading have not affected the children's ability to focus on the phonemic level of the word at this point in their schooling. It may be that group differences might have been found during the first year of schooling, or even that attention to and use of rime units might have developed to a greater degree in the third year of instruction. These are important issues which future research may address. In the second year of schooling, however, few differences between the groups were found.

A training study has recently been carried out (Goswami and East, reported by Goswami (1998)) which tested children on the phonological common unit task before and after an intervention involving training in the use of rime analogies and awareness of rime units. This training succeeded in producing an improvement in levels of rime unit awareness in the common unit task. However, all this study really demonstrates is that if children are trained intensively to detect rime units, then their performance in detecting rime units increases. As demonstrated here, it is apparent that in the absence of phonics training, children are still able to develop phonemic awareness, indicating that it is at this smaller level that children's reading and phonological awareness naturally develops in the early years at school. A more important result for the rime training study would have been in terms of effects on reading ability rather than simply confirmation that it is possible to train children to detect rime units.

Summary and Conclusions

In summary then, the present study has demonstrated accessibility to the phonemic level for children from different instructional regimes. It appears that in the first two years of reading, at least, children attend to phonemes whether they have been taught to or not. This result fits well with small-unit theories of reading development, and indicates the importance of phonemic awareness as a natural component of early reading development. This study cannot say how phonological awareness may develop *beyond* the second year of instruction, though, and an interesting topic for future research would be to test whether rime awareness becomes more important at a later stage as some researchers have argued (e.g., Muter, 1994; Muter et al, 1994).

Chapter 7
General Discussion

In this chapter, the results and conclusions of the various aspects of the research will be summarised. The main threads of the results will then be drawn together, before a brief discussion of the implications of the study.

The first topic explored in the thesis was the nature of phonological awareness (chapter 2). Several different theories relating to whether phonological awareness should be regarded as a single construct or categorised into different types of awareness were detailed. The results of the analyses, however, did not support most of the dichotomies which had been proposed, as the 'phonological awareness' tasks loaded onto just one common factor. Performance on two of the tasks, however, namely Rhyme Generation and Phoneme Segmentation, became separate from the 'phonological awareness' factor at the later points in the study (blocks 3 and 4). Structural equation modelling (path analysis) was used in order to investigate the relationship between phonological awareness and reading, and this found that during the first one and a half years of schooling (blocks 1-3) there was no interaction between reading and the phonological awareness factor. Between the middle of primary 2 (block 3) and the beginning of primary 3 (block 4) on the other hand, there was some interaction, such that phonological awareness and phoneme segmentation at block 3 both had significant paths leading to reading ability at block 4. Correlational analyses showed that letter knowledge made an important contribution to both reading and phonological awareness, and also suggested that rhyme generation skills were the result of good reading ability rather than the opposite pattern of causality which some have argued for (e.g., Goswami and Bryant, 1990; Bradley, 1990; Bryant, 1990).

Chapter 3 explored in more detail the relationship between letter knowledge, rhyme awareness and reading skills, in particular contrasting the theories of those who argue that rhyme awareness is the most important skill in early reading and those who place greater importance on knowledge of the alphabet and phonemic awareness for young readers. The results of the statistical analyses were very clear-cut, and demonstrated that for the children who took part in the longitudinal study, phonemic awareness and especially knowledge of grapheme-phoneme correspondences were the most important factors influencing their reading development. Patterns of correlations showed strong links between early letter knowledge and later reading ability, whilst measures of rhyme awareness taken at the start of primary one did not correlate significantly with reading ability at *any* point in the study. Again the pattern suggested was of reading skills relating to subsequent rhyme ability rather than the other way around. Regression analyses confirmed the importance of letter knowledge, with block 1 letter knowledge consistently predicting the greatest variance in reading throughout the study - indeed letter knowledge was the only block 1 variable to predict significant unique variance in reading ability at the start of primary 3. A series of analyses of variance compared the performance of children starting school with good or poor levels of letter knowledge. These demonstrated that the 'high alphabet knowledge' children performed better on tests of reading *and* phonological awareness.

Importantly, the ANOVAs also showed that good letter knowledge has a significant impact on later ability to perform tasks of rhyme awareness, such as rhyme generation or the odd word out task: the high alphabet knowledge group showed significant increases in performance on these tasks across the period studied, whilst the low alphabet knowledge children did not show any significant improvement in rhyming skills.

Visual skills and their relationship to reading development were the topic of chapter 4. No strong direct link was found between the visual tasks employed and reading ability. The patterns of correlations for ability to read regular, irregular and nonsense words (at block 4) did suggest a visual strategy was being used, though, and an analysis of errors made on the BAS reading test at blocks 2, 3 and 4 showed that a consistent proportion of these (around 40%) were visually-based. Interestingly, the proportion of visually-based errors made did not change significantly across time, indicating that the use of visual strategies for reading also remained fairly constant. Perhaps the most important results from this chapter, though, were those relating to the 'visual advantage index'. By creating this measure, which takes into account both phonological and visual skills, it was shown that *relative* visual skills do make a significant impact on reading ability. More specifically the visual advantage index, based upon skills at the very beginning of primary 1, became more highly related to reading as time went on. The significant correlation between block 1 visual advantage index and block 4 reading was negative, indicating that those children who started out with strong visual (compared to phonological) segmentation skills became poorer readers two years later, whilst children whose phonological skills had been stronger than their visual ability became good readers. The fact that this correlation became stronger across time suggests that the gap in reading skills between children with very high or low index scores was widening as time went by. These results tie in with the theory of reading failure proposed by Johnston and colleagues (Johnston, Anderson and Duncan, 1991; Johnston and Anderson, submitted), which suggest that children who begin school with very good visual relative to phonological skills may become over-reliant upon a visual strategy in their reading. As the demands of the reading environment increase, such a strategy becomes less and less efficient and accurate, leading to reading problems. The present study added an interesting dimension to this theory by demonstrating such a pattern apparently emerging within a population of normal readers.

The final two chapters dealt with experimental data collected as part of the longitudinal study. Chapter 5 reported on a replication and extension of a study by Muter et al (1994, exp. 1). At the beginning of their third year of primary school, the children's ability to use (and be trained to use) analogy strategies was examined using a 'clue word task' procedure similar to that developed by Goswami (1986, 1988). It was found that ability to read 'analogy' words (which shared their rime segments with one of the 'clue' words) improved significantly at the post-training stage of the experiment, whilst performance on 'control' words (which shared letters - though out of sequence - with a clue word) did not. Importantly, though, this result was true regardless of whether the relevant 'clue' was still visible, and also regardless of whether or not the children had been trained to read the clue words. However it was also discovered that 'analogy' words were easier to read than 'control' words even at *pre-training*, suggesting either that the children may already have been spontaneously employing an analogy strategy in their reading, or that some characteristic of the words themselves quite unrelated to their share rime units (such as their frequency within the children's known reading vocabulary) had made them easier to read. This latter explanation is supported by a similar finding in Muter et al's study which employed the same set of stimuli with a younger group of children. Similarly, the significant *increase* in performance for analogy words may be the result of analogy use, but might also be due to characteristics of the post-training lists which may have emphasised the rime units shared by the 'analogy' words. It has been proposed, however, that it is at about this stage in development at which children 'naturally' begin using orthographic analogy strategies (e.g., Muter, 1994; Muter et al, 1994), and so it is possible that this is responsible for the pattern of results found. Interestingly, it was shown that block 1 letter knowledge had an impact upon results in the analogy task at primary 3: children with high block 1 alphabet knowledge showed significant improvements on analogy words whilst those subjects in the low alphabet knowledge group did not improve significantly for analogy *or* control words. Once again the improvement shown by the high alphabet knowledge children was not affected by the presence or absence of the clue word or by whether or not they were trained in reading the clues. This finding suggests that the high alphabet knowledge group children were able to use analogy strategies, but also that this had developed without explicit training. This supports the bulk of previous 'clue word' research reviewed, in indicating that analogy use is dependent upon good grapheme-phoneme skills, and develops at around year three of schooling (e.g., Bruck and Treiman, 1992; Nicholas, Kay and Mitchell, unpubd; Muter, 1994; Muter et al, 1994).

Chapter 6 reported on the results of a cross-cultural replication and extension of Duncan, Seymour and Hill (1997). This looked at children in their second year of school who had received a normal 'mixed' reading instruction regime (Dundee sample), had received intensive phonics training (Fife sample), or who had been taught to read under a 'whole word' approach (New Zealand sample). The three groups of children showed almost no significant differences in performance from each other, and performed similarly on various tests of nonword reading, orthographic skill and phonological awareness. The important feature of this performance was that all groups, including the New Zealand children who had not received phonics training, demonstrated superior awareness of small units (i.e., phonemes) compared to large units (i.e., bodies and rimes), and used a phonemic rather than large unit (analogy) approach to reading nonwords constructed from familiar orthographic units. These results replicate the findings of Duncan et al (1997), and support the view that differences in reading instruction technique such as those sampled here do not significantly alter the path of development of phonological awareness. Rather the expectations of small-unit theories were upheld, supporting the view of a progression in awareness which begins at the phonemic level (e.g., Seymour, 1999; Ehri, 1992).

The main findings of thesis then, were firstly that letter knowledge at the start of primary one played a vital role in the children's reading and phonological awareness development in the first few years at school. Letter knowledge was the best block 1 predictor of success in later tasks, and even predicted rhyme awareness and use of orthographic analogies at primary 3. Early awareness of rhyme, on the other hand, did not play any significant role in reading or phonological development, contrary to the predictions which some researchers have made (e.g., Goswami and Bryant, 1990; Bryant, 1992). Thirdly, there was some suggestion that awareness of rhymes had increased by the start of primary 3, and that those children with good grapheme-phoneme skills may have begun using orthographic analogies spontaneously at around this point in development. A fourth important finding was that the preference for small orthographic units over large was observed even in children who had received no instruction emphasising these units. Thus, the phoneme level bias observed was *not* due to instructional factors, as some had previously suggested (e.g., Duncan et al, 1997; Seymour and Evans, 1994). Finally, the data reported in chapter 4 indicated that relative visual/phonological skill may be an important factor in determining the path which a child's reading development follows, and may even predict those children who will develop reading difficulties.

What, then, are the implications of these results? At the fundamental level of definitions of terms, it has been demonstrated that there exist many flaws and contradictions in the literature regarding the nature of phonological awareness. It is vital that this problem be taken notice of and addressed by future research, since this construct forms a vital component of many studies in the field. Although many dichotomies have been proposed, the present study found that phonological awareness tasks tended to load onto a single factor - though, as was suggested, this may be due to identifying types of awareness by the tasks which are thought to tap them, rather than on the basis of the types of cognitive operations carried out by the individual child. The changing pattern of factor loadings found here may also indicate that the nature of phonological awareness is not static, but alters as the child develops. There is an urgent need for researchers to stop and consider carefully exactly what they believe this 'phonological awareness' *is* that they are measuring and studying rather than happily accepting the various theories as though they are not mutually exclusive.

As has been seen, a great deal of evidence is presented here which points to a crucial role for letter knowledge in learning to read, with this skill leading to growth in both reading *and* phonological awareness skills. This does not agree with the rime-focused theories of reading development which have become so dominant in recent years. On closer inspection, much of the existing research supports the view that grapheme-phoneme correspondences play the most important role in reading development in the first few years before children can begin to use rime-based analogies or analogies based on other units (e.g., Bruck and Treiman, 1992; Peterson and Haines, 1992; Ehri and Robbins, 1992; Walton, 1995). Even many of those studies held up as evidence for the importance of rhyme as a predictor of reading or of rime-based analogies being used from the start of reading, can be seen on closer inspection to have been at best overstated (e.g., Goswami, 1986), or at worst misinterpreted (e.g., Bradley and Bryant, 1983).

The progression suggested by the present results from a focus in reading and phonological awareness on small units, developing towards the inclusion of orthographic analogies at around the third year of reading, is in agreement with many other studies as cited above. Importantly, the cross-cultural data in chapter 6 indicates that this progression is not severely affected by different types of reading instruction.[1] In view of this, advocating a rime-based approach to reading from the start of schooling (see for example, Goswami, 1993, 1994) does not appear to be a logical move. Rather, it seems more helpful to enhance knowledge at the letter level at the beginning of learning to read, and thus enable the child to develop their reading effectively so that a good foundation may be set in place upon which orthographic

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[1]It would be valuable to obtain data from similar comparisons at both earlier and later stages

analogy use may develop as an optional strategy in its own time. Indeed it has been shown (Johnston and Watson, 1997) that giving young children intensive training in grapheme-phoneme correspondences and the way in which letters may be blended to form words, leads to great improvements in reading performance.

The importance of visual skills must also be taken into account as a factor in children's reading development. The idea that relatively strong visual compared to phonological skills may lead to reading difficulties was suggested by Johnston et al (Johnston, Anderson and Duncan, 1991; Johnston and Anderson, submitted) on the basis of poor reader's performance. The present results add great support to this hypothesis by indicating that the visual advantage index may predict which children will become good or poor readers even in a normal population. An interesting test of the theory would be a follow-up to see whether those children who started out with very strongly negative scores on the visual advantage index did indeed develop reading problems at a later point. Of course, the theory does not claim to explain *all* reading difficulties, but it may offer a valuable indication of at least some of those readers who may be at risk.

The apparent lack of a *direct* link between visual skills and reading found here and in other studies (e.g., Gattuso, Smith and Treiman, 1991; Huang and Hanley, 1994; Vellutino, 1979) may be due in part to the fact that IQ measures (which are usually - and justifiably - controlled for) contain strong visual components. This might explain why, for instance, researchers such as Huang and Hanley (1994) have found that once IQ was controlled for, the relationship between visual skills and reading is no longer significant. In effect,

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than the present study in order to confirm this result.

the baby has been thrown out along with the bath water. Taken together with the common finding that children with reading difficulties often have good or above-average IQ scores, the hypothesis that strong visual relative to phonological skills may lead to reading difficulties slots neatly into place.

Conclusions

In conclusion, then, the results of the present thesis have indicated an urgent need for a close inspection of definitions within reading research. Secondly, a great deal of evidence was collected which indicates that regardless of instructional background, letter or grapheme-phoneme correspondence knowledge plays a vital role in developing good reading and phonological skills during the initial years of schooling, with analogy use possibly developing by the third year. Thirdly, rhyme awareness did not play an important role in predicting reading ability, and instead appeared to develop as a *consequence* of alphabetic skills. Finally, relative visual/phonological skills showed promise as a potential early indicator of reading difficulties.

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Appendix 1

Details of Testing Schedule

Block 1 - 7 November 1994 – 6 February 1995

School 1: 30 children; 15 male, 15 female.
class 1: 6 children, class 2: 24 children
School 2: 32 children; 15 male, 17 female.
class 3: 14 children, class 4: 18 children

At the start of block 1, the children were at the beginning of primary 1. Their average score on the Clay Ready-to-Read test was 2.637 items correct (*SD=2.906*). All but 12 of the children were able to read at least one word from the Clay task list, though the median score on the task was 2 words correct, with 35 children scoring at or below this level. Average I.Q., as measured by the matrices and vocabulary sub-tests of the British Ability Scales, was 105.328 (*SD=12.551*), and their average I.Q. as measured by the British Picture Vocabulary Scale was 97.017 (*SD=15.526*). Tests were administered in the following order, with the number of tests per session depending upon the child and the time available.

1) British Picture Vocabulary Scale

2) Clay Ready-to Read Word Task

3) Frostig Test of Visual Perception

4) British Ability Scales - naming vocabulary

5) Pegboard Test[1]

6) Rosner Phoneme Deletion Task

7) British Ability Scales - matrices

8) Alphabet Knowledge

9) Yopp-Singer Phoneme Segmentation Task

10) Children's Embedded Figures Test[2]

11) Phoneme Deletion (extra items)

12) Odd Word Out Task[3]

13) Rhyme Generation Task

<u>Block 2 - 18 May – 27 June 1995</u>

<u>School 1:</u> 25 children; 11 male, 14 female.
class 1: 4 children, class 2: 21 children
<u>School 2:</u> 29 children; 15 male, 14 female.
class 3: 14 children, class 4: 15 children

The children were, on average, 5 yr 10 mth old (*SD=.34yr*) at the beginning of block 2, and their average reading age as measured by the BAS reading test, was 5 yr 9 mth (*SD=.53yr*). The Schonell spelling task scores showed the children's average spelling age to be 5 yr 8 mth (*SD=.63yr*). From block 2 onwards the number of tasks per session was controlled carefully to equalise conditions for all children. This block of testing took place over the last 2 months of the children's first year at school.

[1] Data from this task not used in any data analyses reported here, see appendix 2.
[2] This task was introduced between the first and second halves of task 9.
[3] This task was introduced between the first and second halves of task 11.

Session 1) Odd Word Out Task
British Ability Scales - Word Reading

Session 2) Yopp-Singer Phoneme Segmentation Task
British Ability Scales - Recall of Digits[4]

Session 3) Phoneme Deletion (extra items)

Session 4) Alphabet Knowledge
Rosner Phoneme Deletion Task

Session 5) Schonell Graded Word Spelling Test

Block 3 - 16 October 1995 – 23 February 1996

School 1: 25 children; 11 male, 14 female.
class 1: 4 children, class 2: 21 children
School 2: 29 children; 15 male, 14 female.
class 3: 14 children, class 4: 15 children

The third block of testing was commenced near the beginning of the children's second year at primary school. All children remained in the same classes, the only change being that those children in class 1 now became the older group in the primary 1/2 composite class. The children's average age was 6 yr 3 mth (*SD=.28yr*), and the British Ability Scales showed their reading age to be, on average, 5 yr 11 mth (*SD=.62yr*).

The task order for the two schools remained the same for sessions 1–6, but due to problems with equipment, school 2 subjects were tested on alphabet knowledge at the *end* of the block. The session numbers shown are those for School 1, with the different order for School 2 shown in brackets.

[4] See footnote 1.

Session 1) Odd Word Out Task
British Ability Scales - word reading

Session 2) Rosner Phoneme Deletion Task
Rhyme Generation Task

Session 3) Phoneme Deletion Task (extra items)

Session 4) Yopp-Singer Phoneme Segmentation Task

Session 5) Children's Embedded Figures Test

Session 6) Nonword Reading Test (Duncan, Seymour & Hill)

Session 1) (13) Alphabet Knowledge

Session 1) (7) Nonword Spelling

Session 1) (8) Phonological Common Unit Identification Task, Part A - common onset
Orthographic Unit Identification Task - list 1

Session 1) (9) Phonological Common Unit Identification Task, Part A - common body
Orthographic Unit Identification Task - list 2
Phonological Common Unit Identification Task, Part B - common onset

Session 1) (10) Phonological Common Unit Identification Task, Part A - common rime
Orthographic Unit Identification Task - list 3
Phonological Common Unit Identification Task, Part B - common body

Session 1) (11) Phonological Common Unit Identification Task, Part A - common peak
Orthographic Unit Identification Task - list 4
Phonological Common Unit Identification Task, Part B - common rime

Session 1) (12) Phonological Common Unit Identification Task, Part A - common coda
Orthographic Unit Identification Task - list 5
Phonological Common Unit Identification Task, Part B - common coda

Block 4a - 13 May - 20 June 1996

School 1: 23 children; 11 male, 12 female.
class 1: 4 children, class 2: 19 children
School 2: 27 children; 14 male, 13 female.
class 3: 13 children, class 4: 14 children

Blocks 4a and 4b were separated only by the school summer vacation, and so may be considered two parts of the same testing block. Block 4a took place during the final 2 months of primary 2. At the beginning of the block, the children's average age was 6 yr 9 mth (*SD=.27yr*), and their reading age (British Ability Scales) was 6 yr 10 mth (*SD=.80yr*). Intelligence, as measured by the BPVS was, on average, 97.42 (*SD=14.39*).

At this time, it was decided to combine the original phoneme deletion stimuli of Rosner with the extra items, and to split this list into 2 equal parts (for details, see Chapter 2).

Session 1) British Ability Scales - word reading
British Picture Vocabulary Scale

Session 2) Alphabet Knowledge
Orthographic Awareness Task[5]

Session 3) Phoneme Deletion Task (part 1)
Nonword Reading (Johnston & Anderson)[6]

Session 4) Phoneme Deletion Task (part 2)
Pseudohomophone Detection Task[7]

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[5] See footnote 1.
[6] See footnote 1.
[7] See footnote 1.

Block 4b - 26 August – 4 October 1996

School 1: 21 children; 10 male, 11 female.
class 1: 4 children, class 2: 17 children
School 2: 27 children; 14 male, 13 female.
class 3: 6 children, class 4: 13 children, class 5: 8 children

As mentioned above, this block was the continuation of block 4a, commencing at the beginning of primary 3. At School 1, the children remained in their class groupings, with class 1 now the upper group of a composite primary 2/3 class. At School 2, the classes were changed into three new groupings: children from class 3 were kept together, now forming part of a primary 3/4 class; class 4 was split, with some children being put into a primary 2/3 class, and the others forming part of a primary 3/4 class. (These will now be referred to as classes 4 and 5 respectively.)

At the beginning of block 4b, the children's average chronological age was 7 yr 0 mth (*SD=.27yr*). Their spelling age (Schonell) was, on average, 6 yr 10 mth (*SD=.72yr*), and reading age (Neale Analysis of Reading - accuracy scores) was 6 yr 1 mth (*SD=.87yr*). Changes to the schedule at School 2 are once again indicated in brackets.

Session 5) Nonword Spelling

Session 6) Odd Word Out Task

Session 7) Schonell Graded Word Spelling Test

Session 8) Analogy Task

Session9) Yopp-Singer Phoneme Segmentation Task
Reading Style Index

Session 10) (11) Neale Analysis of Reading[8]

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[8] See footnote 1.

Appendix 2

Methods and Procedures for Unreported Tasks

Neale Analysis of Reading Ability - Revised British edition ***(Neale, 1988)***

In order to obtain a more detailed picture of the children's reading abilities, the Neale Analysis of Reading Ability (Form A) was employed at the final block of testing. This allows analysis of four important components of reading: reading rate; accuracy; comprehension; and error patterns. In this test, the children were given a storybook from which they read short stories of increasing length and complexity. One practice passage was read to familiarise the child with the procedure, and to reassure them that the experimenter would correct and prompt them if they had any difficulties. Test passages were then read, one at a time, until the child reached the maximum of 12–16 errors in any one passage. The children's reading was timed, though there was no time limit set, and the children were encouraged to read carefully rather than quickly. The experimenter prompted the child after 4-5 seconds (or according to the experimenter's judgement) if there were hesitations, and all errors were corrected and recorded. Following each passage, a series of questions relating to the story were asked, in order to assess the child's comprehension of what they had read. No corrective feedback was given for these questions, though encouraging, non-committal, responses were given regardless of whether the child answered correctly or not.

The raw scores for time, number of words read correctly and number of questions answered correctly were calculated and converted into reading ages, and percentiles for rate, accuracy and comprehension. Errors in the child's reading were classified for analysis into six categories: mispronunciations, substitutions, refusals, additions, omissions and reversals.

Nonword Reading Task ***(Johnston & Anderson, submitted)***

This measure of nonword reading involved using a laptop computer with a voice-switch operated by microphone. The stimuli were simple CVC nonsense words, all easily pronounceable. The procedure was similar to that of the alphabet knowledge task (see above). Stimuli were preceded by an asterisk attention point, which was replaced by a nonword written in a simple font, around 1-2 cms high, in the centre of the screen. In order to make the words easier to read, the screen's video was inverted so that the words were in white on a black background. The child responded by saying the nonword into a microphone, tripping a voice-switch to reset the display to the asterisk and record the reaction time. The experimenter then pressed the space-bar and the next stimulus appeared on the screen. If no response was made during the time that the word was on screen (9 seconds maximum), the computer automatically reverted to the asterisk. There were occasions when the switch was tripped too early because of the subject making an extraneous noise. In such situations the stimulus was written down for the child to attempt to read, and note made that the reaction time data for that trial should be discarded. The children were all familiar with the procedure for the computer-based experiments because of the regular use of the alphabet knowledge task.

Each child was told that some 'funny' words which were not real words, were going to appear on the screen, and that they were to try to read them and say their answer loudly into the microphone. Six practice trials were given, during which it was emphasised that the words were not real, but 'made-up'. There followed 20 experimental stimuli, presented in a fixed order. No corrective feedback was given during testing. Scoring was based on the number of nonwords read correctly, and (separately) on the reaction time data from these trials.

Pseudohomophone Detection Task ***(Johnston & Anderson, submitted)***

A laptop computer with a pair of response keys was used in this task. The stimuli consisted of 40 simple words, each paired with a nonword which was pronounced in the same way as the real word (*i.e.,* a *pseudohomophone*), *e.g.* ***post poast***. The position of the real words and pseudohomophones was balanced randomly across the trials so that half of the real words were on the left, and half on the right. The positions of target words and order of presentation remained fixed for all children.

These 'word' pairs were presented to the children in the centre of the computer screen in a simple font, 1-2 cms high. Video was inverted, so that the letters appeared white on a black background. Each pair was preceded by an asterisk fixation point which was displayed for approx. 1 second. The children were told that two words would come up on the screen, and they had to decide which one was the *real* word. They were then to press either the left or right response key, according to the position of the real word on the screen. Each 'word' pair was displayed for a maximum of 15 seconds. When this time elapsed, or when the child made their response with the keys, the stimuli were replaced by the asterisk, which appeared for 1 second before the next stimuli appeared. The presentation proceeded automatically, apart from a pause before the experimental trials, at which point the experimenter checked the child was ready and then pressed the spacebar.

The procedure was clarified using the first practice trial as an example. Four more practice trials were given, and then the children were told that the real test was now beginning, and the experimental trials begun. No feedback was given at any point during the practice or experimental trials. Where the children began to form a response set of simply pressing alternate keys or the same key regardless of the stimuli, the experimenter reminded them of the task, and encouraged them to take time to read the words carefully before reaching a decision. Correct responses were recorded, along with their reaction time data.

<u>Orthographic Awareness Task</u> (Siegel, Share and Geva, 1995)

The procedure for this task was very similar to that for the Pseudo-homophone Detection Task (see above). Pairs of nonwords were presented in the centre of a laptop computer screen in letters around 1-2 cms high. The letters were white on a black background to aid visibility. In each trial an asterisk fixation point appeared for 1 second followed by the nonwords, which were shown for a maximum of 15 seconds. Responses were made using a pair of response keys, which removed the nonwords from the screen and started the next experimental trial. The stimuli for this task were all nonwords. One nonword in each stimulus pair contained a bigram in an orthographically legal position; the other word contained a bigram in the same position, but this time it was not a bigram which ever appears in a real English word. For example, in the nonword pair, *crif cnif,* the target word is *crif* since it contains the legal initial bigram of ***cr***, while the bigram at the start of ***cnif*** is not legal in English words.

The children were told that they were going to see pairs of 'funny' words, and it was emphasised that these were not real, but made-up words. They were to read the 2 'words' and then decide which one *"looks most like a real word"*. It was explained that if this was the word on the left, then they should press the left response key, and if it was the word on the right they should press the right hand response key. The procedure was clarified using the first of the 5 practice trials, and then the children proceeded through the test without corrective feedback from the experimenter.

As in the pseudohomophone detection task, the children were told when the practice was over, and when the child was ready the experimenter pressed the spacebar to initiate the 17 experimental trials. If the child fell into a response pattern of ignoring the stimuli and simply alternating which button they pressed, the experimenter reminded them to take time to read the 'words' and decide which one looked most like a real word.

Data were recorded as to which trials were correctly responded to, and the reaction times for the correct responses were analysed. One point was awarded for each correct response, giving a total possible maximum of 17.

Speed of Motor Functioning

In order to gain a measure of the children's motor skills, they were presented with a pegboard task. This consists of a piece of wood with 2 parallel rows of 10 holes. Ten small wooden pegs were placed in one row of holes, and the child's task was to move the pegs across into the row of empty holes as quickly as possible. The children were first asked to perform the task using only their right hand to move the pegs, and they were then asked to repeat the process using only their left hand. The children's speed was measured using a hand-held stopwatch. Handedness details were obtained from the children's teachers, in order that the response time for each child's dominant (and for their non-dominant) hand could be identified.

British Ability Scales - Recall of Digits (test C) ***(Elliot et al, 1983)***

This test was included as a measure of the children's short-term memory abilities. During the task, the experimenter read series of digits increasing in length, and the child was asked to repeat the numbers in the correct order. Test C of the British Ability Scales was used, which includes 2 numbers each with 2-8 digits, and one 9 digit number. A basal level was first established, and then the testing proceeded through the numbers until the child failed to correctly repeat both items in 2 successive number-length blocks. If the child asked the experimenter to repeat the target number, this was done, but the trial scored as incorrect. One point was awarded for each trial correctly repeated, and these raw scores were then converted into age-standardised scores.

Appendix 3
Task Stimuli

Table of contents

Clay Ready-to-Read Word Test

Practice items: the said is

I	and	Father
Mother	to	come
are	will	for
here	look	a
me	he	you
shouted	up	at
am	like	school
with	in	went
car	where	get
children	Mr	we
help	going	they
not	big	ready
too	go	this
meet	let	boys
away	on	please

BAS Word Reading Task

Words were read across each row from left to right.

the	up	on	go	he
at	jump	you	box	fish
one	cup	van	if	out
said	water	bird	wood	running
window	ship	clock	men	dig
ring	gate	money	thin	light
coat	brick	oil	heel	paper
carpet	skin	knock	switch	sport
building	writing	glove	army	harvest
travel	climb	ladies	calf	leather
believe	idea	chain	lawn	collect
invite	enemy	favour	drab	guest
territory	behaviour	massive	error	beard
groceries	encounter	statue	ceiling	transparent
universal	experience	dough	tentacle	obscure
character	exert	diameter	curiosity	environment
mosquito	nomadic	velocity	lethal	divulge
chaos	emphasise	jeopardy	aborigine	criterion

Neale Analysis of Reading Ability

sample passage and questions (form 2, level 2)

Surprise Parcel
A surprise parcel for Jane and Peter arrived on Saturday. Peter looked at the strange stamps. Jane undid the string. Then they shouted with delight. Uncle had sent some skates for Jane and an electric train for Peter. They were what the children had wanted for a long time.

questions
1. On what day did the parcel arrive?
2. How do you know that Jane and Peter were not expecting the parcel?
3. Who undid the string?
4. How do you know that the parcel came from another country?
5. Who had sent the parcel?
6. What was in the parcel for Jane?
7. What was in the parcel for Peter?
8. Why were the children so pleased to receive these presents?

Reading Style Index

<u>*Regular words*</u>	<u>*Exception Words*</u>	<u>*Nonsense Words*</u>
home	come	lont
seat	gone	mord
cost	friend	trond
nice	sugar	bome
miss	bread	geat
nine	hour	fove
hold	garage	rone
along	works	islop
page	front	inswit
short	move	suther
load	police	fage
alone	months	croad
signal	island	honup
chief	answer	frief
drove	broad	signeb
suffer	sign	botice
switch	trouble	getine
outside	machine	troudser

Rhyme Generation Task

Practice trials

cat	talk	sing

Experimental items

hop
tall
hen
dog
man
coat
tail
door
tree
jump
tin
nest

Odd Word Out Task

<u>Onset Control</u>

Practice trials *bat pot fish* *nod pig bed*

lip	mop	week
deck	tail	bowl
bead	cod	page
lap	hid	top
beak	pen	sock
tip	leak	duck

<u>Onset Experiment</u>

Practice trials *pip pad bun* *win pop wig*

peg	pin	car
cake	doll	cab
hip	life	lad
game	cat	cop
pen	dot	pale
den	dog	tail

<u>Rime Control</u>

Practice trials *pip pit mad* *feed ham feel*

peg	pen	car
cab	doll	cat
knock	line	life
den	deaf	game
pain	dot	pale
lime	cot	cop

<u>Rime Experiment</u>

Practice trials *red fed bin* *had wish mad*

hip	lip	week
deck	nail	tail
bead	seed	page
mop	hid	top
beak	pan	leak
tip	sock	knock

Phoneme and Syllable Deletion Task

Practice items: cowboy steamboat

Original items (Rosner, 1975) - deletion marked in bold italics

1. sunshine	8. wrote
2. picnic	9. please
3. cucumber	10. clap
4. coat	11. play
5. meat	12. stale
6. take	13. smack
7. game	

Additional items

initial phoneme	*initial blend-split*	*initial syllable*
pat	drive	hedgehog
here	green	bathroom
car	stop	hairband
will	trend	pencil
note	clip	teapot
his	blue	lightswitch
dog		suitcase
		target

final phoneme	*final blend-split*	*final syllable*
date	dance	toothbrush
look	heart	doorbell
coffee	help	birthday
bear	milk	garden
book	bird	carpet
house	dark	cornflakes
light	and	pancake
	harp	telephone
	damp	stopwatch

Phoneme Segmentation Task

<u>Practice items:</u> man go ride

list 1	list 2
fine	top
she	wave
grew	in
zoo	red
do	that
at	keep
lay	job
me	ice
by	race
three	dog
no	sat

Phonological Common Unit Identification Task (part one)

Dundee School 1

1) Common Onset

Biff - boy
Chip - chair
mum - make
dad - day
got - game
his - had
put - park
was - with
cake - car
jam - jump

2) Common Start

Biff - big
Chip - chick*
mum - mud
dad - dance
got - gone
his - hill
put - pull
was - watch
cake - cage
jam - jar

3) Common Rime

Biff - sniff*
Chip - ship
mum - sum
dad - bad
got - pot
his - fizz*
put - foot
was - cause*
cake - make
jam - pram

4) Common Vowel

Biff - hill
Chip - twin
mum - run
dad - bag
got - for
his - did
put - book
was - ball
cake - train
jam - had

5) Common End

Biff - roof
Chip - top
mum - him
dad - said
got - sit
his - was
put - cat
was - these
cake - black
jam - time

* These words were not drawn from the book of children's vocabularies, as no suitable words could be found.

Phonological Common Unit Identification Task (part one)

Dundee School 2

1) Common Onset

look - last
yes - yellow
home - hot
mum - make
but - boy
not - nice
Lad - like
Ben - big
run - red
can - come

2) Common Start

look - loose
yes - yet
home - hold
mum - mud
but - bus
not - knock
Lad - last
Ben - bell
run - rug (?)
can - car

3) Common Rime

look - book
yes - mess
home - foam (?)
mum - sum
but - cut
not - got
Lad - bad
Ben - pen
run - fun
can - man

4) Common Vowel

look - good
yes - bed
home - floor
mum - run
but - fun
not - shop
Lad - cat
Ben - set
run - jump
can - bath

5) Common End

look - week
yes - bus
home - swim
mum - him
but - get
not - boat
Lad - bed
Ben - can
run - ten
can - gun

Phonological Common Unit Identification Task (part one)
Fife and New Zealand Schools

Word pairs in brackets were given to New Zealand children (these stimuli were changed due to pronunciation differences)

1) Common Onset

yes - you
look - leg
not - next
bus - boat
can - came
get - gave
car - cake
for - fish
moon - must
let - like

2) Common Start

yes - yet	
bed - bench	
cat - can	(big - bit)
bus - bug	
can - card	(can - camp)
red - rest	
car - camp	(let - left)
for - fog	(for - fall)
dog - doll	
let - leg	

3) Common Rime

yes - dress
look - took
not - got
bed - head
can - man
get - pet
car - far
cat - sat
dog - log
let - pet

4) Common Vowel

yes - ten	(yes - wet)
look - food	(moon - food)
not - god	
bus - fun	
can - far	
get - well	
car - bad	
for - got	
moon - book	
let - head	

5) Common End

yes - kiss
bed - sad
not - cat
bus - cross
can - lean
get - shut
car - year
for - bear
dog - big
let - fat

Phonological Common Unit Identification Task (part two)
Dundee Schools

1) Common Onset

dog - down
part - pick
last - like
six - sun
train - tree
draw - dress
green - grow
bread - brush

2) Common Start

mat - man
can - car
doll - dog
hat - has
cloth - clock
brick - bridge
gran - grass
from - frog

3) Common Rime

ball - fall
boy - toy
man - can
boat - goat
paste - waste
dark - park
tent - went
cold - hold

4) Common End

him - name
get - lot
week - bake
made - road
paint - count
dark - work
just - last
find - sand

Phonological Common Unit Identification Task (part two)

<u>Fife and New Zealand Schools</u>

Word pairs in brackets were given to New Zealand children (these stimuli were changed due to pronunciation differences)

1) Common Onset

boss - boat
got - girl
nice - next
wife - want
step - stay
from - friend
pray - pretty
star - step

2) Common Body

want - war
part - path
boom - book (has - hat)
cup - cut
grab - grass (brick - bridge)
start - stand (stick - still)
place - plane
stuck - stuff

3) Common Rime

bar - far
lot - shot
will - hill
peek - week
burn - turn
think - sink
last - past
jump - bump

4) Common Coda

bit - hot
then - moon
log - rug
had - read
hurt - part
hard - beard (fast - just)
must - past
bump - camp

Alphabet Knowledge Task

order of presentation:

k
g
q
c
x
m
a
n
b
p
o
d
j
s
e
t
v
u
r
f
l
y
i
z
h
w

Nonword Reading Task (Duncan et al)

Dundee School 1

Reading words - Oxford Reading Tree (up to Stage 2, Book 1)

Kipper	Biff	Chip	and
mum	dad	Floppy	a
the	Wilf	Wilma	wanted
party	nobody	to	come
he	got	his	toys
cake	put	in	cornflakes
tomato	sauce	milk	jam
sugar	baked	beans	was
cross	sorry		

Nonword Reading Stimuli - reading scheme words in bold used to create stimuli, unless otherwise stated

1) start + rime

milf	wis
pum	jad*
bis	mut
hilk	chiff
goys	bip

2) onset + rime

mot	pilk
tis	hoys
gilf	wum
dut	mip
chad	bilf

3) start + end

mit	daff
pulk	mus
tolf	chid
jas	gop
wid	bim

4) onset + vowel + end

bom	gim*
chulf	dit
mos	tid
hap	cham
wulk	maff*

---

*Includes word *jam*

Nonword Reading Task (Duncan et al)

Dundee School 2

Reading words - Ginn Reading 360 (up to level 2, book 2)

look	in	here	no
yes	not	I	can
help	we	you	where
mum	home	is	my
it	Lad	Ben	come
stop	and	run	this
like	but	fast	can't
play	he	me	

Nonword Reading Task Stimuli - reading scheme words in bold used to create stimuli, unless otherwise stated

1) start+ rime

stot	hes
belp	yen
lan	nop
mun	bes
cad	plad

2) onset + rime

ren	celp
stook	hun
bis	les
lum	yop
mot	nad

3) start + end

rus	cam
ston	hep
bek	lood
lat	yed
mup	nolp

4) onset + vowel + end

nep	mak
yon	lus
lem	bon
hoon	stet
ced	ralp

Nonword Reading Task (Duncan et al)

<u>Fife and New Zealand Schools</u>

Reading words (taken from New Zealand reading schemes)

yes	look	not	bus
can	get	car	for
let	moon	bed	dog
red			

Nonword Reading Task Stimuli

1) start+ rime

loon*	mook
fot	ges
yed	nog
cad	dat
dor	ret

2) onset + rime

yook	cet*
nus	cus
lan	bot
gar	lor
foon	mes

3) start + end

yer	cak
nos	cas
loon*	buk
gen	ler
fos	moot

4) onset + vowel + end

yat	ner
lon	goog
foos	cet*
cos	bek
lun	mor

* These words had to be discarded from the analyses since they were repeated in more than one condition.

Nonword Reading Task (Johnston & Anderson)

hig
nal
kug
bis
gok
dep
foy
kun
ged
lar
jek
lan
mip
pos
ruk
dal
ped
fik
lom
sul

Orthographic Unit Identification Task

Dundee School 1

Stimuli	rime	start	onset	vowel	end
took	ook	too	t	oo	k
mud	ud	muh	m	uh	d
jam	am	jah	j	ah	m
was	aws	waw	w	aw	z
got	awt	gaw	g	aw	t
good	ood	goo	g	oo	d
toy	oy	taw	t	aw	y
put	oot	poo	p	oo	t
dog	og	daw	d	aw	g
wet	et	weh	w	eh	t

Lists - first two items in each list are practice items

t	*too*	*daw*	*oy*	*eh*
g	*z*	*t*	*aw*	*ood*
goo	g	oo	w	taw
aw	og	uh	d	t
muh	aw	oot	oo	aw
oo	ah	y	am	p
ot	gaw	g	poo	jah
ook	et	m	waw	k
t	t	oz	d	w
j	m	weh	d	ud

lists shown to children

toy	took	dog	toy	wet
dog	was	took	got	good
good	good	good	wet	toy
was	dog	mud	dog	got
mud	toy	put	took	dog
put	jam	toy	jam	put
got	got	got	put	jam
took	wet	jam	was	took
wet	put	was	good	was
jam	mud	wet	mud	mud

Orthographic Unit Identification Task

Dundee School 2

Stimuli	rime	start	onset	vowel	end
look	ook	loo	l	oo	k
yes	es	yeh	y	eh	s
but	ut	buh	b	uh	t
for	or	faw	f	aw	r
not	ot	naw	n	aw	t
Lad	ad	lah	l	ah	d
Ben	en	beh	b	eh	n
run	un	ruh	r	uh	n
can	an	cah	c	ah	n
Tom	om	taw	t	aw	m

Lists - items 1 and 2 in each list are practice items

uh	*aw*	*l*	*ca*	*ruh*
r	*r*	*or*	*un*	*d*
lah	m	eh	oo	en
ot	beh	t	ah	uh
om	ook	an	faw	c
n	ad	eh	n	buh
b	ah	n	n	k
loo	b	muh	ut	aw
y	t	l	s	es
uh	yeh	naw	m	f

lists shown to children

run	for	Lad	can	run
for	run	for	run	Lad
Lad	Tom	Ben	look	Ben
not	Ben	but	Lad	Tom
Tom	look	can	for	can
can	Lad	yes	not	but
Ben	can	run	Ben	look
look	but	Tom	but	not
yes	not	look	yes	yes
but	yes	not	Tom	for

Orthographic Unit Identification Task

Fife Schools

Stimuli	rime	body	onset	peak	coda
yes	es	ye	y	e	s
look	ook	loo	l	oo	k
not	ot	no	n	o	t
bus	us	bu	b	u	s
can	an	ca	c	a	n
get	et	ge	g	e	t
car	ar	ca	c	a	r
for	or	fo	f	o	r
moon	oon	moo	m	oo	n
let	et	le	l	e	t

Lists - items 1 and 2 in each list are practice items

ess	*n*	*ah*	*c*	*naw*
t	*aw*	*g*	*buh*	*ook*
f	l	r	eh	are
n	c	y	moo	b
uh	s	oon	ot	m
oo	an	cah	eh	ah
n	geh	oo	or	eh
et	aw	leh	l	s
loo	et	t	r	faw
cah	yeh	uss	k	t

lists shown to children

yes	moon	car	can	not
let	for	get	bus	look
for	look	for	get	car
can	car	yes	moon	bus
bus	bus	moon	not	moon
moon	can	can	yes	can
not	get	look	for	let
get	not	let	let	yes
look	let	not	car	for
car	yes	bus	look	get

Orthographic Unit Identification Task
New Zealand Schools

Two extra words were added to the Fife lists for the New Zealand children (red and dog), in case of confusion with the rimes of yes (es) and car (ar).

Stimuli	rime	body	onset	peak	coda
yes	es	ye	y	e	s
look	ook	loo	l	oo	k
not	ot	no	n	o	t
bus	us	bu	b	u	s
can	an	ca	c	a	n
get	et	ge	g	e	t
car	ar	ca	c	a	r
for	or	fo	f	o	r
moon	oon	moo	m	oo	n
let	et	le	l	e	t
red	ed	re	r	e	d
dog	og	do	d	o	g

Lists - items 1 and 2 in each list are practice items

ess	*n*	*ah*	*c*	*naw*
t	*aw*	*g*	*buh*	*ook*
f	l	r	eh	daw
ed	c	y	moo	are
n	og	oon	ot	b
uh	s	cah	eh	d
oo	an	aw	or	m
g	eh	oo	l	ah
n	geh	leh	d	eh
et	aw	r	r	s
loo	et	t	k	faw
cah	yeh	uss	reh	t

lists shown to children

yes	moon	car	can	not
let	for	get	bus	look
for	look	for	get	dog
red	car	yes	moon	car
can	dog	moon	not	bus
bus	bus	can	yes	red
moon	can	dog	for	moon
dog	red	look	let	can
not	get	let	dog	let
get	not	red	car	yes
look	let	not	look	for
car	yes	bus	red	get

Pseudohomophone Detection Task

soak	soke
nail	nale
hoap	hope
cum	come
laim	lame
home	hoam
was	woz
luv	love
wurd	word
desc	desk
gave	gaiv
teach	teech
wotch	watch
boath	both
bocks	box
grow	groe
red	redd
post	poast
flud	flood
goal	gole
bear	bair
hoase	hose
low	loe
build	bild
bloan	blown
wosh	wash
saive	save
move	moove
laid	layd
wosp	wasp
own	oan
gone	gon
blood	blud
foam	fome
heer	hear
bowl	boal
taik	take
gluv	glove
bake	baik
cote	coat
mow	moe
hate	hait
heet	heat
shaiv	shave
group	groop

Orthographic Awareness Task

correct answers underlined:

filv	filk
tolz	tolb
powl	lowp
dlun	lund
fant	tanf
miln	milg
togd	togn
wolg	wolt
moke	moje
jofy	fojy
cnif	crif
bnad	blad
hift	hifl
gwup	gnup
nitl	nilt
clid	cdil
vism	visn

Analogy Task

List A			List B		
Pre-test list		*Post-test lists*	*Pre-test list*		*Post-test lists*
rink	*a*	rink	near	*a*	near
sing		sing	hang		hang
heat		gain	fail		gain
beak		sign	cost		ring
gran		rang	lent		barn
gain		wing	gain		sang
lend		ping	neat		bang
sold		king	kind		gang
hand	*b*	bark	went	*b*	soak
lane		sack	tall		dock
bolt		track	mend		rock
cake		rack	cook		cock
meat		beak	sail		cost
pack		cake	lock		cook
rack		crab	cock		sick
sign		pack	ring		lock
band	*c*	grand	rent	*c*	lent
ping		bald	gang		step
late		sand	tile		dent
wing		hand	sang		went
bald		band	step		rent
gold		lend	find		neat
lost		lean	dine		nest
doll		nail	mint		seen
beat	*d*	cold	mail	*d*	bind
crab		bolt	sick		mend
rang		gold	barn		find
cold		hold	bind		wind
sand		toad	dent		tied
king		doll	bang		mint
lean		sold	nest		kind
seat		lost	rail		dine
tent	*e*	team	wait	*e*	late
hold		late	wind		tile
team		lane	late		tall
nail		beat	seen		mail
toad		seat	tied		rail
sack		tent	dock		wait
track		heat	rock		fail
bark		meat	soak		sail

<u>Clue words</u> List A - ring back land told neat
List B - rang sock sent mind tail

BAS Recall of Digits

92
75
756
483
8495
6159
23746
95247
417432
751946
2569874
5814726
38896152
25837461
928414375

Nonword Spelling Test

1. shart
2. vond
3. wege ("weej")
4. tink
5. bave (rhymes with 'grave')
6. grun
7. flad (rhymes with 'glad')
8. blid (rhymes with 'hid')
9. blane (rhymes with 'plane')
10. prent
11. brab
12. buke (rhymes with 'duke')
13. brack
14. grafe (rhymes with 'safe')
15. shold (as in '<u>should</u>er')
16. chack
17. hage (rhymes with 'page')
18. tharn
19. glime (rhymes with 'time')
20. fand
21. glave (rhymes with 'grave')
22. woln
23. flack
24. clune (rhymes with 'spoon')
25. blice (rhymes with 'nice')
26. crich (rhymes with 'hitch')

Schonell Graded Word Spelling Test (B)

1. see
2. cut
3. mat
4. in
5. ran
6. bag
7. ten
8. hat
9. dad
10. bed
11. leg
12. dot
13. pen
14. yet
15. hay
16. good
17. till
18. be
19. with
20. from
21. time
22. call
23. help
24. week
25. pie
26. boat
27. mind
28. sooner
29. year
30. dream
31. sight
32. mouth
33. large
34. might
35. brought
36. mistake
37. pair
38. while
39. skate
40. stayed
41. yoke
42. island
43. nerve
44. join
45. fare
46. iron
47. health
48. direct
49. calm
50. headache
51. final
52. circus
53. increase
54. slippery
55. lodge
56. style
57. bargain
58. copies
59. guest
60. policy
61. view
62. library
63. cushion
64. safety
65. patient
66. account
67. earliest
68. institution
69. similar
70. generous
71. orchestra
72. equally
73. individual
74. merely
75. enthusiastic
76. appreciate
77. familiar
78. source
79. immediate
80. breathe

Appendix 4
Tables of Correlations

Table of Contents

List of Abbreviations

analogy - control1 : Muter analogy task, pre- training control word score
analogy - analogy1: Muter analogy task, pre- training analogy word score
analogy - control2: Muter analogy task, post-training control word score
analogy - control 2: Muter analogy task, post-training analogy word score
BPVS: British Picture Vocabulary Scale
Clay: Clay Ready-to-Read Task
CEFT: Children's Embedded Figures Test
Cuid 1 - onset: phonological common unit identification task (a), common onset
Cuid 1 - body: phonological common unit identification task (a), common body
Cuid 1 - peak: phonological common unit identification task (a), common peak
Cuid 1 - rime: phonological common unit identification task (a), common rime
Cuid 1 - coda: phonological common unit identification task (a), common coda
Cuid 2 - onset (s): phonological common unit identification task (b), common simple onset
Cuid 2 - onset (c): phonological common unit identification task (b), common complex onset
Cuid 2 - body (s): phonological common unit identification task (b), common simple body
Cuid 2 - body (c): phonological common unit identification task (b), common complex body
Cuid 2 - rime (s): phonological common unit identification task (b), common simple rime
Cuid 2 - rime (c): phonological common unit identification task (b), common complex rime
Cuid 2 - coda (s): phonological common unit identification task (b), common simple coda
Cuid 2 - coda (c): phonological common unit identification task (b), common complex coda
digit span: BAS digit span task
IQ: BAS IQ measure

letter names: alphabet knowledge, letter names
letter sounds: alphabet knowledge, letter sounds
Neale - accur age: Neale Analysis of Reading, reading age - accuracy
Neale accur: Neale Analysis of Reading, reading age - accuracy
Neale - rate age: Neale Analysis of Reading, reading age - rate
Neale rate: Neale Analysis of Reading, reading age - rate
Neale - compr age: Neale Analysis of Reading, reading age - comprehension
Neale compreh: Neale Analysis of Reading, reading age - comprehension
nonwords - B/R: Duncan et al nonword naming task, body/rime
nonwd B/R: Duncan et al nonword naming task, body/rime
nonwords - O/R: Duncan et al nonword naming task, onset/rime
nonwd O/R: Duncan et al nonword naming task, onset/rime
nonwords - B/C: Duncan et al nonword naming task, body/coda
nonwd B/C: Duncan et al nonword naming task, body/coda
nonwords - O/P/C: Duncan et al nonword naming task, onset/peak/coda
nonwd O/P/C: Duncan et al nonword naming task, onset/peak/coda
nonword spelling: nonword spelling task
nonwd spelling: nonword spelling task
orthogr awareness: Siegel orthographic awareness task
orthogr aware. : Siegel orthographic awareness task
Ouid - onset: orthographic unit identification task, onset
Ouid - body: orthographic unit identification task, body
Ouid - peak: orthographic unit identification task, peak
Ouid - rime: orthographic unit identification task, rime
Ouid - coda: orthographic unit identification task, coda
OWO - total: odd word out task, total score
OWO - OC: odd word out task, onset control (e.g., hop lip week)
OWO - OE: odd word out task, onset experiment (e.g., peg pin car)
OWO - RC: odd word out task, rime control (e.g., pig pin car)
OWO - RE: odd word out task, rime experiment (e.g., hip lip week)
peg - dominant: pegboard task, RT for dominant hand
pegbd dom: pegboard task, RT for dominant hand
peg - non-dominant: pegboard task, RT for non-dominant hand
pegbd n-dom: pegboard task, RT for non-dominant hand
phoneme del: phoneme deletion task
phon del: phoneme deletion task
phon seg - words: phoneme segmentation, number of words correctly segmented
p seg words: phoneme segmentation, number of words correctly segmented
phon seg - phonemes: phoneme segmentation, number of phonemes correctly segmented
p seg phon: phoneme segmentation, number of phonemes correctly segmented
pseudohom. task: pseudohomophone detection task
pseud detection: pseudohomophone detection task
reading age: BAS Word Reading age
RG - trials: rhyme generation task, number of trials answered with a rhyme
RG - rhymes: rhyme generation task, number of rhyming words produced
spelling age: Schonell spelling age
syllable del: syllable deletion task
syll del: syllable deletion task
visual perc: Frostig Test of Visual Perception
visual percept: Frostig Test of Visual Perception

Block 1 - Block 1

block 1⇨ block 1⇩	*IQ*	*BPVS*	*Clay*	*RG trials*	*RG rhymes*	*OWO total*	*OWO OC*
BPVS	.339*						
Clay	-.031	.363**					
RG - trials	.069	-.110	.035				
RG - rhymes	.012	-.136	.079	.932***			
OWO - total	.160	.394**	.542***	.297*	.213		
OWO - OC	.235	.300*	.327*	.100	.078	.504***	
OWO - OE	.003	.227	.230	.288*	.207	.682***	.158
OWO - RC	.177	.383**	.593***	.128	.093	.758***	.179
OWO - RE	.029	.130	.246	.274	.190	.682***	.199
Phoneme Del	.121	.220	.356*	.318*	.304*	.536***	.237
Syllable Del	.085	.137	.244	.131	.143	.348*	.155
Phon Seg-words	.240	.191	.173	.293*	.302*	.219	.085
Phon Seg-phonemes	.121	.179	.371**	.255	.327*	.249	.023
letter sounds	.259	.268	.531***	.202	.175	.354**	.295*
letter names	.143	.262	.704***	.058	.100	.263	.232
Visual Perc	.391**	.362**	.157	.201	.069	.320*	.104
CEFT	.190	.169	.229	.044	.044	.178	-.014
peg - dominant	-.135	-.187	-.261	-.175	-.175	-.244	-.142
peg - non-dominant	-.000	-.203	-.374**	-.091	-.091	-.412**	-.171

block 1⇨ block 1⇩	*OWO OE*	*OWO RC*	*OWO RE*	*Phon Del*	*Syll Del*	*P Seg words*	*P Seg phon*
OWO - RC	.354**						
OWO - RE	.273	.323*					
Phoneme Del	.476***	.410**	.277*				
Syllable Del	.280*	.290*	.178	.681***			
Phon Seg-words	.318*	.160	.009	.520***	.348*		
Phon Seg-phonemes	.318*	.226	.057	.493***	.384**	.876***	
letter sounds	.243	.265	.154	.362**	.368**	.398**	.533***
letter names	.096	.324*	.035	.153	.278	.032	.269
Visual Perc	.243	.312*	.154	.244	.141	.133	.128
CEFT	.052	.226	.158	.357**	.252	.320*	.318*
peg - dominant	-.057	-.330*	-.086	-.178	-.024	-.011	-.058
peg - non-dominant	-.397**	-.417**	-.068	-.431**	-.263	-.200	-.247

block 1⇨ block 1⇩	*Letter Sounds*	*Letter Names*	*Visual Percept*	*CEFT*	*pegbd dom*	*pegbd n-dom*	
letter names	.667***						
Visual Perc	.244	.067					
CEFT	.162	.124	.429**				
peg - dominant	.083	-.021	-.355**	-.197			
peg - non-dominant	-.082	-.148	-.316*	-.311*	.628***		

Block 2 - Block 2

block 2 ⇨ / block 2 ⇩	Reading Age	OWO total	OWO OC	OWO OE	OWO RC	OWO RE	Phon Del
OWO - total	.475***						
OWO - OC	.151	.605***					
OWO - OE	.421**	.838***	.264				
OWO - RC	.415**	.821***	.262	.677***			
OWO - RE	.383**	.730***	.599***	.442**	.332*		
Phoneme Del	.627***	.673***	.323*	.635***	.454***	.603***	
Syllable Del	.502***	.538***	.281*	.458***	.405**	.468***	.776***
Phon Seg-words	.317*	.262	.053	.303*	.144	.267	.392**
Phon Seg-phonemes	.352**	.291*	.116	.278	.167	.317*	.414**
letter sounds	.246	.291*	.172	.245	.292*	.138	.248
letter names	.557***	.469***	.258	.387**	.427**	.311*	.403**
Spelling Age	.511***	.509***	.173	.472***	.444**	.380**	.622***
Digit Span	-.001	.175	.139	.274	.089	.021	.196
block 2 ⇨ / block 2 ⇩	**Syll Del**	**P Seg words**	**P Seg phon**	**Letter Sounds**	**Letter Names**	**Spelling Age**	**Digit Span**
Phon Seg-words	.354**						
Phon Seg-phonemes	.435**	.933***					
letter sounds	.194	.379**	.396**				
letter names	.402**	.075	.148	.184			
Spelling Age	.496***	.674***	.673***	.585***	.264		
Digit Span	.152	.264	.233	.085	.081	.307*	

Block 3 - Block 3

block 3⇨ block 3⇩	Reading Age	RG trials	RG rhymes	OWO total	OWO OC	OWO OE	OWO RC
RG - trials	.285*						
RG - rhymes	.291*	.901***					
OWO - total	.566***	.223	.266				
OWO - OC	.163	.239	.309*	.578***			
OWO - OE	.556***	.039	.087	.778***	.272		
OWO - RC	.461***	.239	.248	.786***	.177	.525***	
OWO - RE	.411**	.157	.165	.763***	.452***	.391**	.444**
Phoneme Del	.590***	.299*	.200	.708***	.281*	.630***	.570***
Syllable Del	.425**	.237	.086	.481***	.086	.345*	.524***
Phon Seg-words	.386**	.213	.182	.181	-.119	.333*	.192
Phon Seg-phonemes	.415**	.202	.199	.171	.101	.337*	.219
Cuid 1 - onset	.303*	.344*	.318*	.197	.082	.247	.226
Cuid 1 - body	.265	.181	.181	.355**	.320*	.282*	.331*
Cuid 1 - peak	.384**	.127	.145	.351**	.062	.343*	.429**
Cuid 1 - rime	.597***	.328*	.276	.631***	.386**	.569***	.419**
Cuid 1 - coda	.381**	.214	.184	.421**	.180	.317*	.469***
Cuid 2 - onset (s)	.137	.143	.052	-.039	-.069	-.057	-.001
Cuid 2 - onset (c)	.127	-.141	-.126	-.055	-.161	-.093	-.024
Cuid 2 - body (s)	.313*	.231	.180	.332*	.145	.419**	.349*
Cuid 2 - body (c)	.281*	.157	.141	.031	.034	.172	-.024
Cuid 2 - rime (s)	.634***	.284*	.278	.613***	.170	.595***	.530***
Cuid 2 - rime (c)	.472***	.279	.279	.404**	.026	.360**	.419**
Cuid 2 - coda (s)	.343*	.205	.182	.344*	.153	.393**	.265
Cuid 2 - coda (c)	-.074	-.100	-.121	.029	-.146	.140	.151
Letter sounds	.179	.002	.101	.308*	.198	.237	.284*
Letter names	.528***	.241	.207	.510***	.064	.396**	.624***
Nonwords - B/R	.721***	.183	.167	.494***	.068	.544***	.395**
Nonwords - O/R	.690***	.265	.295*	.455***	.052	.538***	.369**
Nonwords - B/C	.611***	.195	.207	.444**	-.012	.487***	.349*
Nonwords - O/P/C	.651***	.120	.176	.484***	.027	.568***	.347*
Ouid - onset	.303*	.157	.087	.219	.103	.186	.218
Ouid - body	.304*	.237	.240	.389**	.142	.400**	.385**
Ouid - peak	.420**	.145	.129	.372**	.326*	.355**	.270
Ouid - rime	.552***	.237	.328*	.508***	.205	.498***	.516***
Ouid - coda	.280*	.179	.155	.290*	.161	.149	.348*
nonword spelling	.490***	.121	.156	.338*	.031	.422**	.249
CEFT	.304*	.308*	.248	.473***	.279	.341*	.244

block 3 ⇨ / block 3 ⇩	OWO RE	Phon Del	Syll Del	P Seg words	P Seg phon	Cuid1 Onset	Cuid1 Body
Phoneme Del	.538***						
Syllable Del	.374**	.754***					
Phon Seg-words	.035	.339*	.303*				
Phon Seg-phonemes	-.047	.359**	.349*	.956***			
Cuid 1 - onset	-.019	.178	.151	.372**	.332*		
Cuid 1 - body	.107	.316*	.119	.346*	.404**	.195	
Cuid 1 - peak	.110	.478***	.289*	.305*	.318*	.140	.414**
Cuid 1 - rime	.472***	.695***	.459***	.311*	.295*	.253	.168
Cuid 1 - coda	.210	.569***	.411**	.374**	.382**	.227	.465***
Cuid 2 - onset (s)	.001	-.101	-.105	-.003	-.026	.145	-.146
Cuid 2 - onset (c)	.098	-.099	-.240	.042	.066	.034	.063
Cuid 2 - body (s)	-.004	.406**	.199	.338*	.414**	.279	.608***
Cuid 2 - body (c)	-.099	.134	.001	.214	.205	.213	.415**
Cuid 2 - rime (s)	.420**	.675***	.405**	.396**	.389**	.207	.461***
Cuid 2 - rime (c)	.298*	.476***	.322*	.272	.283*	.081	.247
Cuid 2 - coda (s)	.162	.525***	.313*	.259	.280	.123	.319*
Cuid 2 - coda (c)	-.138	.040	.022	.127	.145	-.173	.105
Letter sounds	.168	.274	.081	.313*	.324*	-.075	.446***
Letter names	.297*	.604***	.496***	.084	.135	.189	.266
Nonwords - B/R	.362**	.585***	.335*	.700***	.677***	.276	.372**
Nonwords - O/R	.292*	.509***	.216	.673***	.626***	.308*	.364**
Nonwords - B/C	.393**	.576***	.321*	.610***	.586***	.257	.306*
Nonwords - O/P/C	.398**	.512***	.262	.624***	.594***	.278	.351*
Ouid - onset	.112	.227	.311*	.226	.295*	.020	.296*
Ouid - body	.153	.242	.050	.390**	.405**	-.007	.400**
Ouid - peak	.146	.339*	.158	.221	.261	.268	.213
Ouid - rime	.197	.400**	.145	.292*	.353**	.158	.407**
Ouid - coda	.165	.279*	.312*	.266	.303*	.021	.372**
nonword spelling	.229	.376**	.148	.665***	.649***	.294*	.438**
CEFT	.547***	.490***	.345*	.132	.135	.188	.217

block 3 ⇨ / block 3 ⇩	Cuid1 Peak	Cuid1 Rime	Cuid1 Coda	Cuid2 onset(s)	Cuid2 onset(c)	Cuid2 body(s)	Cuid2 body(c)
Cuid 1 - rime	.260						
Cuid 1 - coda	.565***	.324*					
Cuid 2 - onset (s)	-.185	.049	-.041				
Cuid 2 - onset (c)	-.146	-.072	-.129	.114			
Cuid 2 - body (s)	.400**	.315*	.273	.066	.054		
Cuid 2 - body (c)	.199	.061	.282	.109	-.143	.504***	
Cuid 2 - rime (s)	.412**	.673***	.433**	-.014	.013	.534***	.257
Cuid 2 - rime (c)	.291*	.612***	.385**	.056	.063	.380**	.274
Cuid 2 - coda (s)	.505***	.327*	.729***	.080	-.194	.196	.256
Cuid 2 - coda (c)	.112	-.092	.178	-.164	-.122	.201	.088
Letter sounds	.266	.211	.255	-.197	.076	.328*	.080
Letter names	.479***	.318*	.476***	-.052	.120	.259	.024
Nonwords - B/R	.382**	.530***	.457***	.075	.095	.385**	.261
Nonwords - O/R	.461***	.546***	.373**	.153	.066	.401**	.367**
Nonwords - B/C	.441**	.459***	.431**	-.081	.054	.343*	.213
Nonwords - O/P/C	.423**	.464***	.379**	-.064	.071	.335*	.224
Ouid - onset	.032	.050	.065	-.164	-.040	.306*	.219
Ouid - body	.177	.220	.175	.007	.167	.539***	.215
Ouid - peak	.184	.277	.181	.038	-.021	.389**	.130
Ouid - rime	.364**	.372**	.351*	.011	.131	.606***	.317*
Ouid - coda	.202	.137	.093	-.136	.047	.409**	.123
nonword spelling	.441**	.357**	.253	-.160	.146	.411**	.245
CEFT	.124	.425**	.026	-.147	.100	.168	-.055
block 3 ⇨ / block 3 ⇩	**Cuid2 Rime(s)**	**Cuid2 Rime(c)**	**Cuid2 Coda(s)**	**Cuid2 Coda(c)**	**Letter Sounds**	**Letter Names**	**Nonwd B/R**
Cuid 2 - rime (c)	.807***						
Cuid 2 - coda (s)	.346*	.317*					
Cuid 2 - coda (c)	.308*	.418**	.234				
Letter sounds	.329*	.201	.135	.069			
Letter names	.450***	.321*	.392**	-.075	.092		
Nonwords - B/R	.604***	.417**	.458***	.064	.350*	.362**	
Nonwords - O/R	.606***	.482**	.373**	-.016	.322*	.333*	.899***
Nonwords - B/C	.540***	.348*	.470***	.060	.347*	.373**	.892***
Nonwords - O/P/C	.574***	.392**	.447**	.133	.355**	.334*	.882***
Ouid - onset	.101	-.034	.013	.010	-.003	.072	.238
Ouid - body	.415**	.263	.135	.185	.622***	.101	.452***
Ouid - peak	.246	.134	.052	.065	.050	.216	.442**
Ouid - rime	.525***	.438**	.355**	.261	.454***	.361**	.539***
Ouid - coda	.242	.156	-.029	.107	.475***	.213	.246
nonword spelling	.387**	.198	.264	-.076	.442**	.176	.750***
CEFT	.246	.127	.092	-.171	.091	.182	.302*

block 3⇨ *block 3⇩*	*Nonwd O/R*	*Nonwd B/C*	*Nonwd O/P/C*	*Ouid Onset*	*Ouid Body*	*Ouid Peak*	*Ouid Rime*
Nonwords - B/C	.825***						
Nonwords - O/P/C	.852***	.941***					
Ouid - onset	.134	.139	.120				
Ouid - body	.420**	.393**	.401**	.349*			
Ouid - peak	.380**	.322*	.288*	.342*	.116		
Ouid - rime	.512***	.530***	.520***	.191	.703***	.311*	
Ouid - coda	.191	.167	.154	.578***	.465***	.418**	.336*
nonword spelling	.727***	.716***	.699***	.347*	.453***	.295*	.448***
CEFT	.232	.324*	.278	.317*	.098	.211	.163
block 3⇨ *block 3⇩*	*Ouid Coda*	*Nonwd Spelling*	*CEFT*				
nonword spelling	.322*						
CEFT	.185	.351*					

Block 4 - Block 4

block 4⇨ block 4⇩	BPVS	Reading Age	Neale Accur	Neale Rate	Neale Comp	OWO total	OWO OC
Reading Age	.410**						
Neale - Accur Age	.469**	.876***					
Neale - Rate Age	.005	-.083	-.091				
Neale - Compr Age	.380**	.778***	.896***	-.074			
OWO - total	.276	.586***	.484***	.111	475***		
OWO - OC	.185	.474***	.492***	.202	413**	.708***	
OWO - OE	.075	.421**	.227	.122	294*	.740***	.432**
OWO - RC	.198	.425**	.296	.062	.312*	.775***	.287*
OWO - RE	.346*	.408**	.408**	-.051	.384**	.722***	.384**
Phoneme Del	.147	.604***	.390**	.220	.498***	.512***	.535***
Syllable Del	.134	.329*	.223	.163	.376**	.501***	.475***
Phon Seg-words	-.087	-.145	-.390**	.056	-.250	-.138	-.259
Phon Seg-phonemes	-.057	-.152	-.449**	.067	-.337*	-.179	-.296*
Letter sounds	.139	.279	.217	.115	.141	.156	.152
Letter names	.259	.504***	.228	.041	.393**	.437**	.224
Nonword reading	.331*	.720***	.433**	.031	.437**	.379**	.221
Pseudohom. task	.095	.422**	.546***	-.102	.468***	.364**	.305*
Orthogr. Awareness	.158	.395**	.475***	-.035	.488***	.259	.409**
Analogy - control1	.390**	.904***	.835***	-.128	.775***	.532***	.423**
Analogy - analogy1	.510***	.838***	.703***	-.168	.667***	.459***	.340*
Analogy - control2	.441**	.905***	.825***	-.154	.764***	.481***	.354**
Analogy - analogy2	.434**	.816***	.700***	-.180	.673***	.482***	.357**
Spelling Age	.395**	.840***	.745***	-.055	.537***	.538***	.426**
Nonword spelling	.144	.463***	.169	-.036	.170	.233	.056

block 4⇨ block 4⇩	*OWO OE*	*OWO RC*	*OWO RE*	*Phon Del*	*Syll Del*	*P Seg words*	*P Seg phon*
OWO - RC	.531***						
OWO - RE	.228	.476***					
Phoneme Del	.418**	.328*	.241				
Syllable Del	.276	.416**	.317*	.781***			
Phon Seg-words	.134	-.145	-.144	-.115	-.186		
Phon Seg-phonemes	.129	-.158	-.207	-.089	-.198	.932***	
Letter sounds	-.001	.094	.208	.093	.073	-.249	-.179
Letter names	.461***	.425**	.186	.439**	.422**	-.012	-.020
Nonword reading	.301*	.213	.370**	.523***	.247	.152	.144
Pseudohom. task	.168	.329*	.275	.338*	.295*	-.191	-.246
Orthogr. Awareness	.239	.094	.037	.387**	.167	-.137	-.124
Analogy - control1	.286*	.378**	.475***	.531***	.271	-.237	-.268
Analogy - analogy1	.303*	.316*	.388**	.470***	.191	-.128	-.162
Analogy - control2	.258	.393**	.408**	.481***	.222	-.208	-.212
Analogy - analogy2	.311*	.374**	.377**	.517***	.254	-.130	-.156
Spelling Age	.449***	.327*	.381**	.554***	.262	-.025	-.016
Nonword spelling	.320*	.052	.241	.368**	.082	.252	.302*

block 4⇨ block 4⇩	*Letter Sounds*	*Letter Names*	*Nonwd Reading*	*Pseud Detect.*	*Orthogr Awar.*	*Analogy contr1*	*Analogy anal1*
Letter names	.119						
Nonword reading	.317*	.449***					
Pseudohom. task	-.095	.103	.180				
Orthogr. Awareness	.081	-.010	.029	.292*			
Analogy - control1	.277	.410**	.680***	.497***	.301*		
Analogy - analogy1	.255	.400**	.758***	.265	.223	.883***	
Analogy - control2	.251	.387**	.689***	.399**	.297*	.945***	.896***
Analogy - analogy2	.190	.444**	.696***	.332*	.227	.882***	.943***
Spelling Age	.356**	.460***	.630***	.351**	.319*	.779***	.703***
Nonword spelling	.220	.316*	.664***	-.022	.070	.394**	.445**

block 4⇨ block 4⇩	*Analogy contr2*	*Analogy anal2*	*Spelling Age*	*Nonwd Spelling*			
Analogy - analogy2	.897***						
Spelling Age	.750***	.706***					
Nonword spelling	.400**	.351**	.560***				

Block 1 - Block 3

block 1 ⇨ block 3 ⇩	IQ	BPVS	Clay	RG trials	RG rhymes	OWO total	OWO OC
Reading Age	.214	.449***	.492***	.028	.031	.384**	.184
RG - trials	.113	.167	.375**	.296*	.340**	.262	.194
RG - rhymes	.137	.176	.414**	.377**	.405**	.369**	.157
OWO - total	.315*	.393**	.503***	.236	.173	.574***	.203
OWO - OC	.089	.348*	.335*	.165	.103	.375**	.202
OWO - OE	.326*	.332*	.382**	.117	.052	.457***	.108
OWO - RC	.206	.191	.441**	.210	.202	.472***	.154
OWO - RE	.276	.319*	.300*	.203	.140	.364**	.151
Phoneme Del	.208	.306*	.454***	.095	.102	.348*	.148
Syllable Del	.166	.231	.353**	.061	.088	.225	.079
Phon Seg-words	.101	.206	-.079	.150	.194	.059	.016
Phon Seg-phonemes	.121	.182	-.055	.141	.182	.061	-.075
Cuid 1 - onset	.053	.382**	.179	.227	.228	.310*	.207
Cuid 1 - body	.028	.028	.052	.117	.213	.181	-.059
Cuid 1 - peak	-.077	.072	.369**	.143	.217	.300*	.098
Cuid 1 - rime	.299*	.419**	.357**	.024	-.036	.349*	.267
Cuid 1 - coda	-.042	.036	.228	.126	.167	.286*	.179
Cuid 2 - onset (s)	-.201	-.107	.030	-.127	-.231	.187	.109
Cuid 2 - onset (c)	.171	-.040	-.078	-.018	.045	-.181	-.025
Cuid 2 - body (s)	.208	.130	.056	-.004	.041	.082	-.131
Cuid 2 - body (c)	-.108	.066	-.005	-.089	-.018	-.091	-.140
Cuid 2 - rime (s)	.265	.155	.308*	.057	.132	.298*	.183
Cuid 2 - rime (c)	.200	.059	.189	.047	.119	.141	.149
Cuid 2 - coda (s)	-.026	.059	.264	.059	.044	.262	.146
Cuid 2 - coda (c)	-.081	-.169	-.147	-.027	.066	-.134	-.071
Letter sounds	.242	.006	.076	.085	.078	.122	.193
Letter names	.203	.233	.606***	.131	.200	.440**	.305*
Nonwords - B/R	.243	.424**	.131	.095	.087	.174	.063
Nonwords - O/R	.113	.321*	.204	.120	.126	.233	.030
Nonwords - B/C	.188	.289*	.100	.217	.196	.122	-.006
Nonwords - O/P/C	.147	.323*	.167	.227	.199	.187	-.025
Ouid - onset	.241	.241	-.067	-.041	-.020	.068	-.177
Ouid - body	.353**	-.047	-.021	.143	.114	.059	-.063
Ouid - peak	.179	.595***	.199	.060	.105	.356**	.162
Ouid - rime	.298*	.070	.192	.228	.213	.212	.014
Ouid - coda	.251	.278	.124	.052	.154	.240	.151
nonword spelling	.389**	.330*	-.062	.055	.068	.086	.016
CEFT	.282*	.265	.139	.320*	.308*	.146	-.003

block 1 ⇨ block 3 ⇩	*OWO OE*	*OWO RC*	*OWO RE*	*Phon Del*	*Syll Del*	*P Seg words*	*P Seg phon*
Reading Age	.236	.369**	.200	.302*	.290	.373**	.592***
RG - trials	-.013	.267	.239	.175	.162	.187	.363**
RG - rhymes	.131	.353**	.305*	.290*	.169	.208	.345*
OWO - total	.415**	.558***	.287*	.490***	.366**	.483***	.510***
OWO - OC	.286*	.367**	.118	.410**	.178	.245	.194
OWO - OE	.414**	.484***	.139	.404**	.284*	.478***	.470***
OWO - RC	.200	.422**	.431**	.300*	.291*	.278	.414**
OWO - RE	.333*	.352**	.099	.353**	.304*	.406*	.371**
Phoneme Del	.292*	.332*	.123	.494***	.474***	.525***	.632***
Syllable Del	.095	.174	.235	.382**	.486***	.387**	.559***
Phon Seg-words	.107	-.035	.080	.371**	.263	.341*	.380**
Phon Seg-phonemes	.119	-.012	.115	.377**	.284*	.349*	.436**
Cuid 1 - onset	.235	.194	.197	.225	.074	.274	.337*
Cuid 1 - body	.245	.158	.094	.212	.018	.164	.289*
Cuid 1 - peak	.168	.270	.231	.398**	.173	.178	.300*
Cuid 1 - rime	.164	.315*	.181	.328*	.294*	.421**	.476***
Cuid 1 - coda	.193	.149	.253	.279	.175	.183	.320*
Cuid 2 - onset (s)	.062	.141	.183	-.025	.036	-.251	-.118
Cuid 2 - onset (c)	-.209	-.049	-.196	-.231	-.161	-.184	-.154
Cuid 2 - body (s)	.107	.098	.095	.161	-.030	.320*	.391**
Cuid 2 - body (c)	.011	-.044	-.092	-.048	-.057	.082	.198
Cuid 2 - rime (s)	.269	.282*	.044	.342**	.191	.527***	.633***
Cuid 2 - rime (c)	.113	.065	.070	.092	.024	.255	.409**
Cuid 2 - coda (s)	.152	.223	.168	.306*	.158	.020	.192
Cuid 2 - coda (c)	.014	-.252	-.014	-.069	-.166	.091	.103
Letter sounds	.218	-.087	.064	.273	.181	.190	.138
Letter names	.200	.504***	.131	.250	.246	.154	.368**
Nonwords - B/R	.197	.191	-.012	.313*	.205	.386**	.472***
Nonwords - O/R	.197	.283*	.061	.270	.136	.307*	.405**
Nonwords - B/C	.153	.175	-.034	.276	.160	.497***	.536***
Nonwords - O/P/C	.251	.215	.009	.284*	.122	.437**	.479***
Ouid - onset	.049	.090	.161	.192	.202	.247	.287*
Ouid - body	.063	.062	.070	.165	.144	.251	.242
Ouid - peak	.239	.333*	.183	.292*	.113	.402**	.428**
Ouid - rime	.142	.155	.227	.307*	.159	.341*	.440**
Ouid - coda	.141	.069	.300*	.305*	.219	.245	.292*
nonword spelling	.154	.045	.010	.285*	.155	.332*	.320*
CEFT	.229	.157	-.027	.384**	.403**	.459***	.460***

block 1 ⇨ block 3 ⇩	Letter Sounds	Letter Names	Visual Percept	CEFT	pegbd dom	pegbd n-dom
Reading Age	.607***	.531***	.275	.290*	-.121	-.194
RG - trials	.269	.202	.130	.175	-.328*	-.107
RG - rhymes	.291*	.234	.119	.119	-.234	-.137
OWO - total	.486***	.421**	.436**	.328*	-.193	-.323*
OWO - OC	.108	.128	.253	.073	-.292*	-.441**
OWO - OE	.379**	.273	.452***	.265	-.104	-.205
OWO - RC	.479***	.436**	.303*	.283*	-.123	-.129
OWO - RE	.387**	.345*	.252	.304*	-.089	-.248
Phoneme Del	.457***	.398**	.252	.327*	-.274	-.328*
Syllable Del	.416**	.384**	.149	.158	-.200	-.262
Phon Seg-words	.257	-.104	.216	.148	-.067	.067
Phon Seg-phonemes	.287*	-.066	.209	.172	-.094	-.005
Cuid 1 - onset	.208	.055	.221	.104	-.126	.008
Cuid 1 - body	.051	.031	.155	.016	-.169	-.134
Cuid 1 - peak	.175	.212	.164	.230	-.069	-.235
Cuid 1 - rime	.539***	.295*	.335*	.255	-.029	-.109
Cuid 1 - coda	.217	.287*	-.037	.181	-.083	-.226
Cuid 2 - onset (s)	.023	-.052	.060	.186	-.069	-.099
Cuid 2 - onset (c)	.099	.085	-.039	.126	-.149	.078
Cuid 2 - body (s)	.178	.001	.214	.187	-.163	-.163
Cuid 2 - body (c)	-.048	.100	-.024	-.046	-.037	-.102
Cuid 2 - rime (s)	.510***	.338*	.172	.164	-.027	-.062
Cuid 2 - rime (c)	.421**	.276	.004	.101	.083	.022
Cuid 2 - coda (s)	.168	.248	.209	.207	-.119	-.232
Cuid 2 - coda (c)	-.102	-.169	-.108	-.084	.039	.119
Letter sounds	.367**	.121	.182	-.135	-.017	.004
Letter names	.480***	.660***	.044	.160	-.208	-.230
Nonwords - B/R	.399**	.183	.334*	.241	-.054	-.012
Nonwords - O/R	.342*	.118	.306*	.141	.022	.011
Nonwords - B/C	.376**	.140	.244	.195	.021	.032
Nonwords - O/P/C	.408**	.164	.298*	.147	-.059	-.048
Ouid - onset	.088	-.044	.354**	.262	-.325*	-.296*
Ouid - body	.370**	.018	.304*	.094	-.112	.022
Ouid - peak	.098	-.051	.199	.267	-.227	-.274
Ouid - rime	.464***	.237	.131	.151	.046	.013
Ouid - coda	.244	.037	.161	-.018	-.293*	-.163
nonword spelling	.221	-.022	.452***	.200	.005	.047
CEFT	.204	.097	.423**	.464***	-.285	-.335*

Block 1 - Block 4

block 1⇨ block 4⇩	*IQ*	*BPVS*	*Clay*	*RG trials*	*RG rhymes*	*OWO total*	*OWO OC*
BPVS	.265	.443**	.150	.177	.117	.130	.110
Reading Age	.123	.369**	.328*	.054	.016	.379**	.049
Neale - Accur Age	.011	.378**	.328*	.052	-.035	.410**	.192
Neale - Rate Age	-.119	.018	.049	-.129	-.106	.012	.077
Neale - Compr Age	.007	.410**	.454**	.117	.052	.492***	.263
OWO - total	.253	.360**	.326***	.153	.142	.514***	.239
OWO - OC	.210	.293*	.465***	.020	-.063	.341*	.102
OWO - OE	.130	.238	.415**	.163	.207	.454***	.206
OWO - RC	.211	.223	.405**	.108	.71	.388**	.260
OWO - RE	.194	.302*	.274	.153	.100	.331*	.140
Phoneme Del	.053	.231	.280*	.023	.054	.221	.048
Syllable Del	.224	.196	.362**	.047	.101	.220	.188
Phon Seg-words	-.089	-.083	-.105	-.036	.055	-.026	.002
Phon Seg-phonemes	-.083	-.087	-.162	-.072	.026	-.071	-.048
Letter sounds	.204	-.005	.065	.089	.093	.029	.077
Letter names	.175	.242	.507***	.193	.221	.356**	.293*
Nonword reading	.124	.187	.032	.227	.234	.120	-.112
Pseudohom. task	-.211	.225	.387**	-.231	-.157	.172	.003
Orthogr. Awareness	-.033	.204	.231	-.019	-.023	.250	.058
Analogy - control1	.072	.312*	.298*	.078	.019	.348*	.039
Analogy - analogy1	.185	.361**	.207	.198	.158	.253	.031
Analogy - control2	.085	.311*	.246	.119	.067	.319*	-.002
Analogy - analogy2	.114	.328*	.307*	.124	.105	.247	.027
Spelling Age	.109	.248	.198	-.002	-.035	.307*	.044
Nonword spelling	.096	.120	-.172	.112	.087	.008	-.152

block 1 ⇨ block 4 ⇩	*OWO OE*	*OWO RC*	*OWO RE*	*Phon Del*	*Syll Del*	*P Seg words*	*P Seg phon*
BPVS	.118	.054	.079	-.063	.109	.133	.223
Reading Age	.378**	.290*	.246	.257	.182	.241	.434**
Neale - Accur Age	.274	.359*	.228	.132	.179	.072	.241
Neale - Rate Age	.043	-.034	-.029	.317*	.238	-.047	-.136
Neale - Compr Age	.322*	.395**	.258	.338*	.267	.230	.420**
OWO - total	.285*	.407**	.409**	.427**	.346*	.301*	.426**
OWO - OC	.206	.356**	.195	.302*	.272	.232	.223
OWO - OE	.305*	.391**	.274	.329*	.189	.261	.361**
OWO - RC	.133	.299*	.341*	.266	.333*	.232	.393**
OWO - RE	.192	.163	.386**	.355**	.231	.166	.278
Phoneme Del	.276	.203	.034	.447***	.383**	.435**	.533***
Syllable Del	.094	.203	.102	.357**	.460***	.268	.387**
Phon Seg-words	.163	-.105	-.106	.049	-.109	-.018	.023
Phon Seg-phonemes	.077	-.106	-.100	-.006	-.104	-.122	-.075
Letter sounds	-.024	-.131	.199	.154	.113	.086	.119
Letter names	.103	.371**	.173	.321*	.296*	.227	.412**
Nonword reading	.248	.060	.087	.344*	.192	.319*	.428**
Pseudohom. task	.056	.238	.115	.008	.121	-.034	.217
Orthogr. Awareness	.203	.242	.127	.115	.123	.201	.266
Analogy - control1	.326*	.283*	.230	.261	.177	.269	.473***
Analogy - analogy1	.295*	.184	.134	.228	.164	.395**	.533***
Analogy - control2	.319*	.252	.229	.188	.173	.279	.470***
Analogy - analogy2	.220	.209	.166	.175	.085	.302*	.515***
Spelling Age	.337*	.179	.232	.091	.040	.220	.425**
Nonword spelling	.190	-.011	-.038	.296*	.200	.306*	.341*

block 1 ⇨ block 4 ⇩	*Letter Sounds*	*Letter Names*	*Visual Percept*	*CEFT*	*pegbd dom*	*pegbd n-dom*
BPVS	.397**	.286*	.170	-.040	-.175	-.080
Reading Age	.495***	.373**	.307*	.106	-.065	-.149
Neale - Accur Age	.538***	.392**	.240	-.059	-.032	-.135
Neale - Rate Age	-.105	.013	-.237	.021	-.100	-.126
Neale - Compr Age	.601***	.431**	.263	.125	-.125	-.265
OWO - total	.331*	.377**	.380**	.375**	-.270	-.233
OWO - OC	.362**	.388**	.388**	.361**	-.186	-.229
OWO - OE	.189	.186	.203	.388**	-.239	-.177
OWO - RC	.200	.408**	.091	.163	-.103	-.078
OWO - RE	.229	.147	.425**	.193	-.257	-.197
Phoneme Del	.329*	.237	.267	.196	-.100	-.217
Syllable Del	.317*	.395**	.252	.171	-.191	-.243
Phon Seg-words	-.176	-.237	-.054	.022	-.000	-.052
Phon Seg-phonemes	-.231	-.282*	-.023	-.095	-.024	-.002
Letter sounds	.200	.018	-.061	-.256	.019	.032
Letter names	.540***	.520***	.133	.295*	-.131	-.078
Nonword reading	.342*	.105	.284*	.051	-.035	.021
Pseudohom. task	.159	.425**	.045	-.009	-.191	-.185
Orthogr. Awareness	.148	.007	.232	.245	-.130	-.282*
Analogy - control1	.491***	.400**	.303*	.134	-.034	-.176
Analogy - analogy1	.509***	.322*	.338*	.171	.043	-.080
Analogy - control2	.520***	.388**	.280*	.037	.004	-.115
Analogy - analogy2	.543***	.410**	.322*	.162	.080	-.038
Spelling Age	.359**	.189	.267	.028	-.100	-.100
Nonword spelling	.073	-.271	.354**	.159	-.131	-.147

Block 2 - Block 4

block 2⇨ block 4⇩	Reading Age	OWO total	OWO OC	OWO OE	OWO RC	OWO RE	Phon Del
BPVS	.204	.249	.104	.129	.313*	.163	.139
Reading Age	.543***	.619***	.290*	.569***	.531***	.421**	.516***
Neale - Accur Age	.443**	.475***	.152	.436**	.394**	.390**	.416**
Neale - Rate Age	-.096	-.044	.258	-.214	-.079	.047	-.019
Neale - Compr Age	.634***	.488***	.190	.394**	.372**	.494***	.587***
OWO - total	.415**	.608***	.366**	.478***	.493***	.492***	.484***
OWO - OC	.387**	.503***	.303*	.389**	.489***	.304*	.412**
OWO - OE	.374**	.423**	.297*	.385**	.294*	.315*	.417**
OWO - RC	.339*	.503***	.298*	.411**	.397**	.407**	.347*
OWO - RE	.135	.369**	.189	.233	.283*	.418**	.255
Phoneme Del	.524***	.556***	.434**	.474***	.404**	.398**	.606***
Syllable Del	.480***	.458***	.319*	.392**	.366**	.306*	.499***
Phon Seg-words	.008	-.135	.117	-.251	-.193	.038	-.027
Phon Seg-phonemes	-.072	-.190	.089	-.279	-.231	-.037	-.064
Letter sounds	-.068	-.067	-.180	.014	.058	-.191	-.012
Letter names	.521***	.475***	.333*	.363**	.397**	.346*	.416**
Nonword reading	.224	.440**	.294*	.394**	.337*	.302*	.418**
Pseudohom. task	.453***	.332*	.225	.370**	.162	.268	.393**
Orthogr. Awareness	.389**	.123	.029	.116	.066	.157	.346*
Analogy - control1	.503***	.556***	.171	.496***	.485***	.451***	.514***
Analogy - analogy1	.463***	.531***	.140	.487***	.516***	.358**	.466***
Analogy - control2	.447***	.547***	.191	.472***	.471***	.455***	.495***
Analogy - analogy2	.519***	.522***	.183	.427**	.520***	.367**	.431**
Spelling Age	.374**	.438**	.230	.378**	.424**	.242	.303*
Nonword spelling	.094	.220	.213	.234	.043	.231	.336*

block 2⇨ block 4⇩	Syll Del	P Seg words	P Seg phon	Letter Sounds	Letter Names	Spelling Age	Digit Span
BPVS	.348*	.166	.274	.307*	.108	.252	-.017
Reading Age	.343*	.446***	.452***	.508***	.292*	.639***	.255
Neale - Accur Age	.317*	.142	.200	.374*	.269	.377**	.131
Neale - Rate Age	.122	-.169	-.191	-.163	-.022	-.125	.155
Neale - Compr Age	.474***	.321*	.376**	.339*	.365**	.542***	.103
OWO - total	.473***	.273	.300*	.190	.380**	.429**	.305*
OWO - OC	.362**	.073	.054	.246	.406**	.308*	.307*
OWO - OE	.227	.153	.187	.022	.216	.271	.276
OWO - RC	.406**	.198	.217	.162	.367**	.345*	.119
OWO - RE	.398**	.364**	.404**	.137	.147	.340*	.197
Phoneme Del	.533***	.476***	.509***	.302*	.294*	.557***	.396**
Syllable Del	.684***	.324*	.374**	.114	.429**	.411**	.246
Phon Seg-words	-.006	.050	.078	-.054	-.222	-.124	-.078
Phon Seg-phonemes	-.036	.079	.113	-.091	-.264	-.135	-.051
Letter sounds	.116	.112	.110	.329*	-.058	.214	.095
Letter names	.428**	.490***	.553***	.371	.560***	.488***	.031
Nonword reading	.373**	.574***	.599***	.492***	-.007	.588***	.249
Pseudohom. task	.252	.072	.125	.069	.378**	.274	.212
Orthogr. Awareness	.156	.085	.114	.191	-.012	.300*	.100
Analogy - control1	.357**	.412**	.442**	.504***	.319*	.618***	.239
Analogy - analogy1	.345*	.448***	.457***	.552***	.217	.632***	.201
Analogy - control2	.353**	.421**	.461***	.547***	.274	.649***	.236
Analogy - analogy2	.340*	.406**	.451***	.570***	.339*	.617***	.181
Spelling Age	.153	.371**	.412**	.449***	.181	.482***	.332*
Nonword spelling	.170	.558***	.581***	.263	-.176	.371**	.149