THE INFLUENCE OF INSTRUCTIONAL APPROACH ON THE READING STRATEGIES OF BEGINNING READERS

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I, Vincent Connelly, hereby certify that this thesis, which is approximately 72,643 words in length, has been written by me, that it is the record of work carried out by me and that it has not been submitted in any previous application for a higher degree.

Signed: Date: 30 SEPT 1994

I was admitted as a research student in October 1990, and as a candidate for the degree of Ph.D. in October 1991; the higher study for which this is a record was carried out in the University of St.Andrews between 1991 and 1994.

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I hereby certify that the candidate has fulfilled the conditions of the resolutions and regulations appropriate to the Degree of Ph.D. in the University of St.Andrews and that the candidate is qualified to submit this thesis in application for that degree.

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Abstract

There are a number of models of reading development which propose that reading develops in a set sequence of stages (e.g. Frith 1985, Marsh et al 1981), and that each child must pass through one stage before it can move onto the next. It is been pointed out that these models very rarely take into account external factors such as the method of instruction that the children receive (Stuart and Coltheart 1988, Goswami and Bryant 1990) and what effect such factors would have on progression through the stages. This study investigated how the factor of instruction influenced how children read. Young children taught by two different methods were studied. Scottish five and six year olds taught by a phonics method, where they were shown the correspondences between letter segments and their sounds, were compared with New Zealand children of the same age taught by a language experience approach. Samples were matched for reading age, chronological age, time at school, vocabulary knowledge and digit span. Error analyses of responses to single words showed a marked divergence in reading strategies. The Scottish children were much more likely to attempt to read unfamiliar words, whereas the New Zealand children often failed to attempt to read items they did not know. The errors the Scottish children made were also qualitatively different to those of the New Zealand children. The Scottish children were better at pronouncing nonwords and were more advanced in spelling performance. The Scottish children were also superior at a test of simple phonological segmentation. They also produced a word length

effect when reading words. The New Zealanders, however, were better at pronouncing irregular words and were faster readers, especially with familiar classroom words. They did not produce a word length effect even when words were distorted. Overall the Scottish children showed more evidence of a grapheme to phoneme conversion strategy, which in turn was correlated with good reading performance. The New Zealanders displayed signs of a more visual approach to reading. There was some overlap between the national groups particularly regarding the prevalence of errors incorporating beginning and end letters. The older children in each national group also showed a greater convergence of strategy use than the younger readers. This work therefore has implications for the efficacy models of reading, such as Frith's (1985). Matched groups of children should display the same reading strategies if reading skill is accomplished in universal stages, in this study they do not. Future models of reading development will need to take into consideration how the child is taught to read.

Chapter 1-The history of the "skilled" reader

"I think you might do something better with the time"
Alice said,
"than waste it asking riddles with no answers."

Whenever I mentioned to people during the course of my research for this thesis that I was studying reading and its teaching every one of them offered an opinion on the topic (the grand majority of which were very enlightened and thought provoking!). In fact, reading has always been a topic that has interested people in Britain, from Caesar's comments on how druids taught the subject (Caesar 52BC?/1912), through to Henry the Eighth's decision to force children to learn to read in English, right up to the present day. The same is true of psychologists who have also been very interested in reading since the birth of modern psychology over one hundred years ago. Huey in 1908 was amazed at the skills involved in reading and in a famous quote stated that:

"To completely analyse what we do when we read would almost be the acme of a psychologists achievements, for it would be to describe very many of the most intricate workings of the human mind, as well as to unravel the tangled story of the most remarkable specific performance that civilisation has learned in all its history"

(Huey 1908/1968 p.6)

Nevertheless, the history of written language as we know it is quite short. The first archaeological evidence of writing goes back to the cuneiform script of Mesopotamia (Proto-Sumerian) of about 3500-3100BC. Such writing systems were called "logographic" (from the Greek 'logo' meaning word) because each symbol represented a whole word. Most modern Western writing systems are alphabetic in nature where each symbol stands for a basic sound in the language rather than an individual word. This is a much more arbitrary system than a logographic system. It has the advantage of having a small number of symbols to learn which can be recombined to represent almost any word in the particular language of the writer. The Phoenicians who lived in what is now Syria and Israel developed one of the first syllabic and sound based writing systems around about 1500BC. The Ancient Greeks adopted this system which formed the basis of the first alphabet. The rise of the Roman Empire, which had adopted a Greek style alphabet, ensured that the cultural transmission of alphabetic scripts throughout the Western world began in earnest.

Psychologists have therefore tended to look upon reading as a cultural "invention" which is relatively new in human evolutionary terms (Ellis 1993). It is seen as parasitic on human language and the cognitive systems associated with it, for example, memory. It is not seen as an innate skill in humans but rather a formal, learned skill (Adams 1990, but see Marshall 1987 for an alternative view of human "predisposition" to reading).

Since the act of reading in itself involves many brain functions psychologists have sought to discover how we read and how we learn to read. By the early 20th Century psychologists such as Huey (1908) and Orton (1925) had published detailed comments on reading behaviours and their opinions on how these behaviours were formed.

In more recent years a more standardised approach to the study of reading has emerged from cognitive psychology. Cognitive psychologists tend to view abstract brain operations like reading in "information processing" terms. Information processing refers to the idea that mental processes can be broken down into sequential stages. The idea is then to investigate each step between stimulus (question) and response (answer). These stages are generally conceptualised as boxes in diagrams that are similar to computer flow charts illustrating computer programmes. This allows behaviour to be "modularised" into almost independent sub-processes.

Cognitive psychologists often do use the digital computer as a theoretical metaphor for the brain so that there is an easily understandable framework to base results and hypotheses on. Current theory is therefore built on the idea that human cognition resembles computer information processing in many ways. It has become the dominant approach to studying reading in the past three decades.

The next section will examine the dominant models which have grown out of the cognitive psychology approach. Developmental models of reading have relied heavily on the cognitive models of how adults learn to read words that have appeared in the last few decades. Therefore we shall begin with an evaluation of one of the most popular adult models of reading; the dual route model. We shall then look at the analogy model of Glushko (1979) which arose out of criticism of the dual route model, after which we shall plot the dual route response to Glushko by Patterson and Morton (1985). The pendulum then swings back again to anti-dual route theories with an examination of the parallel distributed model of Seidenberg and McClelland (1989). We conclude with a small section on the revised dual route computational model of Coltheart, Curtis, Atkins and Haller (1993). This small review does not cover all the adult models of reading which have been proposed in the last two decades. The models that are discussed here though are those that have been the most influential in psychology and the debate over whether reading involves one route or two has had a great effect on which models of reading development have been influential.

Dual Route Model of Reading

The initial idea that there may be two routes used by the skilled reader to understand text was developed concurrently by certain linguists theorising about the development of the English language writing system (e.g. Venezky 1970) and a group of cognitive neuropsychologists observing dyslexic patients (e.g. Marshall and Newcombe 1973) in the 1970's. The linguists had noted that letter strings could be split into regular and irregular words. The problem was that people could pronounce irregular words correctly despite them not conforming to normal English orthography. Nonwords, which depend for their pronunciation on knowledge of letter-sound associations, could also be correctly pronounced by the vast majority of people. The linguists hypothesised that there should then be two processes available to deal with this dichotomy in reading.

Cognitive neuropsychologists took on board these ideas and deduced that if there were two reading processes available then the population of patients with brain damage that affected reading should show some evidence of this. Marshall and Newcombe (1973) reported that their sample of dyslexics could be split into two types; Deep dyslexics who could not read nonwords but could read irregular words, and surface dyslexics who had an advantage for regular words but a very poor performance with irregular words. Marshall and Newcombe claimed to have demonstrated a double dissociation and that this was confirmation of two possible routes to reading words. Marshall and Newcombe's conclusions were criticised by some (e.g. Marcel 1980) because of overlapping deficits in their patients but more "pure" cases have been repeated by others since this (Funnell 1983, Bub, Cancelliere and Kertesz 1985). The foundations of the dual route model were laid by the dyslexic data. It was thought that there had to be one route which was a direct visual route and that the other route would be a phonological route.

Researchers then moved on to test and work out what level the two proposed routes operated at. Coltheart (1978) put forward a detailed model and claimed that the direct visual route worked by word specific orthographic representations being mapped directly to lexical entries in a mental dictionary (lexicon). Coltheart's phonological route used a set of rules which mapped graphemes to phonemes for coding which were based on the ideas of those like Venezky (1970). The set of rules was acquired during the course of learning to read. He also proposed that when a word was read both independent routes were activated but that the directness of the visual route made it typically faster than the phonological route.

The influence of the phonological route is minimal in normal skilled reading and would only show itself when the subject was presented with nonwords (or perhaps with very low frequency words). By the same token the phonological route cannot deal with irregular words, items that cannot be pronounced using grapheme to phoneme conversion (GPC) rules. Therefore since a direct visual route is the only possible way to read irregular words, the main research focus has been on whether a phonological route does exist independently of the visual route.

Coltheart (1978) claimed that if the two routes existed then when a subject is presented with a word the two routes will "race" to provide an answer to its pronunciation. Due to the direct nature of the visual route this will normally produce the correct response first and the phonological route will later confirm the correct answer. However if there is an irregular word presented to the subject then the visual route will produce a direct response that will not be confirmed by the phonological route. There will be a resultant conflict of potential responses which will necessitate a time consuming spell check. Therefore the Coltheart model predicts that there will be slower reaction times for irregular words compared to regular words in normal skilled readers. This phenomenon was indeed found by researchers at the time like Baron and Strawson (1976) and Stanovich and Bauer (1978).

The dual route model also offered an explanation for the pseudohomophone effect in adult reading. Many studies in the 1970's claimed to show that pseudohomophones (e.g. poast) were responded to more slowly by subjects than ordinary nonwords (e.g. loast) and that there were more errors made from reading the former type of nonword. Coltheart attributed this effect to the confusion arising between the direct and indirect routes over a nonword that was very similar to a real word. This was taken as more evidence for a phonological route to reading (for a more detailed review of the pseudohomophone effect and lexical decision tasks see Chapter 5).

Ultimately of course the best evidence for the independence of both routes of the Coltheart model are the case studies of acquired dyslexics that were mentioned earlier.

Problems with the original Dual Route Model

Seidenberg, Waters, Barnes and Tanenhaus (1984) found that the irregular word effect was only found with low frequency words and was absent with high frequency stimuli. Parkin (1984) studied words that were irregular in terms of GPC rules but regular in terms of the split into onset and rime. Parkin found no regularity effect with these words and so claimed that the Coltheart view of regularity was flawed since the regular onset rime spelling of the words seemed to banish the effects of irregularity. Martin (1982) and Taft (1982) also cast doubts on Coltheart's explanation of the pseudohomophone effect claiming that it was more to do with orthographic than phonological similarity (See chapter 5 for a detailed review of this criticism).

Van Orden and his colleagues (Van Orden, Johnston and Hale 1988, Van Orden 1987, Van Orden, Pennington and Stone 1990) have proposed that phonology is not slower than lexical access and that instead phonology comes before lexical access (i.e. from the outset it is pre-lexical). Van Orden (1987) conducted a number of experiments using a semantic categorisation task. He found that responses to a homophone that was very similar in spelling to its real word equivalent were performed on better in comparison to homophones that had much less similar spelling to their real word equivalents (e.g.

sweet and suite). However this effect of orthographic influence disappeared when the stimulus words were masked. An effect of homophony still remained despite the masking and the words could still be categorised. This led Van Orden to suggest that the phonology of a word and its categorisation is decided on in the earliest stages of recognition.

Taft (1991) pointed out that the result with masking does not mean that the pronunciation of words was generated before lexical access. The lexical entry will contain the pronunciation of the word and so it could still have been accessed "on the basis of purely visual information" (Taft 1991 p.67). Van Orden et al (1988) repeated the task but this time used nonword homophones rather than real words. The same effects were found but this time Van Orden et al claimed that the errors made could not have arisen from lexical sources since nonwords do not have lexical entries. Taft (1991) replied that this result could be explained within a dual route model (the phonological route is used to read nonwords like homophones and so phonology is bound to appear before lexical access) if necessary, and that a real test of pre-access phonology should instead concentrate on using the same paradigm but with irregular words. If irregular homophones are mis-classified on the basis of sound then a pre-lexical explanation must be required.

Dual route theorists presume that sight word reading is achieved through a process of rote memorisation. Rote memorisation is usually a process used as a last resort when learning something that is difficult, arbitrary and unsystematic. Ehri (1984, 1987, 1992, 1994), however points out that since English uses letters and sounds then any relationship is hardly arbitrary. Ehri also claims that there is very little direct evidence for the dual route idea of sight word learning. What evidence there is (e.g. Baron and Baron 1977, Treiman 1984) relates to phonology not having an effect on sight word reading, which is primarily negative evidence.

Dual route theory does not explain, according to Ehri, why developmentally we must learn to GPC rules if sight words are learned by rote memorisation alone. It would seem illogical that we would go to the trouble of learning complex GPC rules to use them once for a word then abandon them in favour of simple memorisation. It would also seem illogical that a systematic alphabetic system, developed over hundreds of years, should not be used as an aide to memory. A reply to this might be that decoding is merely a facilitator of reading which allows us to get past the initial stage of not knowing a word at all (Jorm and Share 1983). However, there is a large body of evidence to suggest that skill at using GPC rules and phonological awareness are the strongest predictors of reading achievement (e.g. Adams 1990, Bradley and Bryant 1983, 1985, Juel 1988, Stuart and Coltheart 1988, Tunmer and Nesdale 1985, Vellutino and Scanlon 1987, Wagner and Torgeson 1987, Yopp 1988).

Ehri (1980, 1984, 1987, 1992, 1994) has proposed that readers "build access routes" from their knowledge of GPC rules to the spellings of words. These access routes allow the knowledge of letters in spellings to be directly linked to the phonemes that make up the pronunciation of the word. "The letters are processed as visual symbols for the phonemes and the sequence of letters is retained in memory as an alphabetic, phonological representation of the word" (Ehri 1994 p.339). Perfetti (1992) has put forward a similar idea based on "bonding" of orthographic and phonological representations. Once the word has been encountered a few times then the need to phonologically recode becomes unnecessary as seeing the spelling automatically activates the connections that lead directly to the pronunciation of the word from memory.

These problems with the dual route model pale into insignificance compared to the data Glushko (1979) put forward. Glushko identified three types of words which did not fit with the simple idea that all words could be split into regular or irregular categories. The first of Glushko's categories consisted of what he called consistent words. These are words which are traditionally seen as regular and which have a word body (or rime) that is invariant in all the words it is found in (e.g. teach). The next category were inconsistent words which were words which again were perfectly regular but which had word rimes which were consistently pronounced in most words (e.g. five) but not in all words of that spelling (e.g. live). He also identified exception words which again on the whole were traditionally irregular but which also contained a word rime that was pronounced in some other words in a regular fashion (e.g. leaf and deaf).

Glushko (1979) showed that inconsistent words took longer to pronounce than consistent words and that more importantly nonwords possessing inconsistent bodies took longer to pronounce than nonwords with consistent bodies. He also noted that inconsistent nonwords were sometimes read aloud with irregular pronunciation (e.g. heaf to /hef/ rather than /hi:f/). Coltheart's (1978) model predicted that all nonwords must be read in the same way using only GPC rules. Glushko showed that orthographic knowledge could help in the pronunciation of nonwords. The lexicon of words appeared to be influencing the reading of nonwords.

Kay and Marcel (1981) found that the pronunciation of an inconsistent nonword could be influenced by irregular words presented prior to seeing the nonwords (for example, following "head" the nonword "yead" was shown). Thirty nine per cent of subject pronounced the nonword in a similar way to the previously presented irregular word.

Rosson (1983) showed that the pronunciation of a nonword could even be influenced by a word seen beforehand that was only semantically related, for example, after "sofa" was presented 89% of subjects pronounced "louch" to rhyme with "couch". Rosson (1985) claimed to show that word and nonword naming times could be affected by the "strength" of the GPC rules inherent in their correct pronunciation. She gauged rule strength by the frequency of particular GPC rules appearing in a large corpus of words.

The lexical analogy model of Glushko (1979)

Glushko used the evidence against dual route theory to propose that skilled reading involved the use of analogies to identify words. His model was an "activation synthesis" unitary model which worked as follows;

"As letter strings are identified, there is parallel activation of orthographic and phonological knowledge from a number of sources in memory. This knowledge may include the stored pronunciation of the letter string and information about the spelling to sound correspondence of various subparts of the letter strings. A pronunciation is generated using procedures for determining how to modify the activated information in order to synthesise the desired articulatory program"

(Glushko 1979 p.678)

He later goes on to state that irregular, exception words and nonwords are pronounced using the same kind of knowledge. There are no separate mechanisms for different kinds of words. Andrews (1982) proposed a similar mechanism and found that irregular words were also affected by consistency. Parkin (1984) and Kay and Bishop (1987) found a delay in named regular and irregular words with inconsistent rimes. Henderson (1981) claimed that many of the GPC rules of Venezky (1970) and Wijk (1966) were influenced by lexical factors. He proposed that knowledge of specific words influenced how GPC rules were applied (e.g. knowledge of the word "shepherd" ensures a different pronunciation for "ph" compared to the common pronunciation of "ph" in words like "morpheme") Treiman, Goswami and Bruck (1990) also claimed that nonwords were not pronounced using GPC rules alone but that the number of analogous rime segments for that nonword which are known by subjects (i.e. the size of the neighbourhood) influences the pronunciation of that nonword to some extent.

Glushko's methodology has been subject to criticism by some researchers who are wary of studies which base evidence on the results of priming studies (e.g. Seidenberg et al 1984, Henderson 1985). Priming studies may produce special effects of their own due to the methods involved. In fact, Stanhope and Parkin (1987) found that consistency effects were exaggerated by prior presentations of irregular word rimes in the subjects word lists.

The strength and applicability of the consistency effect of Glushko (1979) has also been subject to growing analysis. Seidenberg et al (1984) found that the effect could only be reliably found with low frequency words. Taft (1991) reported unpublished data (Taft and Cottrell 1988) where subjects were presented with nonwords that had the rimes of common irregular words contained within them (e.g. "dacht" from "yacht"). These nonwords were very rarely pronounced analogously with the original irregular word; they were instead regularised. An analogy model would predict that the nonwords would be pronounced in line with the more frequent irregular usage. Further to these results it was also found that if an irregular response was actually given then it was a lot slower than the equivalent regular response time. Kay (1985) also found a similar result to this. Coltheart and Leahy (1992) looked at adults and children's reading of nonwords and concluded as did Patterson and Morton (1985) that 70% of nonwords are read using GPC rules and only 30% of nonwords are read by analogy.

Taft (1991) concluded that one of the major problems with analogy models is related to the question of how a final correct pronunciation is actually decided on. If a correct pronunciation is based on a number of phonological representations that are associated with segments of real words then what is the point of having segmentation in the first place? This is especially a problem as this may lead to conflicting pronunciations. Coltheart, Curtis, Atkins and Haller (1993) have also criticised analogy theories for not being explicit about the architecture of their model of reading, nor explicit enough about how they explain the apparent dissociation of function seen in acquired dyslexics.

Revised dual route/analogy theory?

Patterson and Morton (1985) proposed a revised dual route theory of reading taking into account the data from Glushko (1979) and others. The crux of the revision centred around the idea that the indirect phonological route not only operated at the GPC level of analysis but could also handle subword segments similar to onset and rime. They called this the OPC system (orthography to phonology correspondence). Patterson and Morton concluded that total independence of routes was no longer applicable in the light of the analogy evidence and so "a hypothesis of separable routines does not require that the routines operate with complete independence in the normal system" (Patterson and Morton 1985 p.336)

Patterson and Morton (1985) claim that this allows dual route models to account for Glushko's inconsistency effects. It would certainly appear to do so but Patterson and Morton still do not adequately answer the questions posed by data from those like Rosson (1983, 1985) or Kay (1987).

Patterson and Coltheart (1987) argued that lexical analogy models are not really single route models as there is still a basic distinction in their system between words and nonwords. Orthographic neighbourhoods, they claim, can only be made up of real words and so by default nonwords are treated differently in the model. This argument, and the concessions dual route modellers have made to allow for the use of segments of words larger than the phoneme, has led many researchers (Henderson 1985, Humphreys and Evett 1985, Patterson and Coltheart 1987, Taft 1991) to conclude that dual route theories and analogy theories are not all that different any more. Norris and Brown (1985) were of the opinion that it would be difficult to devise experiments which would help differentiate the two theories from one another. In order to account for the criticisms of the other model both have in fact drifted together until they are difficult to tell apart.

Interactive activation and the PDP approach to reading

The notion of activation as an alternative account of lexical mechanics arose from the logogen model of Morton (1969) and the evidence against dual routism proposed by the analogy theorists. Morton's model was the first to put forward the idea that lexical entries were forms of evidence collecting devices (logogens) which would become increasingly activated the more the incoming stimulus resembled the features of the logogen unit. Eventually the logogen would become so activated that it would reach a predetermined level of activation and it would fire. The logogen representation of a word would then be available for response.

McClelland and Rumelhart (1981) and Rumelhart and McClelland (1982) elaborated on the logogen approach but rejected Morton's views on dual routism and instead embraced the views of the analogy theorists that there was no separate phonological route to reading. Their interactive activation network consisted of processing units that became active like Morton's logogens. They were organised in sets that reflected higher and higher levels of language structure, going from visual feature units to letter units to word units. Taft (1991) described the operation of the system as follows:

"In our opinion when a word is visually presented, the appropriate visual feature units are activated which in turn activate appropriate letter units, which similarly activate word units. Not only does the activation of lower level units influence the processing of high level units but as activation continues the higher level unit feeds back to influence the continued processing of the lower level units. Thus the system is interactive." (Taft 1991 p.5)

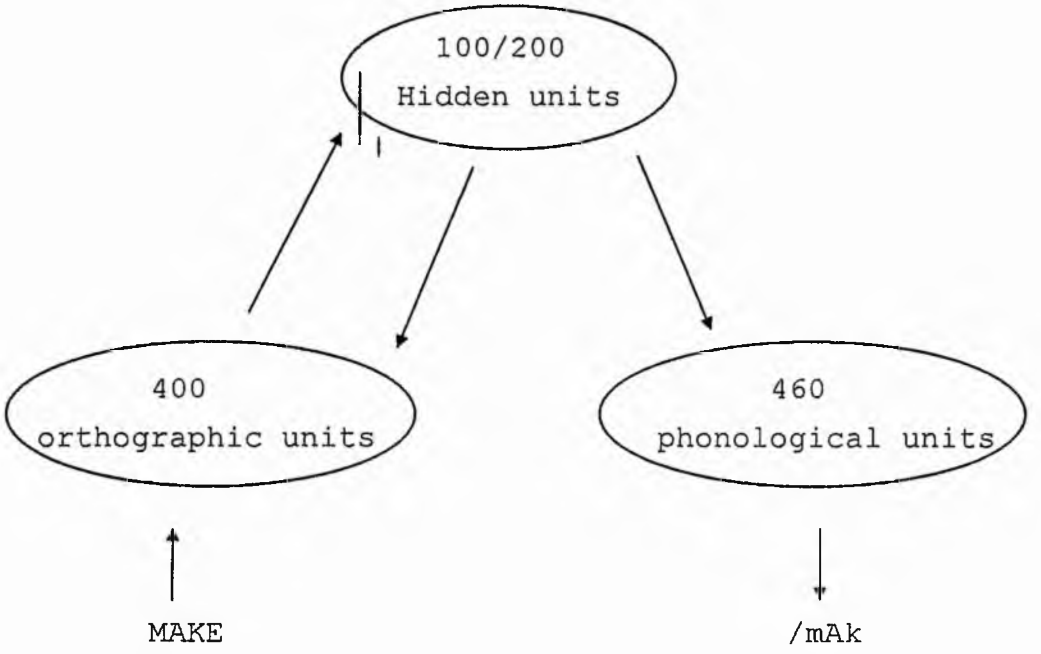
The McClelland and Rumelhart model also ensures that the high level of activation of one unit will begin to inhibit the activation of other units at the same level. This allows the level of activation of the correct units to become salient compared to the other competing units and so leads to the correct word being recognised.

This type of model has been developed significantly by Seidenberg and McClelland (1989) into what they call a parallel distributed processing (PDP) connectionist model of word recognition.

The PDP model of word recognition

This model differs from the interactive activation model in not having any localised units that represent word segments. A word is recognised by the development of patterns of activation that are distributed across a large number of parallel units. There are no lexical nodes representing individual words and there is no feedback from orthographic neighbours and there is no independent phonological route. A single forward spread of activation through the network comes up with the sought after pronunciation.

Figure 1.1 Structure of the Seidenberg and McClelland connectionist model of word recognition
(Seidenberg and McClelland)



The network is made up of a set of orthographic units connected to a set of phonological units via a set of "hidden units" which mediate between the two (See Figure 1.1). All of the orthographic units are connected to the hidden units (80,000 connections) and all the hidden units are connected to the phonological units (92,000 connections). There are also connections from the hidden units back to the orthographic units (80,000 connections). These connections allow patterns produced at the orthographic level to be sustained, reinforced and cleaned up (Seidenberg and McClelland 1989). The connections initially have random weightings so that the network will produce random pronunciations for the orthographic stimuli that it is exposed to. Once it has been exposed to many orthographic-phonological pairings there is a consequent adjustment of weightings which is determined by the workings of a specific learning algorithm. This algorithm is a back propagation algorithm which allows the network to become more accurate by matching the patterns of activation across the orthographic units to the correct phonological units. The network learns the correct responses to stimuli.

The input units of the model can be thought of as containing lists of characters grouped in triples. Each orthographic unit specifies 1000 character triples (the word boundary is included by giving it its own symbol). An input "turns on" an orthographic unit if the input contains a sequence of three characters that match one of the 1000 triples in each unit. Therefore a word like "read" will "turn on" any unit that includes the triples #re (# being the word boundary), rea, ead, ad#. This organisation ensures that different input words will never activate the same set of orthographic units.

The output phonological system is also based on triples. Each output unit represents a single triple which represents a sequence of three consecutive phonemes. These are called wickelphones (in honour of Wickelgren 1969). This system means that any phonological unit should be activated by a word that contains a wickelphone in which the phoneme sequence occurs (e.g.

the words "post", "soft" and "loft"). The computed output is made up of a final activation level in each of the 460 phonological units.

The final activation pattern however is not a simple matter of all correct activations being at one correct level and all the other activations being at zero level. The network rather produces activation levels of different strengths throughout almost all the phonological units. Seidenberg and McClelland worked out an error score (phonological error score) for each projected words' perfect activation level and compared it to the actual activation level that the network produced. If the networks actual output had a smaller phonological error score compared to the scores of all the potential outputs that differed by one phoneme then it was judged correct. This is referred to as the Beatenby criterion (i.e. where a response is scored incorrect if the correct target score is beaten by any alternative).

The model was "trained" on a set of 2,897 words. This set consisted of all of the monosyllabic words from the Kucera and Francis (1967) word count. Training was divided into 250 epochs containing 600 trials. The chances of a particular word being presented in any one epoch was related to its estimated frequency according to Kucera and Francis. These frequency effects were designed to reflect the vocabulary experience of a typical literate American adult.

Seidenberg and McClelland (1989a, b) used their simulation to try and see if it replicated results from previous research. They first evaluated its success at reading words. Using their phonological error score criterion, out of the words the network was trained on only 2.7% were judged incorrect. These errors were mainly on low frequency exception words and so the network performance showed a similarity to human subject data. Seidenberg and McClelland then exposed the network to similar stimuli to that used by Waters and Seidenberg (1985) who found that low frequency strange words produced the largest amount of recognition errors in subjects followed by exception and then regular words. The network replicated these results and produced a reasonable approximation to the recorded human performance. Seidenberg and McClelland claimed that their network was a working model of how humans read words.

Seidenberg and McClelland also claimed that since their model started off with no "knowledge" of words and "learned" to recognise words over time then the model was also a developmental simulation. The "developmental progression" of the model was assessed by studying its skill at various stages while it learned the stimuli from the Taraban and McClelland (1987) paper mentioned previously. Seidenberg and McClelland claimed that the network replicated a lot of the data found by Backman, Bruck, Hebert and Seidenberg (1984) in their study of children's reading. Backman et al found that young readers in Grade 2 were better at reading regular words than exception, inconsistent or ambiguous words. This trend was reported in the early training stages with the network by Seidenberg and McClelland. Backman et al (1984) also found that word class differences gradually lessened with the low frequency words and disappeared completely with high frequency stimuli. This was also found by Seidenberg and McClelland in the later stages of training the network.

Patterson, Seidenberg and McClelland (1989) used the PDP model to try to also simulate forms of acquired dyslexia. They "damaged" the hidden units and showed in subsequent "tests" of reading that the model made regularisation errors to exception words. They claimed that this was a finding analogous to surface dyslexia. Seidenberg and McClelland (1989a) also found that if they trained their network with only half the normal hidden units then the performance was similar to that of the poor readers in the Backman et al (1984) study. Exception words were pronounced badly whether they were high or low frequency stimuli.

The PDP model of word recognition would seem to provide a powerful way of accounting for a lot of experimental data relating to word recognition that other models find difficult to absorb. The important point about the PDP model is that it is computational and it learns. This does not mean that the model is perfect and in the next section we shall discuss the pitfalls of the PDP model but it is sufficient to conclude that Seidenberg and McClelland's research has stimulated new work and provided a fresh vantage point from which to study reading and its development.

Problems with the PDP model of Seidenberg and McClelland

First we shall discuss those problems which are specific to the Seidenberg and McClelland (1989) model and then there shall be a more general discussion about the problems with PDP modelling in general.

Besner, Twilley, McCann and Seargobin (1990) carried out an analysis of the networks performance on the nonwords from Glushko's (1979) experiment 2. The model scored 65% of the items correct and with two other sets of nonwords (from McCann and Besner 1987) the model scored 59% and 51% correct. The human subjects in the Glushko experiment scored on average over 90% correct and the subjects in the Besner and McCann study scored 94% and 89% correct (even under speeded naming conditions). There is a large difference between the Seidenberg and McClelland model and the human subjects.

Seidenberg and McClelland (1990) protested that this was a consequence of the small vocabulary of the model. They claimed that subjects could read nonwords based on their large knowledge of real words:

"ask how well a person would pronounce nonwords if the persons vocabulary was limited to 2,900 words"

(Seidenberg and McClelland 1990 p.448)

Coltheart, Curtis, Atkins and Haller (1993) claim to have developed a model using a different algorithm to Seidenberg and McClelland but which was trained using the same corpus of words and that this model could read nonwords at the human performance level. If this process can be replicated then it could seriously damage the viability of the Seidenberg and McClelland model.

Besner et al (1990) noted that the Seidenberg and McClelland model produced a high error rate in a lexical decision task with orthographically strange words from the Water and Seidenberg (1985) word set. Human subjects did considerably better. The model also produced chance performance on phonological lexical decision and was unable to produce a robust pseudohomophone effect. These results again deviate from human performance (McCann et al 1988, Besner et al 1990).

Coltheart et al (1993) point out that some of the structure of the model only exists to ensure that lexical decision processes are replicated. They claim that if the feedback units from the orthographic units to the hidden units were removed then this would have no effect on how the model "reads" but only on its ability to perform lexical decision.

Patterson, Seidenberg and McClelland (1989), Patterson (1990) investigated the models simulation of dyslexia when it was "lesioned". They tried to replicate surface dyslexia but found that the model did not produce the same amount of regularisations that the dyslexics did. The dyslexics were also better at nonword reading than the model. In fact the model produced quite random results rather than the characteristics specific to a particular reading disorder. Coltheart et al (1993) have also argued that the Seidenberg and McClelland model could not model the semantic dependence of phonological dyslexics due to its architecture.

Besner et al (1990) point to the classic double dissociation of dyslexics illustrated by the works of Coltheart et al (1983) and Funnell (1983). They are puzzled over how a functional architecture like the that of Seidenberg and McClelland's can simulate this data with only one routine underlying reading.

Besner et al (1990) also point to the Seidenberg and McClelland claim that PDP models do not have a lexicon as such. Besner et al propose that distributed representations may not be the same as individual representations in a lexicon but that both are actually functionally equivalent and so they both "provide a level of representation that interfaces the sensory surface with the semantic system and other lexical systems" (Besner et al 1990 p.444). In other words they both provide the same service in reading so the Seidenberg and McClelland claim that the concept of lexicons is outdated may be premature as they have devised a system that carries out the same function.

Taft (1991) claims that PDP models have a problem with their falsifiability in that they could explain away any data that is presented to them by manipulating the mathematical parameters of the model. The weights between connections could be changed to allow modelling that would be closer to human experimental data.

Seidenberg and McClelland (1990) have responded to criticisms like these by pointing out that PDP models have very few parameters to actually change and that PDP models are self learning models and are difficult to change easily. Seidenberg and McClelland also point out that the earlier McClelland and Rumelhart (1981) model upon which their model was founded could be falsified successfully.

PDP models though have a very different way of modelling behaviour so much so that it may be difficult to adequately compare them with other cognitive models of the same function. For example the PDP model of Seidenberg and McClelland (1989) defines outputs as output values and it is these values that are used to test experimental data. No other models apart from PDP models define their outputs in terms of scores.

Besner et al (1990) and Taft (1991) question the value of a model which is trained to respond exactly as a human. This may tell us about the nature of the neural system but reproduction of human performance does not necessarily provide an explanation of human performance. They claim that is difficult to relate this reproduction to abstract theorising about lexical access.

The return of the dual route model

Coltheart et al (1993) have developed their own computational but dual route model of reading. They have called it the dual route cascaded model. This is because the processing stages in the model convey information in a cascaded rather than in a threshold way as in other computational models. The model is truly modular, claims

Coltheart, and the computational learning algorithm, when it is exposed to printed words and their pronunciations, learns the GPC rules inherent in them. It can then apply the rules to read new words. Preliminary results with this algorithm would seem to show that it replicates human performance at nonword reading. In depth modelling of the lexical route has not yet been perfected in the model and to date they rely on an adapted version of the McClelland and Rumelhart (1981) model to simulate the route.

The model is still in an early phase so proper comparison with other computational models may be premature. It remains to be seen whether the model Coltheart has developed will enhance the original dual route model and so achieve more from the computational perspective or whether it will just combine the problems of the dual route model with the problems of the connectionist models.

Conclusions

It has been seen that there is a great split in the literature at the moment over the status of adult models of reading. There are those who advocate dual routes, i.e. a model based in some way on lexical and non-lexical routes and those who advocate a single analogical type route to reading. There would appear to be no end in sight to this debate as our knowledge of human cognition at this time is too limited to dismiss one approach over another. It is therefore important to bear in mind that any theorising or speculation about how the unskilled learn to read must be tempered by the knowledge that we do not know an awful lot about how the skilled read. Only continous research which investigates both skilled and unskilled reading will allow us to turn the key to Pandora's box.

Chapter 2-Models of reading development

"Consider your verdict." the King said to the jury.
"Not yet, not yet!" the Rabbit hastily interrupted.
"There's a great deal to come before that!"

The dual route tradition has provided the background to many influential theories on how children learn to read. Therefore, before they begin to elaborate on any developmental progress, those theories already suffer from the inherent disadvantages (and advantages) of the dual route philosophy about reading. The PDP models have not been so influential due only to their relative recency. PDP models though, as we have seen, have the advantage of encapsulating their own developmental predictions within them.

There have been many models of how children learn to read in the past three decades but, as in the above section on adult reading, we shall only review some of the most influential. We shall first examine the Marsh, Freidman, Welsh and Desberg (1981) model of reading development. This model inspired Frith (1985) to present her own account of how children learn to read. The Frith model was very widely accepted in cognitive psychology circles and Morton (1989) and Ehri (1992, 1994) have both elaborated on it. The Frith model is a stage model of development based on cognitive concepts of information processing and modularity. It will be examined in detail because of the influence it has had on research in the last ten years.

The Marsh, Freidman, Welsh and Desberg (1981) theory of reading acquisition

Marsh et al (1981) proposed a theory of reading development which involved the child passing through four distinct phases. These phases are briefly summarised below:

1) Linguistic guessing

This first stage is identified by the child approaching reading as though it were a matter of rote memorisation. The child establishes a small number of visual letter and word recognition units and learns to recognise a small number of words by sight. The child has no capacity to carry out tasks like phonological segmentation yet and if they are presented with unfamiliar words they usually refuse to answer. There is a very limited ability to guess words during reading in context based on the child's real word experience but nothing more. Marsh et al claim that this strategy is "congruent with the whole word approach to teaching reading" (p. 202) but they do not consider that it may be the product of whole word teaching. Marsh et al did not reveal how their experimental subjects were taught.

2) Discrimination net guessing

Later in the first year of learning to read the child progresses to stage two. The child is still building up a set of visual word recognition units but is now more willing to respond to an unknown word in isolation. The child operates a mechanism which Marsh et al term the "discrimination net" where a word is processed only to the point that it is just possible to discriminate it from another word. The child's guesses are still only drawn from previously learned words and there is emphasis on the first letters of words.

Marsh et al's (1981) evidence for the existence of stage 1 and stage 2 is quite weak. The observational studies they ran did not reveal any readers with overwhelming use of such strategies. They had to rely on secondary observational sources for their evidence in that they quote studies by Weber (1970) and Biemiller (1970) to support the existence of stage one and two. These studies noted that as the children became more skilled they made more errors which incorporated graphemic information (for more details about these papers see Chapter 4). There have been a number of problems with these papers, not the least being that Weber gave first letter correspondence between target and response an unusually high rating. This weighting "reflected intuitions about the significance of various cues for the identification of words" (Weber 1970 p.438). Not too surprisingly Weber concluded that first letter correspondence was highly associated with other correspondences between target and response.

3) Sequential decoding

Marsh et al suggest that this third stage develops in response to environmental and cognitive factors prevalent at about age seven. One of the main environmental factors which they claim limit the child at this stage is that the child's memory is not good enough to rote learn the large amount of words encountered in print. Therefore a new strategy must be developed in response to this potential handicap. The child at this reading stage will have also reached the Piagetian cognitive stage of concrete operations. This means that the child has increased mental flexibility and basic logical analysis skills to bring to bear. The child can begin to work out and remember rules for decoding novel words. This sounding out follows a simple left to right manner and is limited to short words with short vowels.

The evidence for this stage of development comes primarily from observational studies by Cohen (1974-75) and Barr (1974-75) which Marsh et al claim shows the transition from stage two to stage three. Stuart and Coltheart (1988) claim that all this evidence shows is that phonological processing increases as reading develops, not necessarily that it has just appeared. The Cohen and Barr studies also did not show that the phonological processing was necessarily limited to left to right, letter by letter small word decoding.

Stuart and Coltheart (1988) cite a study by Davies and Williams (1974) which they claim contradicts Marsh et al's theory. Marsh et al assume that an increasing sight vocabulary problem is instrumental in pushing the child towards a sequential decoding stage. Davies and Williams found that children's vocabulary knowledge followed a s-shaped growth curve, as did their phonic skills. However the growth spurt in phonic skills happened before the growth spurt in sight vocabulary knowledge. According to Marsh et al the vocabulary spurt should have appeared first. It would seem that in the Davies and Williams study that phonic skills precipitated sight vocabulary growth and not vice versa.

4) Hierarchical decoding

As the child grows older reading skills become more complex. In stage four of development, the rules of orthographic structure and other complex language rules are learnt. The child is also able to use analogy to aide reading. Marsh et al rally little evidence to support this stage of development. They provide error analysis of older readers who can accomplish more complex decoding tasks better than younger children but have no real evidence of substance.

Hierarchical decoding is seen by Marsh et al as the ultimate stage of reading development. However as we have already seen, most models of skilled reading encompass some sort of mechanism whereby there is a direct link or route between print and meaning. The Marsh et al theory relies on a sophisticated non-lexical decoding route instead.

It can be appreciated that the Marsh et al (1981) theory of reading acquisition has quite weak supporting evidence and that in some cases there is even direct contradictory evidence (e.g. Davies and Williams 1974, Stuart and Coltheart 1988). Despite this, the theory provided an conceptual framework for many other researchers to build their own ideas on, chief among whom was Frith (1985).

The Frith (1985) theory of reading acquisition

Frith devised a theory of reading development consisting of three consecutive stages. A model with definite stages provided her, she claimed, with an easy explanation of the differences in speed and acquisition of reading in children. It also gave a simple and convenient way of explaining dyslexia, which became a "persistent failure to advance to the next step in the normal acquisition process" (Frith 1985, p.304). The stages were hypothesised to follow each other in "strict sequential order" (Frith 1985, p.305) and were developmentally contingent, in that the later stages could not be attained unless the prior ones had been achieved. Each new stage was assumed to "capitalise" on the earlier stages.

Frith also believed that the development of spelling was vital to the development of reading and that the growth of both skills were intertwined. This led her to split her three stage theory down into six steps to properly illustrate the relationship between reading and spelling. The complete sequence is illustrated in Figure 2.1.

Figure 2.1 The Frith theory of reading aquisition (Frith 1985)

Step	Reading	Writing
1a	*logographic*$_1$	(symbolic)
1b	logographic$_2$	logographic$_2$
2a	logographic$_3$	*alphabetic*$_1$
2b	alphabetic$_2$	alphabetic$_2$
3a	*orthographic*$_1$	alphabetic$_3$
3b	orthographic$_2$	orthographic$_2$

We shall examine this theory in great detail in the next few pages because it has been very influential in the development of research into children's reading in recent years and has been used as a framework to illustrate many research results (e.g. Morton 1989, Ehri 1987, 1992, 1994, Goswami and Bryant 1990, Seymour and Elder 1986, Seymour and Evans 1992, Johnston and Thompson 1989, Coltheart and Laxon 1990, Wimmer, Landerl, Linortner and Hummer 1991, Wimmer and Hummer 1990, Gough, Juel and Griffith 1992, Byrne and Fielding-Barnsley 1989, 1990 1991, Byrne 1992). Morton (1989) and Ehri (1992) have elaborated on the original Frith (1985) theory and have put forward their own evidence and opinion on how children learn to read. Although their ideas may slightly differ from Frith on particular technical aspects they are still very close to the original theory and this will allow us to treat them as one in the following discussion.

The logographic stage

It can be seen from figure 2.1 that the earliest use of a logographic strategy in Frith's model begins with reading. Logographic writing is assumed to commence slightly later in the process. Frith's logographic assumptions are rather similar to that of Marsh et al's (1981) discrimination rote guessing stage. A logographic process is a nonphonemic, visual, contextual, graphic process. No letter sound correspondences are implicated at all. Logographic reading is equated with a form of picture recognition and pictorial semantics. The word is instantly recognised based solely on the minimum amount of graphic features necessary to distinguish the word from other visual stimuli.

Evidence to support a logographic stage

. Frith states that there is much observational evidence for this stage and quotes Torrey (1979) as a review of the area. Stuart and Coltheart (1988) have pointed out though that in the studies mentioned by

Torrey all the best readers had some amount of knowledge of letters and sounds and that this may have influenced the way the children read and so the form of the children's results.

In recent years it has been claimed that there is other evidence of logographic reading in young children (or visual cue reading as Ehri (1987) calls it) that Frith did not point out or that has only recently come to light. Gough, Juel and Griffith (1992) taught one group of beginning readers to read selected words that had distinctive visual cues printed next to them. Another group were taught just using the words without any accompanying visual cues. The group exposed to the visual cues learned words more rapidly than the other group but their performance dropped when the visual cues were removed from the words. Masonheimer, Drum and Ehri (1984) showed that very young beginning readers were unable to read environmental print like the Coca-Cola logo when distinctive environmental cues were removed. Mason (1980) looked at four year old beginning readers and found that they could not read words out of the context in which they had been learnt. Mason taught them a set of simple words in upper case and showed that the children could not transfer their knowledge to lower case identical words despite them knowing the individual lower case letters. Other studies of beginning readers also showed similar results in that young children appeared to use visual context cues rather than any form of alphabetic cues when they first started to learn to read (Dewitz and

Stammer 1980, Goodman and Altwerger 1981). Kimura and Bryant (1983) found that English seven year old beginning readers were not affected by concurrent vocalisation (designed to disrupt phonological processing) but rather by the visual confusability of words. In this respect the English children were identical to Japanese subjects who were using the Kanji logographic script.

One of the main planks of evidence that supports the existence of a logographic stage in reading is the study of the first year of reading by Seymour and Elder (1986). They studied a class of first year primary school children aged between 5 and 6 years old. The children were taught by the whole word method. No letter sound associations or phonic work was shown to the children during reading instruction. The children learned each new word as a whole. Seymour and Elder found that the children produced some errors in their reading that were semantically related to the target words, for example, "children" as "girl" or "lions" as "tigers" (See Chapter 4 for a full discussion of the errors made by the children). Errors that did share a letter or letter group with the target did so "often without regard to position". The children tended to respond only to words they had been taught already. They did not attempt to sound out and blend unfamiliar words. Longer words were not read more slowly than shorter words which would indicate that the readers were processing the cues in parallel and not serially. Seymour and Elder concluded that the children were reading the words in a pictorial manner and were thus logographic readers.

Ehri (1994), however, has pointed out that in the Seymour and Elder study subjects were able to read visually distorted words correctly and so she claimed that letter cues did have a role in recognition for the children. Ehri claims that most views of logographic reading comment that letters in words at this stage are not well represented (e.g. Morton 1989) and so the Seymour and Elder subjects cannot be true logographic readers. Ehri also pointed out that the amount of semantic errors produced was rather small and that on the spelling task, which involved writing nonwords, a large proportion of the class spelled one or more sounds correctly. Ehri claims that the Seymour and Elder subjects were actually novice alphabetic readers. To support this claim she points out that a typical error in the Seymour and Elder study, like judging the word "smaller" to be "yellow", may not be based on the visual qualities of the word, "it's yellow because it has two sticks", but rather to a phonetic association between the "el" sound in both target and error.

The logographic stage and phonology

A particular difficulty with deciding whether there is a logographic stage in reading is trying to show that reading at this stage shows no phonological influences. Letters in the English language are inherently phonological so that once they are used as visual cues then the issue of phonology naturally arises. It can then be argued that if phonology is involved, even only to a small degree, then reading cannot be wholly logographic. A particularly difficult issue in reference to this is the interpretation of how beginners process initial and boundary letters in words. Boundary letters are very important to beginning readers and serve as a vital clue to the identity of words both familiar and unfamiliar (Adams 1990, Ehri 1987, Frith 1985, Goswami and Bryant 1990, Gough and Tunmer 1986, Perfetti 1992). Are these letters processed nonphonemically or in a simple alphabetic manner?

Perfetti (1992) hypothesised that children who produced errors that shared initial or boundary letters with their target word had used a basic form of GPC rules to achieve such a level of performance. Stuart and Coltheart (1988) found that children's errors which incorporated the boundary letters were correlated with letter-sound knowledge and the development of phonological skills. They also found that pre-school phonological skills combined with letter-sound knowledge predicted word reading in the first year of school. How can this be if the first stage of reading is logographic? Wimmer (1990) replied to this data by claiming that Stuart and Coltheart's (1988) regression analyses were flawed and that only letter sound knowledge predicted word reading. The letter-sound knowledge scores were taken nine months into schooling and therefore it could be argued that the logographic stage was probably coming to an end for those children, hence the predictive value of the letter sound scores.

Huba (1984) found that the beginning readers (kindergarteners) in her study knew some letter sounds and could read a number of real words but could not read any nonwords. She assumed that they were logographic readers and that reading would show no relationship with phonological awareness skills. However, when she correlated word reading with phonological awareness, even at this very early age, she found a significant correlation between the two. This should not have been the case if the children were reading purely logographically.

The studies by Backman, Bruck, Hebert and Seidenberg (1984) and Waters, Seidenberg and Bruck (1984) have also been used to contest the idea that there is a logographic stage by some researchers (e.g. Barron 1986, Masterson, Laxon and Stuart 1992). These studies showed that young readers produced regularity effects when reading regular and irregular words. This would indicate the use of spelling sound information to aide reading. The youngest children tested though were at grade 2 level. Therefore one could contend that these children had already passed through a logographic stage before they received the regularity tests.

When does the logographic stage begin?

The issue of when one stage ends and another begins will always be a problem with stage theories. This issue is also tied in with whether a new strategy totally subsumes the old or whether the new strategy exists in parallel with the old.

There would appear to be some debate over exactly when the logographic stage begins and when it ends. Frith (1985) is very vague on the matter and merely states that the child enters the logographic stage when "starting to learn to read" (Frith 1985 p.307) and that the children move onto the logographic strategy when they have chosen "their own time to apply taught knowledge" (Frith 1985 p.310). Here she would appear to be assuming that change in reading strategy is mainly child driven. Morton (1989), however, who has taken Frith's model and developed it into an information processing framework, claims that "most children are only in the logographic stage for only a brief time before they begin to get instruction in reading" (Morton 1989 p.53). This would appear to indicate that he believes that change is instruction driven. He does not elaborate on what kind of instruction he means though. Is it the kind of instruction Seymour and Elder (1986) witnessed when the children still "satisfied a broad description of logographic, pre-alphabetic reading" (Seymour and Elder 1986 p.27) after a year at school? Ehri (1987, 1992, 1994) also claims, like Morton (1989), that logographic reading only "occurs during the pre-school years before children have received any reading instruction" (Ehri 1994 p.347). Again it is not clear what form of instruction she may mean.

One of the main debates relating to the logographic stage is how instruction affects it. Frith's original theory is mainly internally driven by the child but the research evidence would appear to point to external factors having a large influence. The type of instruction that the child receives when they begin reading would seem to determine how long they are in the logographic stage, if at all.

Logographic writing

Frith (1985) also claims that the first stage in the development of writing is logographic and that it is driven by the experience of logographic reading. Unfortunately there is a dearth of evidence to reinforce this claim (See Chapter 9 on spelling for a complete discussion of Frith's theory as it relates to writing development) and most evidence would seem to point to spelling beginning in a more phonological manner (Adams 1990, Bryant and Bradley 1980, Goswami and Bryant 1990, Ehri 1987, Read 1986). A thorny issue in this area is again how to define the use of letters as cues. Are they used as pictorial or phonological cues? Children are taught to spell in the majority of schools in a phonological manner. They learn letter sounds and are expected to use this knowledge in their attempts at spelling. Therefore instruction has also a large influence on how the children start writing as well as start reading (Ehri 1992).

The alphabetic stage

This stage is characterised by the ability of the children to decode a word which may be quite novel to them by use of grapheme to phoneme conversion rules. To begin with only simple rules are acquired but eventually more complex "context-sensitive" rules are learnt. Frith admits that some teaching about these rules "would seem to be necessary" (Frith 1985 p.307). She claims that alphabetic reading is originally driven by alphabetic writing. To begin with this leads to a disparity between the alphabetic writing and the logographic reading. She refers to Bradley and Bryant (1980) study as evidence of this disparity. Morton (1989) refers to examples from Read (1971) to illustrate the difference. These studies have been criticised by Perfetti (1992) and are covered in more detail in chapter 9 on spelling. Ehri and Wilce (1987a) found that beginning readers who were taught to phonetically generate spellings were able to learn to read a set of similarly spelled words easier than beginners who were simply taught about letter sound relationships.

The Ehri alphabetic stage

Ehri and Wilce (1987a, 1987b) theoretically divided the alphabetic stage into two separate parts. The first part they called phonetic cue reading and the second cipher reading. Phonetic cue reading is a novice alphabetic skill level which relies on limited phonological cues to read words. Cues such as initial and final sounds and other simple letter sound correspondences are linked to words in a simple systematic manner. This is of course a very inaccurate system but as reading progresses and more sounds are learned then the reader can become a more advanced cipher reader. The cipher reader is much more skilled in using GPC rules, to the point of automaticity, and they use their better skills to build up a large reading vocabulary.

What happens to the logographic strategy?

Frith does not explain what happens to the logographic strategy once the child has reached either the phonetic cue or cipher reading level. She is again very vague on the matter and reasons that earlier strategies "may remain available at all times" (Frith 1985 p.306). Morton (1989), however, hypothesises that during the alphabetic phase the previous logographic reading strategy will have "become completely suppressed" (Morton 1989 p.61). This leads to Morton (1989) claiming that during the alphabetic phase, for example, the child "may lose the ability to pronounce irregular words that used to be in her vocabulary" (Morton 1989 p.47) because they are not fully pronounceable using just GPC rules. There is though a lack of evidence which shows that children suddenly lose the ability to read words they could previously recognise. There is a certain instability in the words they do know (Downing and Leong

1982, Perfetti 1992) but no definite wholesale loss of knowledge.

A few authors have proposed, however, that irregular words could be attempted using GPC rules. Adams (1990) and Ehri (1994) both point out that irregular words contain only a small percentage of letters or letter clusters that are irregular. In the majority of cases most of the letters in irregular words are pronounced in a normal regular manner. This would then allow a rudimentary grapheme to phoneme conversion to take place for the particular word. It would seem unlikely, however, that young children would have the phonological capability or the extensive vocabulary knowledge required to work out irregular words using grapheme to phoneme conversion rules alone.

Reitsma (1983) found that beginning readers were quicker at reading words they had seen before than phonetically identical equivalents they had never seen before. This was despite being able to easily sound out the phonetically identical equivalents. This would lead one to the conclusion that some form of sight vocabulary is still intact during the alphabetic stage.

Ehri (1980, 1984, 1987, 1992, 1994) claims that phonological recoding skill is "essential" for the continued development of sight word reading. She proposes that alphabetic readers, after they had practised reading a word by phonologically recoding it a few times, form access routes into memory. These access routes are constructed by the children "using their knowledge of grapheme phoneme correspondences to amalgamate letters in spellings to the phonemes in the pronunciations of the words" (Ehri 1994 p.339). By seeing the visual spelling of a familiar word the child no longer needs to decode it because the visual spelling activates connections that are directly connected to the pronunciation of that word in memory and its meaning. Therefore sight word reading in Ehri's view is intimately tied up with phonological processes and spelling patterns. In fact at times it is so tied up with spelling patterns that it is difficult to conceptually separate it, except in terms of degree, from the next supposed stage of development, the orthographic stage.

Frith (1985) also has a problem of separation of the phonological from the orthographic. She states quite clearly that readers in the alphabetic phase learn rules about how to apply rules like soft 'c' and silent 'e'. She quotes as evidence for this the Marsh et al (1981) paper. Marsh et al, however, claimed that these rules belonged with the "conditional rule patterns and other complex rules of orthographic structure" (Marsh et al 1981 p.206).

The orthographic stage

The development of orthographic skills in the Frith model refers to the ability to instantly analyse words into orthographic units "without phonological conversion" (Frith 1985 p.306). It involves the construction of recognition units above the level of alphabetic units, ideally at a morphemic level. Input representations become established for the proper letter order and structure of words. These representations or lexical units can be recombined with each other to make up an almost unlimited set of potential words. Frith claims that the orthographic strategy is different from the logographic stage in being more accurate and systematic but also because it is non-visual. It is also different from the phonological stage because it uses bigger input units and is non-phonological. So if it is non-visual and non-phonological then what is it? Frith gives no adequate explanation of how units based on morphemes can be non-visual or non-phonological.

The orthographic stage is the culmination of Frith's model and would seem to tie in with a dual route adult model of reading. It has an orthographically based instant recognition system and a phonologically based decoding system. In fact Frith does not make clear whether she sees a phonological decoding route as part of the orthographic system (as Ehri does) or whether she sees it as remaining independent of sight word reading as in the classic dual route model of reading. Morton (1989) claimed that the phonological route did remain quite separate and thus ensured it matched his "logogen" model of adult reading.

Conclusions about the Frith model and Stage theories in general

Stage theories provide a simple, convenient way of classifying reading development in children. They allow experimental data to be presented against a structured, coherent background. They in themselves help provide testable hypotheses about children's reading at various ages.

In the last few pages we have shown though that solid evidence of a set sequence of stages of reading development is lacking. There is great disagreement over the initial stage of reading. No-one is sure when stages begin or end. There is no consensus on why one stage must succeed another. There is confusion over what becomes of the old strategies. The final stages of development do not seem to tie in very well with adult models of reading.

A stage theory of reading development does seem a very logical way of explaining progress, after all are not other cognitive developmental theories couched in terms of stages of some sort or another (e.g. Piaget)? Is it justified though to think that these stages may be universal in the way Piaget thought his stages of cognitive development to be universal? The reading of alphabetic scripts is less than 3,000 years old, which is nothing in evolutionary terms. It is a culturally transmitted, artificially derived skill. Reading is a skill which needs to be learnt and is parasitic on many cognitive systems like vision, language and memory.

Stage theories would appear to suffer from a lack of regard for two main factors; (i) the type of reading instruction that the child receives and (ii) individual differences between the children themselves. Some authors have protested against this and claim that there must be a fall back acquisition procedure that occurs if all other conditions are equal (e.g. Byrne 1992, Ehri 1992). They do not explain in what kind of conditions this default procedure would be used to learn to read. This kind of theorising is a very half hearted attempt to preserve a theory that has not lived up to expectations, for example, Byrne (1992) states that "the default option...applies unless the child has access to certain initial representations of phonological structure" (Byrne 1992 p.5). This would appear to imply that the children follow one course of development until someone teaches them something different (i.e. about phonic structure). In other words there is no default option but rather the way a child learns to read depends on what it is taught.

Stage theories of learning to read, we have seen, associate each particular stage with particular reading strategies. Therefore one would predict that it would not be possible, if the theory was generally applicable to all children, to find children who cannot use the particular strategy associated with that stage while other children of the same reading ability can. A weaker version of this prediction would state that groups of children matched on reading ability should show the same preferential strategy use for reading as is consistent with the stage they are hypothesised to be in. This study will investigate whether these hypotheses can be upheld by comparing readers who are experiencing different instructional regimes but who are matched on reading ability (for details of both instructional regimes and to see how they differ see Appendix 1). We can then see if they exhibit any strategy differences that are due solely to this factor. We will then examine how, if any differences are found, they relate to the theories of reading development detailed here.

The effects of instruction on reading acquisition

There has been interest in how instruction affects reading acquisition for many years (see Adams 1990, Balmuth 1982 for detailed reviews of this contentious area) but these have mainly been concerned with determining which method is better and faster at helping children learn to read. Studies which have examined and compared how different instructional regimes affect the reading styles and strategies of readers are more rare. Bertelson (1986) commented on the fact that work in educational and psychological circles has usually either ignored or assumed that instructional influences do not affect reading acquisition to any great degree. He concluded that there is a great need for research into teaching techniques and how they affect the way children read. More recently Snowling (1987) and Goswami and Bryant (1990) have also come to this conclusion and admit that instruction could influence the strategies that beginning readers use when they first learn to read.

We have already read that the Seymour and Elder (1986) study claimed to show that the developmental stages described by Frith were "a product of a particular instructional regime (especially the regime applied to the children in our sample)" Seymour and Elder 1986, p.25). Unfortunately, as Goswami and Bryant (1990) have pointed out, Seymour and Elder had no direct comparison with children who had been taught about letter sound relationships as well as about whole words. Would the same error types and the predominantly visual strategy still be prevalent in another classroom of phonics taught children?

Wimmer and Hummer (1990) followed seven year old Austrian children through their initial year at school. These children were taught about letter sound relationships using a phonic approach to teaching reading. There was evidence of use of a phonological strategy in the mistakes the children made when reading which were very different from the mistakes in the Seymour and Elder (1986) study. They made mistakes using the letters and sounds from the target word. They also produced nonsense words which were phonologically similar to the targets. The authors therefore concluded that their children did not show a strong visual strategy when they began to read. Ehri (1994) and Goswami and Wimmer (1994) speculate that this may be because of the more regular orthography of the German language which discourages a visual strategy. As in the Seymour and Elder study no comparison was made with a whole word taught class.

Other researchers have also found that different instructional regimes can affect initial reading strategies. Barr (1974-1975) reported that the teaching technique experienced by children in their initial years at school affected the strategies they used for later reading. She compared phonics taught and whole word taught children in their first year at school. She concluded that the phonics taught children did use a strategy in their reading that evolved from the phonics influence and that was different from the strategies evident in the whole word taught group. Error analysis was used to come to this conclusion and this study (and its shortcomings) is discussed in much more detail in chapter 4 on reading errors. Other studies have also shown differences in errors produced by beginning readers under different instructional regimes (e.g. Biemiller 1970, Elder 1971) but suffer from the same shortcomings as the Barr study.

Alegria, Pignot and Morais (1982) showed that children taught to read using a method which encourages sounding out and paying attention to the sounds of letters (phonics) were better at manipulating phonic information about words than those taught with a global or whole word strategy. They studied first grade children aged between 6 years and 7 years old in French speaking Belgium. One group was taught in school using a phonic method to teach reading and the other group was taught in a school which practised whole word methods. The children were given the task of reversing syllables and phonemes in words and articulating their answers to the experimenter. There was no difference in ability when it came to reversing syllables but there was a difference in the capability to reverse phonemes. The phonics taught children were significantly better at this skill than the other group. The authors did not, however, give any indication of the reading level of the readers in each group. The phonics taught children may simply have been better readers and so could do the task because of a greater maturity in reading skill, we noted earlier phonological awareness is highly correlated with reading skill. Furthermore, the children in this study were learning French which is a more phonetic language than English and comparisons may not be valid.

Johnston and Thompson (1989) also presented what could be a difference due solely to different teaching methods. Here British eight year olds were compared to New Zealand eight year olds. The British children were taught using a phonics approach while the New Zealanders were taught using a variant of the look and say method. The British children falsely accepted pseudohomophones (nonwords that sound like real words) as words much more often than the New Zealanders. This would appear to be indicative of the British children using a phonological strategy. In another task though, when usage of phonological information was advantageous (which nonwords sounded like words), the British children performed much better. A more detailed description of this study is contained in Chapter 5.

Similar results to these were found by Coltheart and Laxon (1990). Here a reading for meaning task was used. Children taught by a phonics method were more likely to be fooled by a sentence which sounded correct but which was actually wrong than children taught by other methods. Coltheart and Laxon hypothesised that children taught by phonic methods, with its greater reliance on sounds to decode words, will have a greater advantage in learning to read than children taught by whole word methods.

Adams (1990) in her lengthy volume documents many years of research that leads her to conclude that initial reading programmes that include the systematic teaching of phonics lead to better reading skills. Children taught in this way would appear to have better word recognition skills, be better at recognising unfamiliar words and have better spelling skills than children who have not received phonics instruction.

Thus the question of what effect differing forms of instruction have on reading acquisition would still appear to be an open issue. The evidence presented so far is mainly concerned with the early years of reading acquisition and takes the view that these are the years most susceptible to variations in teaching technique. Older children do not show as many differences in reading strategies (Adams 1990, Ehri 1992, Goswami and Bryant 1990, Johnston and Thompson 1989, Thompson, Tunmer and

Nicholson 1993) and once instruction is beyond the first few years the differences in teaching techniques are also reduced considerably (Adams 1990). This study will therefore be concerned with those early years at school.

The influence of individual differences on reading acquisition

The other issue which must be taken into account when deciding on a general theory of reading acquisition that we mentioned are the individual differences inherent in each reader. Some researchers (e.g. Seymour and Elder 1986) see this as so important that individuals are analysed separately in their papers. The cause of individual differences in reading acquisition are a matter of debate but it has been clear for many years that the main predictor of reading ability is the level of general intelligence of the child (Adams 1990, Bryant and Bradley 1986, Stanovich 1991, 1992). This is so no matter how the child is taught and is generally measured by some form of IQ test. This individual difference more than any other accounts for variation in reading skill. Vocabulary, short term memory and age are also seen as some of the most important contributors to an IQ measure (Elliot 1982) and will be taken into account in this study.

Stanovich (1992) has also pointed out that after IQ levels have been accounted for then the next greatest source of individual variation which contributes to reading acquisition is the level of phonological awareness the child shows. There is great debate, however, over the relationship between reading and phonological awareness (See chapter 8 for a detailed study of these opposing views and the authors who hold them). Some think that phonological awareness may be a pre-requisite to reading while others think it a consequence of reading and another group have come to the conclusion that there is an interaction between phonological awareness and reading (including reading instruction) and Chapter 8 aims to investigate these issues.

This study, therefore, intends to control for individual differences by using groups that are matched on age, vocabulary knowledge, digit span, time at school and word recognition. This will allow us to state with more confidence that any possible differences that are found may be due to the type of instruction the child has received.

Study rationale

This study aims to investigate the claim made by theorists like Frith (1985) that reading is acquired in a number of sequential developmentally contingent stages that are universal to children. This study also examines the role of instruction in the development of children's reading strategies in their first years at school. Both of these aims will be achieved by studying groups of readers who are matched on the criteria mentioned above but who are receiving different forms of reading instruction in school. It is proposed to compare strictly phonics taught children in Scotland with children taught by the language experience approach in New Zealand.

Children who are matched on word recognition ability and the other factors mentioned should not, according to the developmental models of those like Frith (1985), show a difference in the basic reading strategies that they use, i.e. they should be at the same stage of reading development. There should be no major differences in the types of errors that they produce (a classic marker of strategy use) when reading words. Their capacity for reading different types of words such as nonwords and irregular words should be the same. They should depend on the same cues to read words and have the same access to strategies to enable them to read known and unknown words. Since spelling and reading are so intertwined in developmental theories like that of Frith then their spelling skills should also be equivalent. It is believed, however, that it will be shown that, despite being carefully matched, instruction will have an effect on the reading strategies of the children and that those who advocate stage theories of reading development have not taken this fully into account.

This belief will be investigated in the remainder of the thesis by observation and experiment. The investigation shall commence, however, with a detailed examination of how the subjects were selected and matched before any detailed comparisons are made.

Chapter 3-Subject selection

The lion looked at Alice wearily.
"Are you animal -or vegetable -or mineral?"

Tests Used for Subject Selection

The Word Reading test from the British Abilities Scales (BAS) was used to measure the word recognition skills of the children in New Zealand and Scotland. Since word recognition is the main aspect of reading skill which is measured in this study a simple word recognition test was considered sufficient for subject selection and matching.

The BAS word reading test was developed under the supervision of Peter Pumfrey in the Department of Education at the University of Manchester. A list of 300 words was drawn from studies of word frequency in children's literature. These words were tested on large pilot samples and subjected to intense item analysis. 100 words were then selected for BAS standardisation. The items went from the most commonly found words in children's reading to much less frequent words, and there was a mixture of frequent and infrequent items at each difficulty level. The words also sampled a wide range of the phonic rules in the English language while including a proportion of irregular words. A deliberate effort was made to exclude specialised words or words with a cultural or social bias. During the standardisation it was noticed that some biased words had been included and these were dropped to leave a final list of 90 items covering an age range of 5 to 14.5 years.

The British Abilities Scales Recall of Digits test was also used to help equate the samples on short term auditory memory, a factor which is correlated with reading ability (Adams 1990, Johnston et al 1987). The BAS recall of digits test has a high level of reliability compared with other digit recall tests due to its homogeneity and its length (in particular the large number of trials per span length). There are 36 items in the test covering an age range from 2.5 years to 17.5 years.

The British Picture Vocabulary Scale was used to equate the vocabulary skills of the samples. Vocabulary skill is also highly correlated with reading ability and classroom learning (Dale and Reichhert 1957). Elliot (1982) reported correlations between measures of vocabulary knowledge and IQ of between 0.60 and 0.74, and this, along with a factor analytic study of IQ scores, led to the conclusion that vocabulary is one of the most important contributors to measures of IQ. The short form of the test was used as it is can be administered very quickly while still giving a high correlation with the factors mentioned above.

Test Administration

1) British Abilities Scales Word Reading Test.

The full reading test of 90 items, Test A, was administered according to the procedure outlined in the BAS "Directions for Administration and Scoring" manual (Elliott et al 1983). The child simply reads out each word as best it can, working from left to right down the page. The child is stopped after failing ten successive words. The test was administered individually and in quiet conditions. Incorrect responses were noted for later analysis.

2) British Abilities Scales Recall of Digits Test.

The full test, Test A, was administered according to the procedure outlined in the BAS "Directions for Administration and Scoring" manual (Elliott et al 1983). The child, once a basal level has been established, recalls verbally all the digits in the order that they were read out by the experimenter. The test follows an ascending staircase procedure. The test is discontinued after all five items in a block of numbers have been failed. The test was administered individually and in quiet conditions.

3) British Picture Vocabulary Scale (BPVS)

The short form of the BPVS was administered in accordance with the manual supplied with the test (Dunn, Dunn, Whetton, Pintillie 1982). The child listens to a test word and is then shown four line drawn pictures. The child points to the picture which best describes the word heard. Testing is discontinued after four errors are made in six consecutive responses.

Section A

Initial Subject Selection

i) Scottish subjects

The Scottish subjects were drawn from two state schools in the Dundee area. Permission was given by the school authorities to study pupils from three classes. There were two Primary One classes (Ages 5 years to 6 years approximately), and one Primary Two class (Ages 6 years to 7 years approximately). This gave a total potential subject number of 86 pupils; fifty five of these were the Primary 1 pupils, thirty one pupils were from Primary 2. Five pupils from this total were rejected because of they were receiving remedial teaching for reading. A further four pupils were rejected because they were too young or too old (See "New Zealand subjects" for details about the age criterion). This left a potential 77 pupils who were eligible for testing. The local educational authority requires that all experimenters receive express parental permission before testing can begin. Fifty four parents expressed their wish to have their child included in the testing. Twenty three parents did not reply to the letter of invitation and so their children had to be withdrawn from the test sample. This sample therefore consisted of thirty six Primary One pupils and twenty Primary Two pupils. Two further pupils had to be dropped from the study because their Vocabulary test scores were in the bottom 10 per cent range for their age. This was taken as a cut off point because such a low score may mean that the child will have a disadvantage compared to others when it comes to reading, as vocabulary knowledge correlates highly with classroom learning. So the final sample of fifty four pupils had a total mean age of five years and ten months and a total mean time at school of 10.37 months. There were 27 males and 27 females. The mean British Abilities Scales word reading raw score was 22.2 (which yielded a mean reading age of six years six months). No child performed so poorly on the BAS test that they had to be excluded from the sample. The mean standard score of the sample on the British Picture Vocabulary Scale was 102.15. See Table 3.1 for a summary of the means for the sample.

ii) New Zealand subjects

The New Zealand subjects were drawn from two state schools in the Wellington area. In school 1 pupils from the Junior One class (ages five years to six years approximately), and the Junior Two class (ages six to seven years approximately), were studied. In school 2 pupils from

Table 3.1 Initial Subject summary

	Scotland	New Zealand
Factor		
Age (months)	70	73
Time at school		
(months)	10.37	12.8
BAS Score	22.2	26
(months)	78	80
BPVS Score	102.15	97.07

the Junior section of the school were studied, which encompasses both Junior one and Junior two. This Junior section consisted of four classes ranging from the New Entrant level (which is below junior one level) up to late Junior Two level, in an open plan area (see the Schools section for a more detailed analysis and explanation of the terminology). This gave a total potential subject number of 120 pupils.

Those for whom English was a second language were then removed from the sample. This left 99 pupils, of which three were excluded because they had received some remedial reading help, bringing the number down to 96. This sample was then reduced further using a number of criteria which would help make it as similar to the Scottish sample as possible. No child younger than 5 years three months could be included in the study for a number of reasons. Firstly, this was the youngest age in the Scottish sample, secondly the British Abilities Scales word reading test starts to show floor effects below this age. Time at school was another factor to be considered as no Scottish pupil had been at school less than four months before testing began. Therefore, no New Zealanders were tested who had been at school less than four months. Also, since the study was only concerned with the first two years of schooling, an upper age and "time at school" limit had to be set. In Scotland the children all start school at the same time and so receive their first two years of instruction in unison. In actual teaching time this is 21 months of instruction due to the Summer vacation and other holidays. In New Zealand the child starts school on its fifth birthday. This means that the children's time at school is more variable and so children who would have accumulated more than 21 months of instruction by the end of the testing period had to be excluded. This meant that since the testing period was four months long, no child who had had more than 17 months instruction was included in the study. This "time at school" factor also helped set the upper age limit for the children in the sample, as a New Zealand child receiving the full 21 months instruction over a 24 month period (the amount of holiday time being equivalent between Scotland and New Zealand) would be seven years old at the end of the test period. Therefore, no child over six years eight months old was tested. Ten pupils were removed from the sample due to these age restrictions. These restrictions placed on the selection of the New Zealand sample also had implications for the final selection of Scottish pupils for the matched groups.

This then left 86 New Zealand pupils to be tested. They were first tested on the British Picture Vocabulary Scale. Ten pupils were found to be in the bottom 10 per cent for their age group on this test and so were removed from the sample. A further eight pupils were removed from the sample because they were at or below the floor level of the British Abilities Scales word recognition test (i.e. 3 items correct). Three subjects were removed because they were absent for both tests. This left a total of sixty five pupils, 31 from school 1 and 34 from school 2. There were 25 males and 40 females with a total mean age of six years one month and a mean time at school of 12.8 months. Their mean standard score on the British Picture Vocabulary Scale was 97.07 and they had a mean raw score of 26 on the British Abilities Scales word recognition test (which yielded a mean reading age of six years eight months). See Table 3.1 for means and standard deviations.

This large cross national sample then constituted the basic sample from which tightly controlled cross national groups were drawn, matching for chronological age, reading age, vocabulary knowledge and short term memory. This subject matching procedure is described in section B below.

Section B

Selection of Matched Experimental Samples

From the main pool of subjects described above, it was decided to select Scottish and New Zealand samples who were matched in terms of chronological age, time at school, short term memory, vocabulary knowledge and word recognition ability. It was also decided to study separately those children under six years of age and those over six years of age so that developmental changes could be observed. Those children over six years of age were all in their second year at school and those under six years of age were all in their first year at school. This led to the selection of four groups of subjects who were matched using the tests above. These will be subsequently be referred to as the Scottish and New Zealand groups for year 1 and year 2.

(i) Scottish Year 1 Sample

This sample consisted of eighteen children from two state schools in the Dundee area. They were drawn from the sample of 54 children detailed earlier. There were 9 females and 9 males in this sample. The mean chronological age was five years and seven months, with a mean time at school of 6.77 months. The children had a mean standard score of 102.11 on the British Picture Vocabulary Scales and an ability score of 108.14 on the British Abilities Scales Recall of Digits test. Their mean reading age on the BAS word reading test was six years and two months. This test will subsequently be referred to as their BAS 1 test. Reading was retested four months later at the end of the test period and reading age was found to be six years and five months. This test will subsequently be referred to as the BAS 2 test. See Table 3.2 for means and standard deviations of all the samples.

(ii) New Zealand Year 1 Sample

The seventeen children in this sample were drawn from two schools in the Wellington area and consisted of 12 females and 5 males. They were drawn from the sample of 65 children detailed earlier. The mean chronological age was five years eight months, with a mean time at school of 7.01 months. The children had a mean standard score of 98.65 on the British Picture Vocabulary Scales test and an ability score of 110.23 on the British Abilities Scales Recall of Digits test. The mean reading age was found to be six years and two months on the Word Reading test of the British Abilities Scales (BAS 1). This was retested four months later (BAS 2) at the end of the test period when reading age was found to be six years six months.

Table 3.2 Summary of Subject Group Means

(standard deviations in brackets)

Year 1 Groups

	Scotland	New Zealand
Factor		
Age (months)	67.3 (2.5)	68.0 (1.9)
Time at school (months)	6.77 (0.25)	7.01 (1.8)
BAS 1 score	15.07 (4.9)	15.12 (5.5)
BAS 2 Score	21.33 (5.9)	22.8 (9.85)
BPVS score	102.11 (11.2)	98.65 (8.35)
Digit score	108.14 (13.7)	110.23 (13.7)

Year 2 Groups

	Scotland	New Zealand
Factor		
Age (months)	76.8 (2.5)	77.3 (1.9)
Time at school (months)	14.7 (0.2)	14.9 (2.6)
BAS 1 score	27.1 (7.9)	25.7 (9.0)
BAS 2 Score	33.4 (11.1)	33.8 (10.8)
BPVS score	98.4 (10.5)	95.2 (7.1)
Digit score	117.7 (20.7)	118.0 (13.2)

(i) Scottish Year 2 Sample

This sample consisted of twenty three children drawn from two state schools in the Dundee area. They were drawn from the sample of 54 children detailed earlier. There were 10 females and 13 males in this sample. The mean chronological age was six years and four months with a mean time at school of 14.7 months. The children had a mean standard score of 98.41 on the British Picture Vocabulary Scales test and 117.7 on the British Abilities Scales Recall of Digits test. Using the Word Reading test of the British Abilities Scales (BAS 1) their mean reading age was found to be six years and eight months. This was retested four months later (BAS 2) at the end of the test period and reading age was found to be six years and eleven months.

(ii) New Zealand Year 2 Sample

There were twenty four children in this sample and they were drawn from the two schools in the Wellington area described above and consisted of 14 females and 10 males. They were drawn from the sample of 65 children detailed earlier. The mean chronological age was six years five months with a mean time at school of 14.9 months. The children had a mean standard score of 95.21 on the British Picture Vocabulary Scales test and 118 on the British Abilities Scales Recall of Digits test. The mean reading age was found to be six years and eight months on the Word Reading test of the British Abilities Scales (BAS 1). This was retested four months later (BAS 2) at the end of the test period and reading age was seven years exactly.

Tests of matching

To evaluate the closeness of the matched groups on reading age, chronological age, vocabulary knowledge and time at school, analyses of variance were carried out to ensure there were no differences.

Reading Test Scores

For the reading tests there were two between-subjects factor, groups (Scottish samples and New Zealand samples), and age (year 1 and year 2), and one within subjects factor, reading test (BAS1 and BAS2). There was no main effect of groups, ($F<1$) but the main effect of reading test was significant ($F(1,78)=135.16$, $P<0.01$), as was the main effect of age ($F(1,78)=40.42$, $p<0.01$). No interactions were found to be significant. Therefore, the two older age groups performed better than the two younger age groups and the scores of the samples increased significantly between BAS 1 and BAS 2 by an equivalent amount over for each age group.

Chronological Age

A similar analysis of variance was also carried out on chronological age. There was a main effect of age ($F(1,78)=255.34$, $p<0.01$) but no main effect of Group ($F(1,78)=1.55$, $p>0.05$) or any significant interactions. The year 2 children in Scotland and New Zealand were significantly older than the year 1 children in Scotland and New Zealand. There were no significant age differences between Scottish and New Zealand children in either year 1 or year 2.

Vocabulary Knowledge

There were no significant main effects of Age ($F(1,78)=3.6$, $p>0.05$) or of Group ($F(1,78)=3.23$, $p>0.05$) or any significant interactions when the standard scores of the British Picture Vocabulary Scales were subject to analysis of variance. Therefore there were no differences between the national groups in vocabulary knowledge at each age level or between age groups.

Recall of digits

Analysis of variance on the scores for the BAS recall of digits test revealed a main effect of Age ($F(1,78)=5.56$, $p<0.05$) but no main effect of Groups ($F<1$) or any significant interactions. The Year 2 groups were therefore better at this task than the year 1 groups.

Time at School

Analysis of Variance on the time at school of the 4 groups revealed a main effect of Age ($F(1,78)=444.71$, $p<0.01$) but no main effect of Groups ($F(1,78)=0.37$, $p<0.01$) or any significant interactions. This merely reflects the fact that the Year 2 groups have been at school significantly longer than the year 1 groups.

Therefore, the two year 1 groups and the two year 2 groups would seem to be closely matched in terms of word reading, chronological age, vocabulary knowledge, recall of digits and time at school at each age level. The chapters that follow will report analyses of reading errors made by the four matched groups and describe a number of other tasks that were also carried out by the matched groups.

Chapter 4-Error analyses of single word reading

"Of course you know your ABC?"
said the Red Queen.

Following the dictum that much can be learnt through the study of mistakes, it was decided to analyse the errors that had been made by the children in the word reading test.

Error analysis of word reading has been prevalent in psychological and educational writings throughout most of the Twentieth Century (Gates and Boeker 1923, Schonel 1948, Clay 1968, Stuart and Coltheart 1988). The majority of these studies, however, did not specify which teaching method the children had been exposed to in the course of their learning but were mainly interested in error differences between good and poor readers (more recent examples include Weber 1970, Biemiller 1970, Fowler et al 1977, Stuart and Coltheart 1988). These studies, though, do not appear to have come to a consensus as to what differences there are in the errors made by good and poor readers. Leu (1982) has criticised error studies for their inconsistent evidence. For example, some studies of reading errors have claimed that good readers rely more on contextual cues when reading than poor readers (Goodman 1969, 1973, Murray and Maliphant 1982, Potter 1982). They found in their studies that the good readers produced more errors which were semantically in line with the stories they were reading, while the poorer readers did not. Other studies, however, state that good readers rely less on contextual clues than poorer readers (Goodman and Burke 1973, Cohen 1974-75, Biemiller 1977-78). Biemiller argues that error patterns in children develop in three distinct stages. First there is a phase in which the errors are generally haphazard guesses at the unknown word with a very limited use of context. The second phase is characterised by either 'no' responses or responses which are graphophonically (i.e. errors similar graphically and phonologically, Goodman 1969) similar to the target word. Biemiller hypothesised that the 'no' response errors are due to the child being aware that their graphophonological knowledge of the target word, limited though it may be, is not consistent with what they actually think the word is. The child therefore prefers not to make a response due to this contradictory evidence. The second phase still contained semantically correct errors but in slightly less quantity. The third phase was characterised by fewer refusal errors and much more graphophonic errors, especially for the better readers in the sample. All phases contained a lot of errors which were words reproduced from the child's reading vocabulary taught to them in the school year. Biemiller's work seemed to show that good readers relied less on contextual cues than the poorer readers.

Contradictory claims are also made for the amount of graphophonic information that good and poor readers use. Clay (1968, 1969) claimed that in her study of children aged 6 to 9 years that the good readers use less graphophonic information than the poor readers. Clay (1968) claimed that only 41% of the errors she found were graphophonically similar to the targets while 72% of errors occurring were grammatically acceptable substitutions. The graphophonic errors that were recorded were only recorded from the single word substitutions that the children made in story reading. The single word substitutions that were nouns were also discounted even though this category made up 52% of the total single word substitutions. If one takes the top group of the four groups of readers that Clay describes, the sample of words subjected to graphophonic analysis falls even further. The top group made 1,964 single word substitutions but only the 604 non-noun responses (31%) from this total were analysed for graphophonic similarity. Of this, 56% were judged by Clay to be graphophonically similar which is a higher percentage than any of the other groups. The lowest ability group in Clay's paper had 99 words out of 1208 single word substitutions analysed (8%) for graphophonic similarity. If one considers that non-nouns are most likely to be more predictable in text than nouns, as evidenced by their higher self-correction rate in Clay's paper and as discussed in Adams (1990), as well as generally being of high frequency, then context is more likely to be used in reading them. Nouns on the other hand are less predictable, are of generally lower frequency than non-noun function words and context is less likely to be so pointed towards their identity (Adams 1990), therefore graphophonic cues are more likely to be used to read them. The fact then that nouns were not analysed by Clay indicates that her conclusion, that error behaviour was not guided by grapheme phoneme relationships, may be very tentative. What of the data then that shows 72% of errors were grammatically acceptable? Cohen (1974-75) and Weber (1970), however, showed that graphophonic errors were in the main also grammatically acceptable errors, therefore the idea that the error behaviour of the children could have been driven by phoneme-grapheme relationships in words was not challenged by Clay.

Weber (1968, 1970), using her graphemic similarity index, which is a measure of how close graphemically an error is to a target word, found that better readers produced more errors that were graphophonically closer to the original target word. Weber also noted that the first grade children (mean age of 6 years and 3 months) she studied made errors on the first and last letters of each word a lot less than letters in any other position. On simple CVC words the vowel in the middle was always the least likely letter to be read correctly. This observation was also noted by other researchers like Fowler, Liberman and Shankweiler (1977) who manipulated consonant and vowel positions in words. They found that errors of the medial vowels in a target word far exceeded those of the final consonants in the word, which in turn far exceeded those made for initial consonants in the word in first grade age children. Stuart and Coltheart (1988) found that the better readers in year 1 of school progressed to word errors with only the medial vowels wrong far more quickly than the slower readers who still tended to make errors on the initial and final consonants. The successful readers were making errors where only a small part of the word was wrong, usually a medial vowel or a final consonant.

Fowler et al (1977) and Stuart and Coltheart (1988) have tried to explain this pattern of error development as a development in phonological knowledge. Stuart and Coltheart noted that errors in their classification that either contained the same beginning letters as the target or contained the same beginning and end letters were highly correlated with knowledge of letter sounds. Probing further into this they also found that these same error types were correlated with the production of nonwords by the children, which is a common test of phonological processing. Stuart and Coltheart then looked into when these error type started to appear among the children. They found a wide variation, with the better readers producing more of these errors earlier. They also found that the incidence of these errors rose considerably almost as soon as the child could score above chance on a test of phonological segmentation and knew more than half of the letter sounds. This prompted them to classify the error types where either the beginning letters are correct or both beginning and end letters are correct as phonological errors. Knowledge of the phonological system led to a strategy of reading whereby these errors, which correlated significantly with reading performance, were a symptom.

Perfetti (1992) has tried to alternatively explain this form of error pattern as a problem in the quality of representations. The young inexperienced reader does not have concrete representations for words (See Figure 4.1). For example the second vowel in the word "iron" in figure 4.1 at level 1 can be thought of as a free variable as it has no concrete representation to the child. As the child develops its reading skill, the free variables in each word reduce, as the word becomes familiar to the child.

Figure 4.1

Changes in representation precision over three skill levels

Taken from Perfetti (1992)

Word	Level 1	Level 2	Level 3
iron	ir*n	iron	iron
tongue	t*g*	t*ng**	tongue
ukulele	uk*	ukil*	uk*l*l*

Note: The asterisks denote free variables in the childs representation at that level.

How does the child develop the reading skill to fix the free variables? Is it done by the application of phonological knowledge to the reading system or by a more whole word oriented approach? Perfetti thinks that both have a role to play in reading development.

The question that we are trying to answer here is more simple. We have seen that there is much controversy and contradictory evidence about children's reading errors. The main controversy would seem to lie in the area concerned with grammatical and semantic differences, not letter differences. Therefore this area of controversy need not be of concern in this experiment. The errors to be analysed are from the BAS word reading test, which is a test of single, unrelated words with no grammatical and very little semantic content. We will therefore focus on the letter differences, if any, between the target word and the child's error. Does the sequence or progression of error production that Stuart and Coltheart found remain constant under different instructional regimes? It may be found that the type and quality of errors produced by young readers does vary with the instruction they are receiving. Is there any evidence for this view in those studies that have detailed the instructional regime and the errors that the children make?

Those studies that have examined errors relating to a particular system of teaching reading have usually taken just one system and looked at it in detail (Cohen 1974-75, Seymour and Elder 1986, Wimmer and Hummer 1990).

Cohen (1974-75) investigated children who were receiving phonics instruction. She found a very similar pattern to Biemiller, in that initially the 'no response' error was predominant. The children then produced large numbers of nonwords as errors, the better readers producing more nonwords than the poorer readers. The better readers went through a phase of what Cohen termed "High nonsense" where the amount of nonsense errors was overwhelming. They then began to reduce their nonsense word error production and began to increase their real word substitution errors. This trend was also paralleled by a growth in graphical accuracy. Cohen observed, as did Stuart and Coltheart, that the most predominant type of errors involved getting first and last letters or beginning letters only correct.

The trend of producing increasing numbers of nonword errors was also observed by Wimmer and Hummer (1990) when they studied first year children taught by a phonic method. They gave the children lists of words to read and observed that a large amount of nonwords were produced as errors by the children when reading real words. The graphophonic effect observed by Wimmer and Hummer were not so strong as that found by Cohen in that they found that the nonword errors usually began with only the same first letter as the target, but this was still judged by them as "at least partially phonologically correct".

Wimmer and Hummer, however, included nonwords in the reading lists that they gave to the children, along with the real words described above. This may have given the children encouragement to tackle reading real words like nonwords. The children were also Austrian and were learning German which is a language with a more phonetic base than English so comparisons may not be all that valid.

It has been found that children taught by a strict "look-say" method (Seymour and Elder 1986) produced word error responses primarily from the words taught in their reading scheme and very rarely responded with nonwords. The errors, when they contained similar letters to the target word, did not usually have these letters in the correct position in the word unlike the errors found by Cohen (1974-75), Stuart and Coltheart (1988) or Wimmer and Hummer (1990) where letter order was preserved. The children also tended to be flummoxed by completely new words and so refusals were very common. This then is quite a different pattern from that found by Cohen (1974-75).

Barr (1975) compared phonic taught children with children receiving whole word instruction. She found the same patterns of errors as found by Seymour and Elder (1986) and Wimmer and Hummer (1990). The phonics taught children made errors that included nonwords or errors that are quite close graphophonically to the target, while the whole word taught children responded with words from their reading set or made no response. The groups of children compared, however, were not matched on word reading ability or any other relevant factors. Generally, the phonics taught children in the studies were ahead in word recognition skill compared to the whole word taught children. So was the difference in error types due to the fact that the phonics children were simply better readers? In the study reported here the children are matched for word recognition ability, age, time at school, vocabulary knowledge and short term memory. Any differences found should not be due to one group being simply better readers than the others.

We have seen then that error analysis is a tool that can potentially reveal a lot about the underlying strategies inherent in how the child approaches the reading of words.

The segment of the error which corresponds to the target word can reveal what the reader chose as the basis for their response for that specific word. These correct segments of the error are also reflective of the information that the reader uses regularly when they read words. It is a presupposition of error analyses that the same underlying strategies are used for all words, should they turn out to be errors or correctly read words. This presumption may be a bit unjustified in that with error categories like "no response" (which predominates in Seymour and Elder's (1986) 5 year olds) we cannot be sure wether the subject has the right answer in mind but is not confident enough about the response to utter it, or whether the subject is unable to generate the appropriate response at all.

Errors can therefore be studied at many different levels of analysis. A single word substitution error can be looked at in terms of the substituted word itself. Is it a real word? Is it a word the child has met before? Or can the error be looked at in relation to the overlap between the intended target and the error? Which consonants were correct? Were the vowels correctly recognised? In terms of letters correct, it could be claimed that some errors are better than others. Those that approximate the target word more closely will generally yield more information than those errors that are dissimilar to the target word.

The aims of the error analyses reported here are to classify the errors made on the BAS reading tests and to infer from those errors the strategies that the children use to identify words. The groups from Scotland and New Zealand will be compared to see if there are differences in error categories between the groups; these may reflect the different methods of instruction that the children are receiving and may show that the two groups use a different approach to reading. Similarily, errors made by the older groups were compared to the younger groups to examine age related differences in reading strategies.

The error categories decided on in any error analysis study will always reflect the beliefs and biases of the experimenter. If one holds the view that letter sounds are incidental to the association between whole words and meaning then you would attach less importance to an error categorisation that differentiated between first and last consonants correct. With this in mind and given the point made earlier that errors may have more than one meaning when analysed differently, it was decided to have two levels of analysis for the errors that were made by the children. The first level considers the errors in relation to the whole word and the second level looks at the letter differences between the target and the response.

Error Analyses

The level of analysis looking at whole word differences is split into two parts and is a similar scheme to that used by Cohen (1974-75). The first analysis splits the errors into real words, nonwords and refusals. The second analysis splits the errors into those in the child's reading set, those not in the child's reading set, and refusals.

The analysis that looks at the letter differences between words is adapted from Stuart and Coltheart (1988) and is detailed later in this chapter.

As stated before, the children in the Scottish sample had been taught in a phonics rich regime. The children were encouraged to pay attention to the sounds in words and to attempt to decode new words using spelling sound correspondences. The children in the New Zealand sample had a substantially less emphasis on phonics (initial letters only being emphasised) and were not encouraged to decode using spelling sound correspondences. Therefore, it was predicted that different types of errors would be made by the two error groups (after Cohen 1974-75, Barr 1975, Seymour and Elder 1986, Wimmer and Hummer 1990). It was also predicted that the Scottish sample would make more errors having a phonological link with the target word than the New Zealanders. Attempts to decode words phonologically may produce more nonword responses, so it was further predicted that more errors of this type would be found. It was predicted that the New Zealanders would produce more "refusal to respond" errors than the Scottish sample because the reading test contained many words unfamiliar to them. The New Zealand sample should also be more inclined to make error responses from the set of words used in their reading scheme.

Subjects

The 4 Groups as detailed in Chapter 3

Method

The errors made on the BAS reading tests administered at the beginning and end of the test period (BAS 1 and BAS 2) were studied in detail. On the basis of the predictions made above these errors were initially classified as follows:-

1) Refusal to attempt word.
2) Error is a real word.
3) Error is a non-word

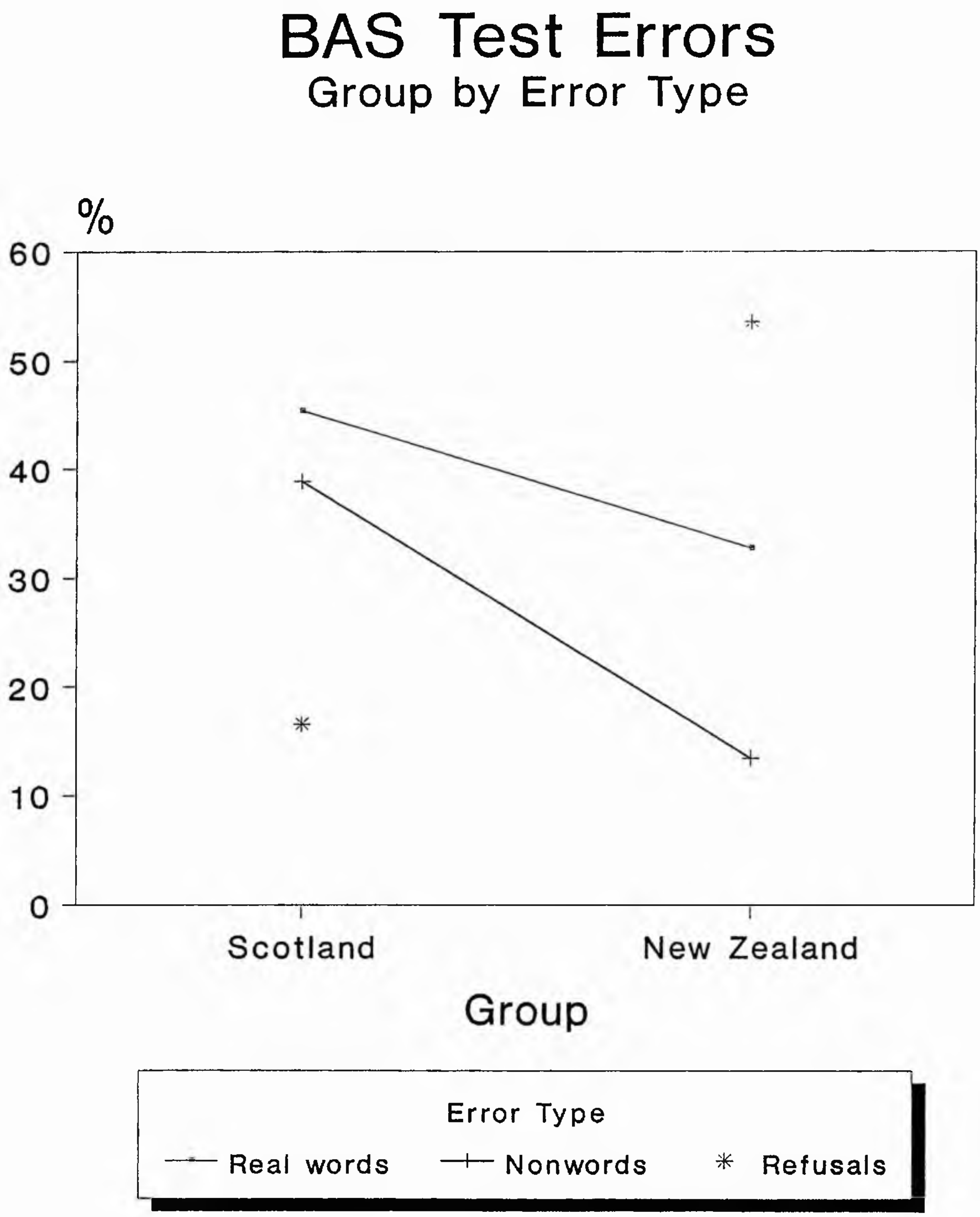
Results

Table 4.1-Error Types as percentage of total errors (Standard deviations in brackets)

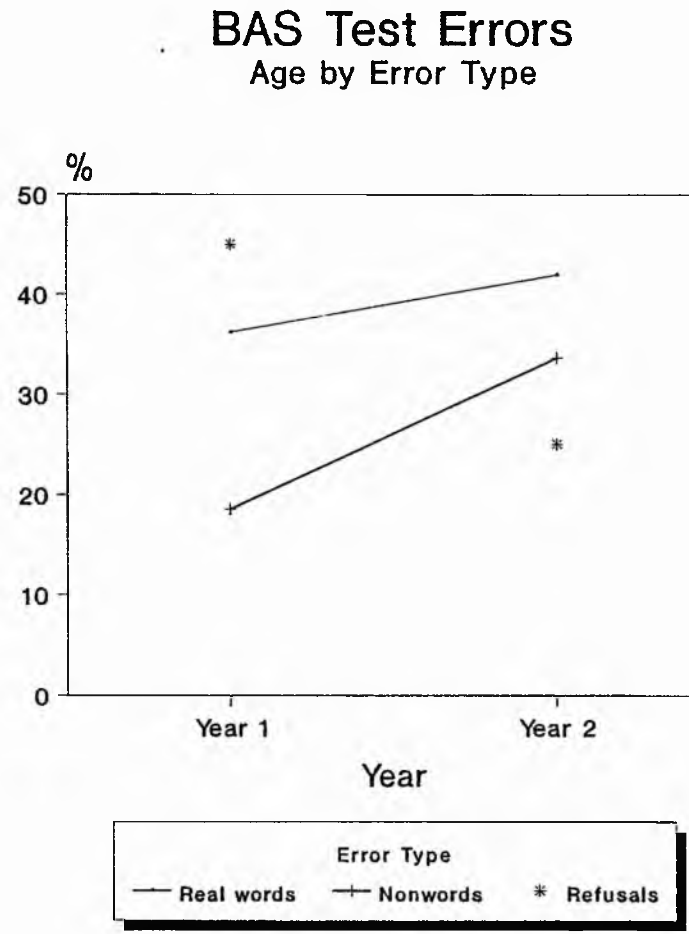
Scottish samples	Year 1		Year 2	
	BAS 1	BAS 2	BAS 1	BAS 2
Refusals	39.5	18.9	6.6	1.1
	(36.4)	(29.5)	(15.5)	(2.2)
Real words	38.0	45.4	51.7	46.4
	(21.4)	(24.5)	(15.6)	(18.9)
Nonwords	22.3	36.2	44.4	52.4
	(20.9)	(24.2)	(17.4)	(19.8)

New Zealand samples				
	Year 1		Year 2	
	BAS 1	BAS 2	BAS 1	BAS 2
Refusals	67.5	54.0	49.5	43.3
	(28.6)	(36.4)	(34.7)	(33.5)
Real words	27.5	33.9	35.6	33.9
	(22.4)	(27.8)	(21.7)	(19.5)
Nonwords	4.9	10.9	14.6	23.0
	(8.9)	(14.4)	(19.3)	(21.0)

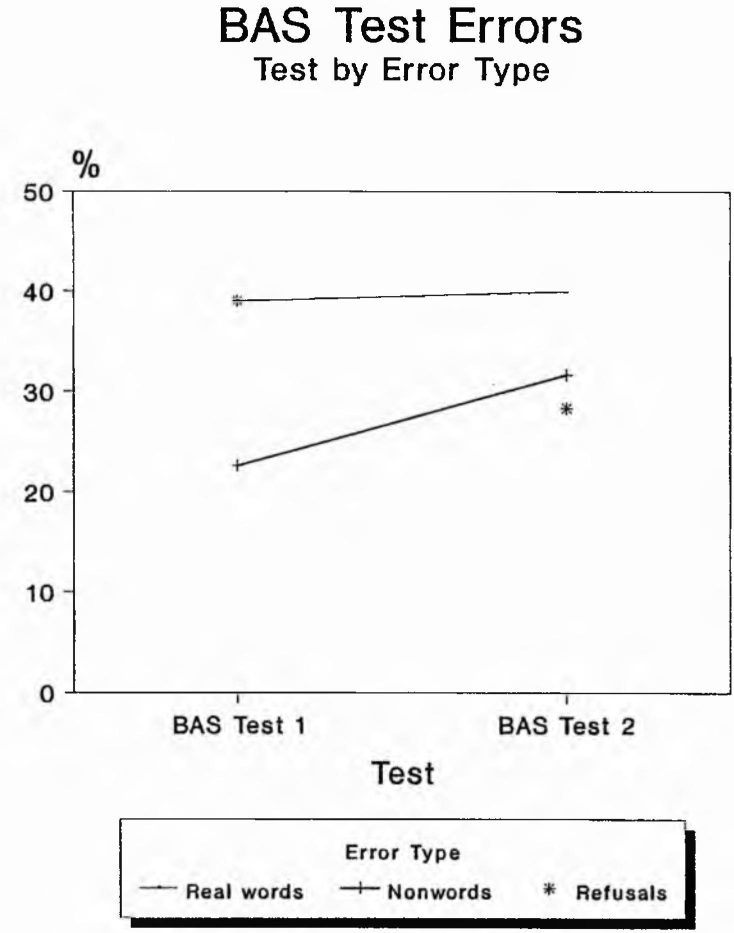
An analysis of variance was performed on these data with two between subjects factors, Group (Scottish or New Zealand) and Age (year 1 and year 2). There were two within subjects factors, Reading Test (BAS 1 and BAS 2) and Error Type (Refusal, Real word and Nonword). A significant main effect of Error Type was found ($F(2,156)=5.99$, $p<0.01$) but there was no main effect of Group ($F(1.78)=1.12$, $p>0.05$) or Reading Test ($F<1$). There were significant interactions between Group and Error Type ($F(2,156)=37.05$, $p<0.01$), Age and Error Type ($F(2,156)=11.11$, $p<0.01$), and Test by Error Type ($F(2,156)=9.33$, $p<0.01$) (see Graphs 4.1, 4.2 and 4.3). (Note: All Newman Keuls posthoc differences reported in this thesis are significant to $p<0.05$ unless otherwise indicated.) A Newman Keuls posthoc test revealed that the Age by Error type interaction was due to the older groups producing significantly less ($p<0.01$) refusals and significantly more ($p<0.01$) nonword errors. Newman-Keuls posthoc tests also revealed that the Group by Error Type


BAS Test Errors
Group by Error Type
%
60
50
40
30
20
10
0
Scotland
New Zealand
Group
Error Type
Real words
Nonwords
Refusals

Graph 4.1


BAS Test Errors
Age by Error Type
%
50
40
30
20
10
0
Year 1
Year 2
Year
Error Type
Real words
Nonwords
Refusals

Graph 4.2


BAS Test Errors
Test by Error Type
%
50
40
30
20
10
0
BAS Test 1
BAS Test 2
Test
Error Type
Real words
Nonwords
* Refusals

Graph 4.3

interaction was due to the Scottish children producing significantly more ($p<0.01$) non-words and real word errors than the New Zealand sample. The reading test by error type interaction was due to there being significantly more non-word errors and significantly fewer refusals in the second reading test, BAS 2, for all samples.

This analysis therefore confirms the work of Barr (1974-75), and supports our prediction that the Scottish children would produce more nonword errors than the New Zealanders even though they were matched for reading age and the other factors. The prediction that the amount of refusals would be higher in the New Zealanders was also confirmed.

Biemillers developmental error progression was also generally confirmed (save the differences between the Scottish children and the New Zealanders) as the refusal errors decreased with age and the production of nonwords increased.

The proportion of errors in each category were then correlated with the children's performance on the BAS word recognition tests. These correlations of performance on the reading test with the type of errors produced are shown in Table 4.2

The pattern of correlations are similar to those found by Biemiller, Cohen and Barr, in that the production of nonword errors is correlated positively with word recognition performance. It is the better readers in both Scotland and New Zealand that are producing more nonword

Table 4.2-Correlations of items correct on the BAS reading test with proportions of error types produced

(Real=Real word errors, Non=nonword errors, Refusal=refusal errors)

Year 1

	Scottish group			New Zealand group		
	Real	Non	Refusal	Real	Non	Refusal
BAS 1	-0.02	0.31	-0.16	0.31	0.13	-0.28
BAS 2	-0.50	0.52	-0.01	-0.08	0.45	-0.12

Year 2

	Scottish group			New Zealand group		
	Real	Non	Refusal	Real	Non	Refusal
BAS 1	-0.68**	0.59**	-0.11	0.15	0.48**	-0.36
BAS 2	-0.68**	0.64**	-0.41	-0.14	0.37	-0.14

Combined over age national groups

	Scottish groups			New Zealand groups		
	Real	Non	Refusal	Real	Non	Refusal
BAS 1	-0.02	0.64**	-0.44**	0.26	0.50**	-0.42**
BAS 2	-0.43**	0.63**	-0.26	-0.09	0.47**	-0.19

(*=p<0.05, **=p<0.01)

errors. The production of refusals is generally found to be negatively correlated with reading ability, i.e. the poorer readers in both samples are producing more refusals. The New Zealanders overall, however, are producing more refusals and less nonwords than the Scottish children which may not be a good sign for their future word recognition performance.

The complete error set was then further analysed into the following categories:-

1) Refusal to attempt word

2) Error was from taught reading scheme word set (In set)

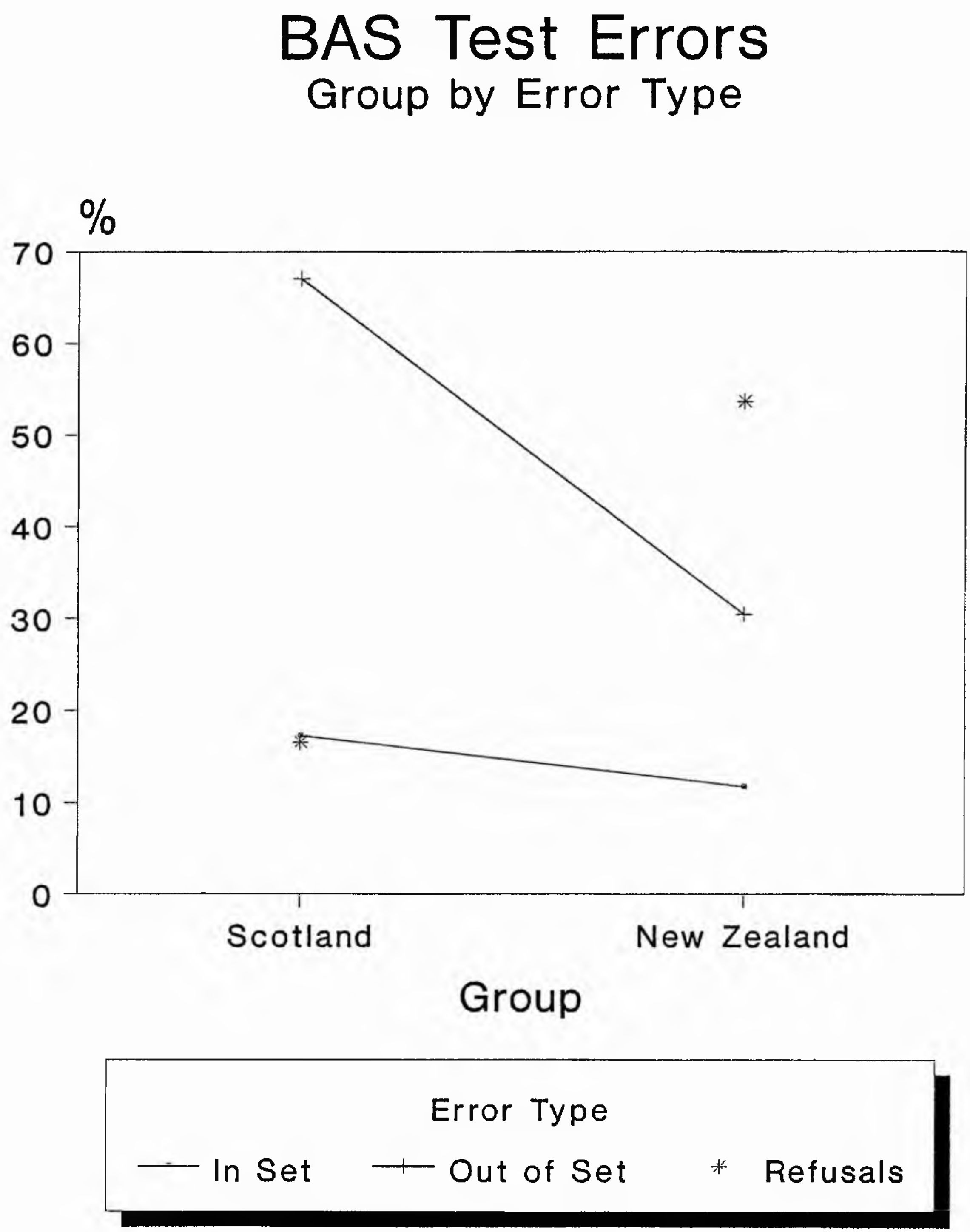
3) Error was not from taught reading scheme word set (Not in set)

Table 4.3-Errors Types as percentage of total errors

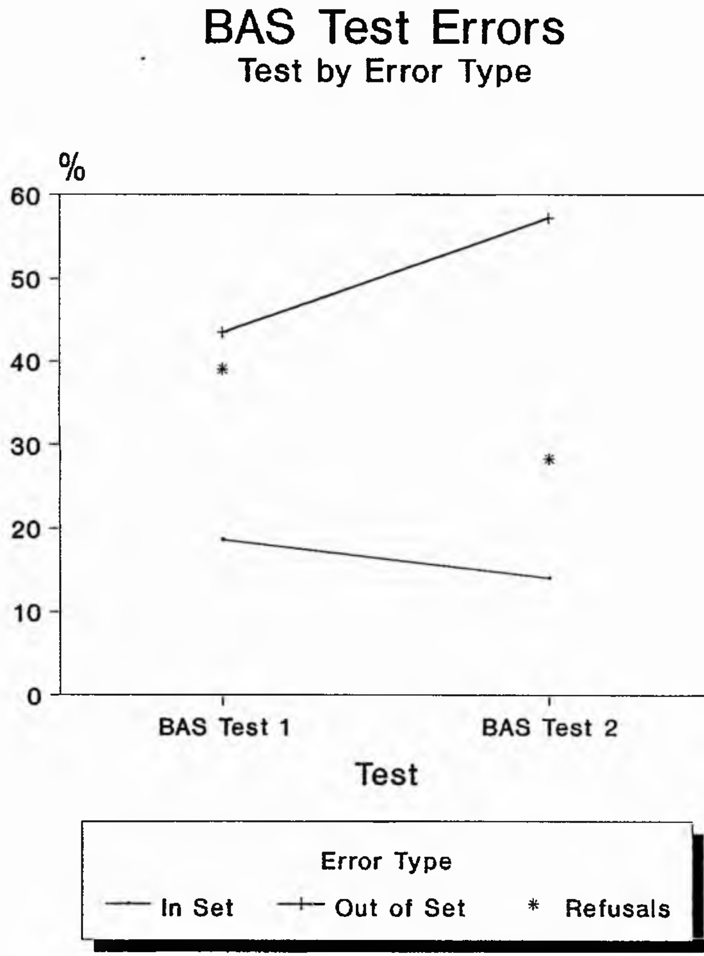
Scottish samples				
	Year 1		Year 2	
	BAS 1	BAS 2	BAS 1	BAS 2
Refusals	39.5	18.9	6.6	1.1
	(36.4)	(29.5)	(15.5)	(2.2)
In Set	17.7	15.5	23.4	12.2
	(13.4)	(15.5)	(18.1)	(13.1)
Not in Set	41.9	64.2	75.4	86.6
	(31.7)	(29.1)	(14.3)	(14.1)

New Zealand samples				
	Year 1		Year 2	
	BAS 1	BAS 2	BAS 1	BAS 2
Refusals	67.5	54.0	49.5	43.3
	(28.7)	(36.4)	(34.7)	(33.5)
In Set	17.1	17.7	15.6	12.1
	(15.3)	(16.6)	(15.2)	(13.5)
Not in Set	15.3	27.6	33.8	44.8
	(20.8)	(24.4)	(30.0)	(30.5)

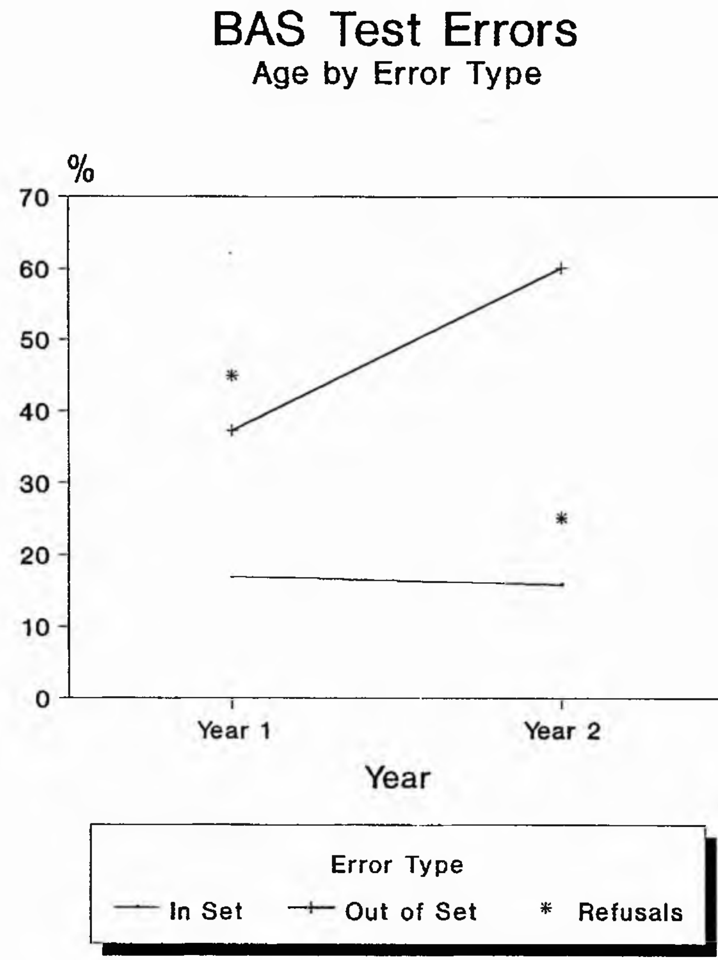
An analysis of variance was carried out on these data with two between subjects factors, Group (Scotland and New Zealand) and Age (year 1 and year 2). There were two within subjects factors, Reading test (BAS 1 Test and BAS 2 Test) and Error Type (Refusal, Error in Set and Error not in Set). A significant main effect of Error Type was found, ($F(2,156)=33.81$, $p<0.01$) but there was no main effect of Group ($F<1$) or Reading Test ($F(1,78)=1.03$, $p>0.05$). There were significant interactions of Age by Error Type ($F(2,156)=14.82$, $p<0.01$), Group by Error type ($F(2,156)=43.74$, $p<0.01$) and Test by Error Type ($F(2,156)=16.27$, $p<0.01$) (see Graphs 4.4, 4.5 and 4.6). A Newman Keuls posthoc test revealed that the interaction of Age by Error Type was due to there being significantly more (P,0.01) errors produced that were "not in reading set" and significantly fewer ($P<0.01$) refusal errors in the older age


BAS Test Errors
Group by Error Type
%
70
60
50
40
30
20
10
0
Scotland
New Zealand
Group
Error Type
In Set
Out of Set
Refusals

Graph 4.4


BAS Test Errors
Test by Error Type
%
60
50
40
30
20
10
0
BAS Test 1
BAS Test 2
Test
Error Type
In Set
Out of Set
Refusals

Graph 4.5


BAS Test Errors
Age by Error Type
%
70
60
50
40
30
20
10
0
Year 1
Year 2
Year
Error Type
In Set
Out of Set
Refusals

Graph 4.6

groups compared with the younger age groups. Newman-Keuls posthoc tests also showed that the Group by Error type interaction was due to the Scottish children producing more errors "not in Set" ($p<0.01$) while the New Zealanders produced more ($p<0.01$) Refusals. There was no difference in quantity of "in Set" errors. The interaction of Reading Test by Error Type was shown to be due to the fact that over both tests the amount of Refusals went down significantly while the amount of errors "not in Set" rose significantly between the reading test carried out at the beginning and end of the testing period. The "in Set" errors did not differ significantly between the two tests (BAS 1 and BAS 2).

The differences here are not quite as predicted, in that the New Zealanders are not producing more "in set" errors. However the Scots are producing more "Out of set" errors. This is due, in part, to the greater amount of nonwords that have been produced by the Scottish sample, as nonwords cannot be "In set". An interesting point about the greater percentage of errors that are "not in set" in the Scottish sample is that this percentage is almost exactly the percentage difference between refusal production for both national groups. There is no difference in the amount of "in set" errors produced. It is possible that the New Zealand children make refusals in situations where the Scottish children would produce "not in set" responses.

The errors were again correlated with word recognition performance on the BAS tests. Results are shown in Table 4.4

Table 4.4-Correlations of items correct on the BAS reading test with amount of error types produced

(In set=error in reading set, Not in set=Error not in reading set, Refusal=error is a refusal)

Year 1

	Scottish group			New Zealand group		
	Not in Set	In set	Refusal	Not in Set	In set	Refusal
BAS 1	0.31	-0.29	-0.16	0.25	0.18	-0.28
BAS 2	0.33	-0.65**	-0.01	0.33	-0.27	-0.12

Year 2

	Scottish group			New Zealand group		
	Not in set	In set	Refusal	Not in set	In Set	Refusal
BAS 1	0.55**	-0.27	-0.11	0.52**	-0.22	-0.36
BAS 2	0.72**	-0.70**	-0.43	0.41	-0.55**	-0.14

Combined over age groups

	Scottish groups			New Zealand groups		
	Not in set	In set	Refusal	Not in set	In set	Refusal
BAS 1	0.61**	-0.07	-0.44**	0.55**	-0.11	-0.42**
BAS 2	0.58**	-0.59**	-0.26	0.46**	-0.45**	-0.19

Combined over national groups

	Year 1 groups			Year 2 groups		
	Not in set	In set	Refusal	Not in set	In set	Refusal
BAS 1	0.18	-0.04	-0.14	0.43**	-0.22	-0.26
BAS 2	0.20	-0.40**	-0.02	0.34**	-0.62**	-0.08

(*=p<0.05, **=p<0.01)

The trend then would appear to be similar to that seen for the nonword errors. The good readers are producing more "out of set" errors. There is, in fact, a tendency in the BAS 2 results for "in set" errors to be negatively correlated with performance, as well as the negative correlations of the refusal errors.

Letter differences

The errors were further analysed by looking at the actual letter similarities between the target and the error. Eight categories of error were decided on, based loosely on Stuart and Coltheart's (1988) error analysis. Their scheme had six categories of error types. It was decided to expand these to include a "Beginning Letter Correct Only" category; this was deemed important as New Zealand children are actively encouraged to use the first letter in a word to decode the whole word. A "Final Letter Correct Only" category was also included to mirror the new category. Therefore the eight categories of error were as follows:

TYPE 1 Partial/irrelevant information used

eg	Target	Error
	up	dot
	van	away
	running	Sparky

TYPE 2 Letters/Letter segment from target used in no particular order

Target	Error
bird	ride
clock	lo
jump	tum

TYPE 3 Beginning Letter Correct

Target	Error
you	yes
one	out
cup	can

TYPE 4 Beginning Letters Correct (up to first half of word)

Target	Error
switch	swim
dig	did
massive	massey

TYPE 5 Final Letter Correct

Target	Error
ring	dog
water	oor
oil	hall

TYPE 6 Final Letters Correct

(up to last half of word)

Target	Error
out	ut
digging	willing
that	fat

TYPE 7 Beginning and End Letter Correct

Target	Error
text	tint
word	wand
men	man

TYPE 8 Target included in Error

Target	Error
climb	climbed
behaviour	behave
air	aircraft

It was hypothesised that the Scottish children would show more of what Stuart and Coltheart termed errors with a "phonological component", ie. Type 4 and Type 7 errors, in this analysis.

It was also predicted that the New Zealand sample would produce more Type 3 errors, (beginning letter correct), in that they would be guessing an unknown word based on the first letter only.

Results

The following mean amounts of error types were found:

Table 4.5-Mean amount of error types produced

Year 1 comparison

BAS 1 Reading Test

Error Type->	1	2	3	4	5	6	7	8
Scotland	4.58	5.34	10.44	25.27	3.12	8.38	14.49	2.35
	(8.7)	(5.9)	(8.7)	(11.5)	(3.4)	(10.8)	(13.1)	(4.5)
New Zealand	0.43	1.73	11.31	9.68	0.83	3.57	9.28	0.44
	(1.3)	(2.6)	(11.0)	(9.9)	(1.8)	(4.6)	(11.6)	(1.8)

BAS 2 Reading Test

Error Type->	1	2	3	4	5	6	7	8
Scotland	3.03	4.52	10.62	13.91	2.71	4.95	33.9	7.21
	(4.5)	(4.7)	(11.2)	(7.8)	(3.2)	(5.6)	(19.2)	(6.4)
New Zealand	2.31	1.09	16.75	8.73	1.06	1.16	13.20	0.92
	(2.8)	(2.1)	(19.2)	(7.8)	(1.7)	(2.4)	(12.8)	(2.2)

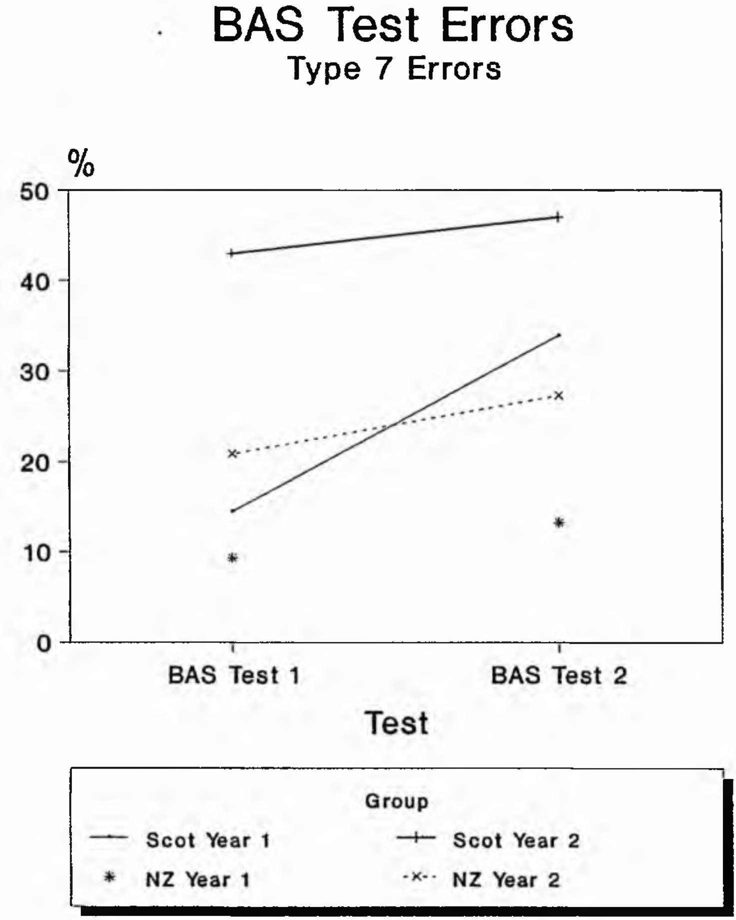
Year 2 comparison

BAS 1 Reading Test

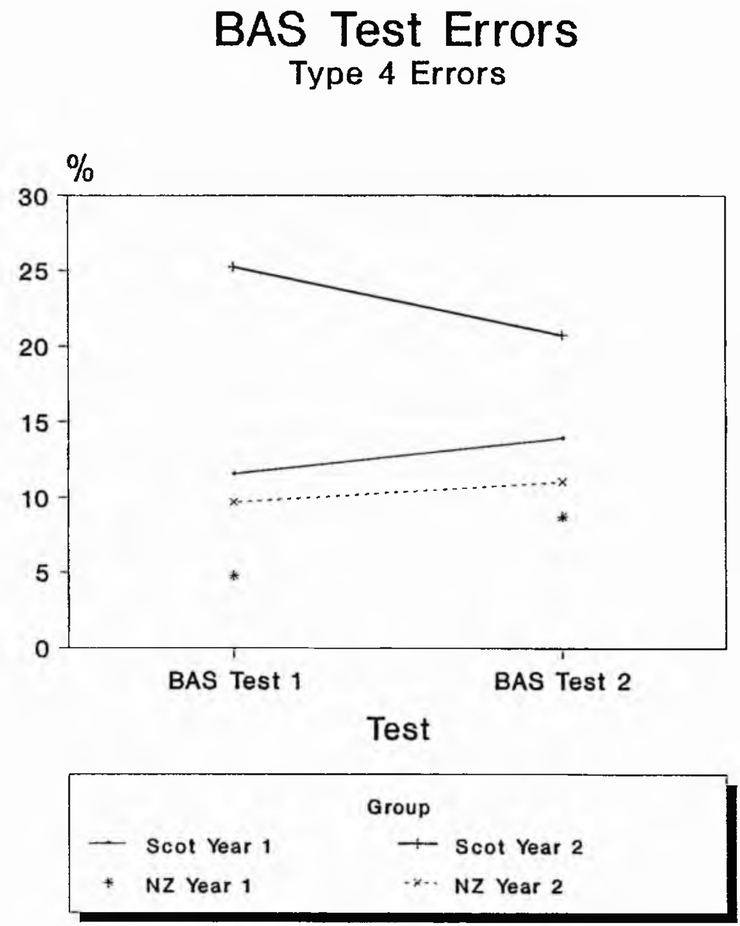
Error Type->	1	2	3	4	5	6	7	8
Scotland	2.21	3.36	15.64	25.27	1.50	3.58	42.92	1.10
	(3.8)	(3.8)	(10.7)	(11.5)	(2.1)	(2.8)	(13.6)	(3.4)
New Zealand	0.53	1.50	13.22	9.68	0.33	2.99	20.90	0.44
	(1.8)	(2.3)	(12.1)	(9.9)	(1.1)	(3.5)	(17.4)	(1.2)

BAS 2 Reading Test								
Error Type->	1	2	3	4	5	6	7	8
Scotland	5.80	2.64	14.64	20.77	2.28	3.58	47.02	1.19
	(12.47)	(3.5)	(8.8)	(8.9)	(3.3)	(4.2)	(17.8)	(1.7)
New Zealand	0.94	1.42	12.43	11.05	0.38	2.46	27.28	0.77
	(2.1)	(2.3)	(13.9)	(9.3)	(1.1)	(3.1)	(15.3)	(2.0)

An analysis of variance was carried out on these data. There were two between subjects factors, Group (Scotland and New Zealand) and Age (year 1 and year 2). There were two within subjects factors, Reading Test (BAS 1 and BAS 2) and Error Type (Type 1 to Type 8). A significant main effect of Group was found ($F(1,78)=46.56$, $p<0.01$) as was a significant main effect of Reading Test ($F(1,78)=10.05$, $p<0.01$). The main effect of Error Type was also significant ($F(7,576)=143.86$, $p<0.01$). Finally the interaction of Age by Group by Test by Error type was significant ($F(7,546)=3.21$, $p<0.01$). A Newman-Keuls posthoc test on this interaction revealed a number of interesting findings which are summarised below. (Cautionary note: This is a very complex interaction and post hoc testing may not be wholly sufficient to analyse the interaction complexity. It was decided not to collapse across error categories due to the stated interests in single letter differences as discussed on p.79 and p.99)


BAS Test Errors
Type 7 Errors
%
50
40
30
20
10
0
BAS Test 1
BAS Test 2
Test
Group
Scot Year 1
Scot Year 2
NZ Year 1
NZ Year 2

Graph 4.7


BAS Test Errors
Type 4 Errors
%
30
25
20
15
10
5
0
BAS Test 1
BAS Test 2
Test
Group
Scot Year 1
Scot Year 2
NZ Year 1
NZ Year 2

Graph 4.8

i) Year 1 Groups

On BAS 1 there were no differences in the quantity of error type 7 produced between Scottish and New Zealand subjects (see Graph 4.7). Four months later, however, on BAS 2, the Scots had increased production of the type 7 (beginning and end letters correct) error so much that there was a significant difference ($p<0.01$) between the Scots and the New Zealanders on this error type. There were no other differences in error types between the Scots and New Zealanders for this age group.

Within groups the Scots on BAS 1 produced more Type 7 errors than any other error type, except when compared with the Type 4 and Type 3 error. Four months later, on BAS 2, the Type 7 error was produced significantly more often than all the other error categories. The Type 4 error was next most prevalent, being significantly more common than all other error types apart from type 3 (See Graph 4.8).

The New Zealanders on BAS 1 produced Type 3 errors significantly more often than all the error types except for type 7, 4 or 6 errors. The Type 3 error frequency in BAS 2 increased so that it was significantly higher than all other error types except Type 7. Type 7 errors were significantly more frequent than all other errors except for type 4.

ii) Year 2 Groups

The Scots produced significantly more ($p<0.01$) of the Type 7 error than the New Zealanders (See Graph 4.7). The frequency of type 7 errors did not increase significantly for either Scots or New Zealanders from BAS 1 to BAS 2. The Scots also produced significantly more ($p<0.01$) of the Type 4 error than the New Zealanders for both BAS 1 and BAS 2 tests (see Graph 4.8). The frequency of type 4 errors did not increase significantly for either Scotland or New Zealand from BAS 1 to BAS 2. There was no difference in frequency for any of the other error types between the two national groups.

Within groups the Scots on BAS 1 produced significantly more ($p<0.01$) Type 7 errors than any other type. The Type 4 error was the next most prevalent being significantly more frequent than all other types apart from type 7 (which was significantly higher in quantity than type 4). Type 3 errors were next most frequent being significantly more prevalent than all the other error types apart from the significantly more frequent type 4 and 7. This pattern was identical for the Scottish BAS 2 error results.

The New Zealand sample at this age produced the Type 7 error significantly more ($p<0.01$) frequently in BAS 1 than any other error. The Type 3 error was next most frequent being significantly higher than all other error types apart from type 7 (which was significantly higher in frequency) and type 4 (being equivalent in frequency to the type 3). Type 4 was the third most frequent error, it being higher than all other errors apart from Type 3 and type 7. This pattern was repeated for the New Zealand sample in BAS 2.

The differences in error production are generally as we predicted and are in line with Stuart and Coltheart's (1988) findings. Those children who are receiving more instruction in the phonological aspects of reading (i.e. the Scots) are generally producing more errors that have beginning and end letters correct. This error type also shows a developmental pattern with older children making more of these types of errors than the younger ones. The New Zealanders did not show a high incidence of type 3, first letter only correct, errors, however, which was contrary to our hypotheses.

These error results were then correlated with performance on the BAS tests. The correlations are shown overleaf in Table 4.6.

The correlational analysis replicates the findings of Stuart and Coltheart (1988). The better readers are those readers who are producing error types 4 and 7 in both national groups. The year 2 groups results also confirm that this trend is developmental.

Table 4.6-Correlations of items correct on the BAS reading test with amount of error types produced.

Combined Year groups

Scottish Sample

	Error Types							
	1	2	3	4	5	6	7	8
BAS1	-0.30	-0.19	-0.05	0.51**	-0.16	-0.24	0.69**	-0.06
BAS2	-0.21	-0.35	-0.28	0.37**	-0.25	-0.19	0.49**	-0.08

New Zealand Sample

	Error Types							
	1	2	3	4	5	6	7	8
BAS1	-0.18	0.05	0.15	0.46**	-0.15	-0.12	0.52**	-0.04
BAS2	-0.21	0.14	-0.31	0.32	-0.01	0.06	0.54**	0.19

Year 1 combined Sample

	Error Types							
	1	2	3	4	5	6	7	8
BAS1	-0.26	-0.21	0.05	0.16	0.07	0.05	0.37**	-0.04
BAS2	-0.27	-0.13	-0.23	0.14	-0.02	-0.24	0.22	0.27

Year 2 combined Sample

	Error Types							
	1	2	3	4	5	6	7	8
BAS1	-0.23	0.11	-0.11	0.30	-0.06	-0.27	0.37**	-0.04
BAS2	-0.24	-0.14	-0.44	0.24	-0.18	-0.03	0.37**	0.26

* $p<0.05$ ** $p<0.01$

Discussion

We have seen from a simple error analysis that there are quite striking differences between the Scottish and New Zealand groups despite being matched on word recognition. The previous results of Barr (1975) have been generally confirmed by the analysis of error patterns. The phonics taught Scots produce more nonword and "not in set" errors than the New Zealanders while the New Zealanders produce more refusals.

It is interesting that the Scottish children's errors correlated with success at word reading. Does this mean that the Scottish children have the potential to become independent readers faster than the New Zealanders? This may explain why older children in New Zealand do worse on word recognition tests compared to Scottish children (Johnston and Thompson 1989). A reading strategy which involves non-responses to an unknown word would not appear to hold great potential for the future but an active method which involves trying to find an answer to a problem does. Even the smallest attempt to decode a word will improve the chances of recognition. Identifying only one letter in one position in a word will reduce the possible alternatives it could be by about a half (Walker 1987). Attacking a problem will also in the long run lead to a deeper understanding of what you are trying to acheive and how to go about it.

The Scots produced more errors that were graphophonically like the target word, in particular, they got the first and last letters correct more often than the New Zealanders. These errors were also correlated with success at word reading. This is not too surprising considering that the more letters in a word that are correct the closer you are to identifying it. The data does fit in with the idea of Perfetti (1992) that word recognition is a matter of representation precision. The errors the Scots are producing would appear to be higher up Perfetti's scale of precision than the New Zealanders' errors and so the majority Scottish errors should correlate with success in word reading. The fact that the Year 2 samples produce more of the beginning and end letters also supports the idea that the Scots' errors are developmentally ahead of the New Zealanders.

The Scots are producing nonword errors and error types which Stuart and Coltheart (1988) claim are associated with phonological knowledge. Therefore, according to theories like those of Frith (1985), the Scots are displaying signs of being in a phonological reading stage. The New Zealanders are displaying much less evidence of a phonological stage and it could be hypothesised that they seem more like the visual readers of Seymour and Elder (1986). The national groups are matched on word recognition and a host of other variables so how can the Scottish children appear developmentally ahead if the stage theories are correct? The results found in the error analyses have implications for those who advocate a universal, step by step, stage development. The idea that there is more than one route to skilled reading gains support from the present results. The idea that there are different types of readers (Baron and Strawson 1976) ranging from "Chinese" to "Phoenician" may stem, in part, from how they are taught to read.

The proposition that the Scottish children are displaying evidence of a phonological strategy in word reading while the New Zealanders may have a more visual approach is further investigated in the next chapter. Here we shall examine the extent to which the Scottish children do use a phonological approach when reading and if the New Zealanders can use a phonological approach when they are forced to do so. The New Zealanders may have the capacity to use a phonological approach but might choose not to use it as their major strategy.

Chapter 5-Phonology in reading: Lexical Decision, Homophone Decision, Sentence Decision and Nonword Naming Tasks

"Take care of the sense,
and the sounds will take care of themselves."

The size and extent of the role played by phonology in reading has proved to be a controversial issue for many years in devising models of skilled adult word recognition. One focus of this research has been the issue of whether subjects make more errors and respond more slowly to pseudohomophones (e.g. poast) than ordinary nonwords (e.g. loast) in lexical decision tasks, where the subject is asked to decide whether the item is a word or not, in order to provide an insight into the phonological influences in reading. Many studies in the 1970's found what has since been called the Pseudohomophone effect (Rubenstein, Lewis and Rubenstein 1971, Patterson and Marcel 1977, Coltheart, Davelaar, Jonasson and Besner 1977). There is no pseudohomophone effect with real words.

Coltheart (1978) interpreted these results as evidence supporting his dual route model of reading (See chapter 1 for a more detailed discussion of this model). The slower response to pseudohomophones was attributed to the pseudohomophones being converted into phonological codes which then, because the codes resemble real words, access the entry for the real word in the phonological lexicon. This necessitates a time consuming spelling check to avoid a false positive result. Ordinary nonwords however have no entries in the lexicon and so a post access spelling check is not required. This was taken as evidence for phonological recoding in reading and supports the concept of a phonological route to reading. Such effects are not shown with real words because they are assumed to be processed on the basis of their orthography not their phonology.

The pseudohomophone effect can then be used as a diagnostic test of whether the reader can use the phonological route or not. Patterson and Marcel (1977) examined two acquired dyslexics who failed to produce the pseudohomophone effect (and who could not pronounce nonwords) and so concluded that they had deficits in the skills involved in converting print to sound.

There have been a considerable number of criticisms of the Coltheart view of the pseudohomophone effect and his explanation of it. The main counter to Coltheart's view is the argument that the effect may be due to pseudohomophones being processed more slowly because they are orthographically similar to real words, whereas ordinary nonwords tend to be less similar and so there is no confusion. Coltheart et al (1977) recognised this pitfall and claimed that they did match the pseudohomophone and ordinary nonwords on orthographic similarity. This was achieved by changing one letter of the pseudohomophone to form the control nonwords, for example the pseudohomophone FRAZE was matched to the nonword FRUZE.

This attempt to control for orthographic similarity has been criticised by Martin (1982) and Taft (1982) in a number of ways. Martin (1982) showed that the pseudohomophones in Coltheart et al's study had significantly more orthographic neighbours (an orthographic neighbour being defined as the number of real words that can be made from a letter string by changing one letter) than did his nonwords. Coltheart et al's study had also shown that words with high numbers of orthographic neighbours were responded to more slowly than words with low orthographic neighbours. Martin (1982) attempted to replicate the Coltheart experiment but with pseudohomophones and nonwords which did not differ in the amount of orthographic neighbours they had. She found no pseudohomophone effect. Martin also criticised Patterson and Marcel (1977) who claimed that the acquired dyslexics they studied did not show a pseudohomophone effect and so were deficient in phonological skills. She pointed out that Patterson and Marcel may have used an unreliable method to measure reaction times to nonwords. In the study Patterson and Marcel measured the total time it took for the dyslexics to read through two lists of words and two lists of nonwords with a stopwatch. These times were then compared.

Taft (1982) also claimed that Coltheart et al (1977) may not have had a rigorous measure of orthographic similarity. He pointed out that in Coltheart et al's (1977) paper for example that FRAZE was still orthographically more similar to PHRASE than the nonword control of his, FRUZE. Taft claimed to have devised a method that was more rigorous than that of Coltheart et al's. Basing his ideas on the theories of Glushko (1979) (See chapter 1 for a fuller discussion) Taft took common orthographic structures such as OST, that could be pronounced in more than one way in real words, e.g. GHOST and FROST, and constructed a pseudohomophone and a nonword from the two alternate pronunciations, e.g. GHOAST and FROAST, by adding a letter to them. The words were then considered to be orthographically similar to real words to the same degree.

Taft argued that by using this stricter criterion the pseudohomophone effect in adult skilled readers was abolished, replaced instead by a reliance on grapheme to grapheme rules, not grapheme to phoneme rules. He did however hypothesise that young beginning readers may use grapheme to phoneme rules for beginning reading, but that this effect would reduce with age and reading experience.

McQuade (1981) controlled for visual similarity between pseudohomophones and control nonwords by matching them on the summed positional frequencies of the letters making up the nonwords. The best pseudohomophone effect was obtained when pseudohomophones constituted a small amount of the total nonwords (13%), but not when they made up the majority of nonwords. She hypothesised that subjects had some sort of conscious or unconscious control over the strategies to adopt when reading nonwords. In the high percentage of pseudohomophones condition she thought that subjects adopted a more visual strategy to avoid being fooled by the pseudohomophones, while in the low percentage of pseudohomophones condition a phonological strategy was adopted to avoid being fooled by the visually similar nonwords.

Treiman, Goswami and Bruck (1990) also concluded that all nonwords are not read in the same manner and so simple accounts of grapheme to phoneme conversion of nonwords may depend on other interrelated factors. Treiman et al found that nonwords with a large amount of orthographic neighbours were read more easily than nonwords with lower amounts of orthographic neighbours.

These critical views about the reality of the pseudohomophone effect, and the existence of Coltheart's grapheme to phoneme route have in themselves not been immune to criticism. Besner and Davelaar (1983) pointed out that although Martin (1982) had made some valid points about the pseudohomophone effect, it was not the end of the story. Besner and Davelaar re-analysed the Coltheart et al (1977) original material and found a subset of the pseudohomophones that were orthographically equal in neighbourhood size to that of the controls using Martin's criteria. If Martin was correct and orthographic neighbourhood size was responsible for the pseudohomophone effect then Besner and Davelaar should have found no difference between nonword and pseudohomophones. Eleven out of the twelve pseudohomophone subset were responded to more slowly than their equivalent nonwords. Besner and Davelaar also noted that Taft's (1982) 20 control nonwords contained 15 embedded real words in them. This embedding has been shown to reduce naming times to nonwords (Coltheart et al 1977).

McCann and Besner (1987) found, as did Treiman et al (1990), that orthographic neighbourhoods did have an effect on ordinary nonword naming and that the more neighbours the word had the faster the reaction time to it in a lexical decision task. However they noted that orthographic neighbourhood size did not seem to have an effect upon the reaction times of pseudohomophones. They assumed that this was because the pseudohomophones corresponded to real words and so involved contact with the whole word representation in a phonological lexicon. There is no neighbourhood effect similar to that found in ordinary nonwords because it is quite clear what word the pseudohomophone is associated with.

Many studies, for example Backman, Bruck, Hibert and Seidenberg (1984), Waters, Bruck and Seidenberg (1985), McCann and Besner (1987) and Coltheart and Leahy (1990), have also attacked the idea put forward by those who have criticise the pseudohomophone effect, that the reading of pseudohomophones is by analogy not by GPC rules. Backman et al (1984) found that in their sample of readers there was no general tendency to pronounce unfamiliar words or nonwords by analogy with a familiar word that had an irregular pronunciation. Their readers drew upon their knowledge of spelling sound correspondences and used regular pronunciations even when the irregular pronunciations were higher in frequency. Coltheart and Leahy (1992) found a slightly more complex picture than this. They found in adults that rime segments of words and analogies from them were used in nonword reading but not to any large extent. They noted in the Treiman et al (1990) study that rime analogy could only account for a 10% increase in nonword reading accuracy and that this was mainly for nonwords with high orthographic neighbours. They concluded that Treiman's 41% accuracy rate for low orthographic neighbourhood nonwords must have been mainly due to the use of some sort of GPC rules. Coltheart and Leahy found that young children use GPC rules more than older children, giving many more regular responses to irregular and ambiguous nonwords. Coltheart and Leahy hypothesised that from early in their reading development children are acquiring both an orthographic and a sublexical system of letter sound rules.

Opinion then is divided over the extent to which readers use a grapheme to phoneme conversion route and whether the pseudohomophone effect is evidence for such a route. What is apparent though is a consensus of opinion that use of a GPC route in skilled readers is much smaller compared to that of beginning readers. Much of the material children read is unfamiliar or novel so a spelling sound correspondence system would help with the identification of unknown words. This system would also serve as a self teaching mechanism for visual word recognition (Jorm and Share 1983, Adams 1990). It is then logical to surmise that this approach is more prevalent in children than in adults.

A number of studies have indeed suggested that there is this progression from reliance on phonological information in children to the establishment of a more skilled visual word recognition system like that of adults. Doctor and Coltheart (1980) investigated six to ten year old readers use of phonology by asking them to classify as meaningful a number of sentences, some of which contained homophonic words and pseudohomophones. They found that meaningless sentences that sounded correct, for example "He ran threw the street", were misclassified more than sentences which sounded meaningless, for example "He ran saw the street". This was also the case when the key words were pseudohomophones. The size of the effect diminished with age, as the older children achieved ceiling performance on the sentences which sounded meaningless. Johnston, Rugg and Scott (1988) carried out a similar study where pseudohomophone effects were found in eleven year old children but not in adults in a lexical decision task, in another experiment pseudohomophone effects were found in sentence decision tasks in eight and eleven year old good and poor readers. The children in both experiments had been taught by a phonics approach. Could the pseudohomophone effect in the Johnston et al studies be due to the teaching approach which emphasised the sounding out of unfamiliar words? Children not exposed to this sort of teaching may be no more dependent on phonological information than skilled readers.

Johnston and Thompson (1989) tested this idea by comparing eight year olds in Scotland taught by a phonics method with 8 year olds in New Zealand taught by the language experience approach to reading (See Appendix 2 for a full account of these two approaches). They found that the Scottish children were less accurate at rejecting pseudohomophones than the ordinary nonwords in a lexical decision task but that the New Zealanders did not show any difference in accuracy between pseudohomophones and nonwords. Johnston and Thompson hypothesised that the New Zealanders may not have shown a pseudohomophone effect due to an inability to use prelexical phonological information. The same children were then given a homophone decision task where they had to decide if the experimental items sounded like real words or not. The Scottish and New Zealand matched samples were equally good at classifying pseudohomophones as words; but the Scots were better at rejecting ordinary nonwords. They then had to pronounce those words that in their opinion sounded like real words. The Scottish children were better at pronouncing the nonwords than the New Zealanders.

Johnston and Thompson concluded that the Scottish children generated a phonological code for the nonwords prior to making any lexical decisions. This led to some advantages in tasks where use of phonological information was obligatory in the homophone decision and nonword naming tasks and to a disadvantage when deciding on the lexical status of pseudohomophones. The New Zealand children seemed to make decisions based on visual information alone when they were not obliged to use a phonological approach. However, they were capable of phonological strategy use in tasks where it was needed.

Coltheart and Laxon (1990) studied phonics taught and look say taught children and found on sentence decision tasks, including both homophonic and pseudohomophonic words, that children taught by a phonic method used phonological encoding earlier than children taught by the look say approach. The older children at both schools, though, were able to use both phonological encoding and a more visual strategy, showing again that all the children developed some sort of grapheme to phoneme conversion and orthographic systems no matter how they were taught.

The experiments presented here investigate, on a general level, the degree of influence the type of reading instruction can have on reading strategy. How will the children respond to tasks where it is not optimum to use the strategies they have been taught? Do the Scots or New Zealanders have the ability to bring other more appropriate strategies or knowledge to bear? The studies reported here also investigate the role of phonology in reading at a young age. Do the children have the capacity to use phonology in reading when it is appropriate to do so? Does instruction have any bearing on the answer to this?

It is predicted that the Scottish children will be worse at rejecting pseudohomophones in a lexical decision task and at rejecting homophones in a sentence decision task. The phonics teaching the Scottish children receive has a large emphasis on how words sound rather than on orthography. Therefore they are more likely than the New Zealand children to be fooled in a task where the use of a phonological strategy is a disadvantage. The New Zealand method of teaching places almost no emphasis on the sounds of words and so they should not show a pseudohomophone effect or be fooled by homophonous sentences.

The Scottish children should be better at deciding if a nonword sounds like a real word or not as a phonological approach to reading is an advantage in such a task. It is also hypothesised that the Scottish children should be better at pronouncing nonwords since use of a phonological strategy is obligatory in this task. If the New Zealand children cannot use a phonological strategy to read words then they should score very poorly on this task. There is evidence, however, that phonological skills can develop outwith a phonic teaching scheme (Seymour and Elder 1986) so it is likely that the New Zealanders will pronounce some nonwords correctly but not as often as the more practised Scottish children.

Lexical Decision Task

Subjects

The two year 1 groups from the matched sample carried out this task. There were 18 Scottish children in year 1 and 17 New Zealand children.

Materials

These consisted of a list of 10 pseudohomophones, 10 nonwords and 20 filler words (to equate the number of yes and no responses). The stimuli are listed in Appendix 3. The words were constructed by Johnston and Thompson (1989) using Taft's (1982) criteria. Two visually similar words with differing vowel pronunciations e.g. move and dove were selected and the vowel sound replaced in each by the same alternative spelling to create a matched pseudohomophone and nonword e.g. 'moove' and 'doove'. The pseudohomophones and nonwords were generated from lists of words with similar mean frequencies (Nonword mean frequency was 102, standard deviation of 239, Pseudohomophone mean frequency was 304, standard deviation of 89).

For each of these items a filler word was selected of similar length and word frequency (See Appendix 3).

All of the items were piloted by Johnston and Thompson with adults as to whether they sounded like words or not for both Scottish and New Zealand speakers.

The words and nonwords were clearly printed in lower case in the middle of white index cards. The set of cards was shuffled for each subject. Three practice items were generated in order to explain the task to the subjects.

Procedure

The experiment was conducted individually and in quiet conditions. Each child was told that the pack of cards consisted of "real" words and "made up words". They were asked to sort the cards into two boxes labelled "real" and "made up" (the position of the boxes was alternated from subject to subject). The experimenter worked through the practice items with the children, correcting classification errors. This included an explanation for each subject that a pseudohomophone sounded the same as a real word but was spelt incorrectly and was therefore a made up word. The experimental items were then presented, the child being asked to sort the cards with both speed and accuracy.

Results

Responses to pseudohomophones and nonwords were expressed as percentage correct and analysed with analysis of variance. A table of means and standard deviations is shown below. There was one between subjects factor Group (Scotland and New Zealand) and one within subjects factor stimulus type (pseudohomophones and nonwords).

Table 5.1 Lexical decision task

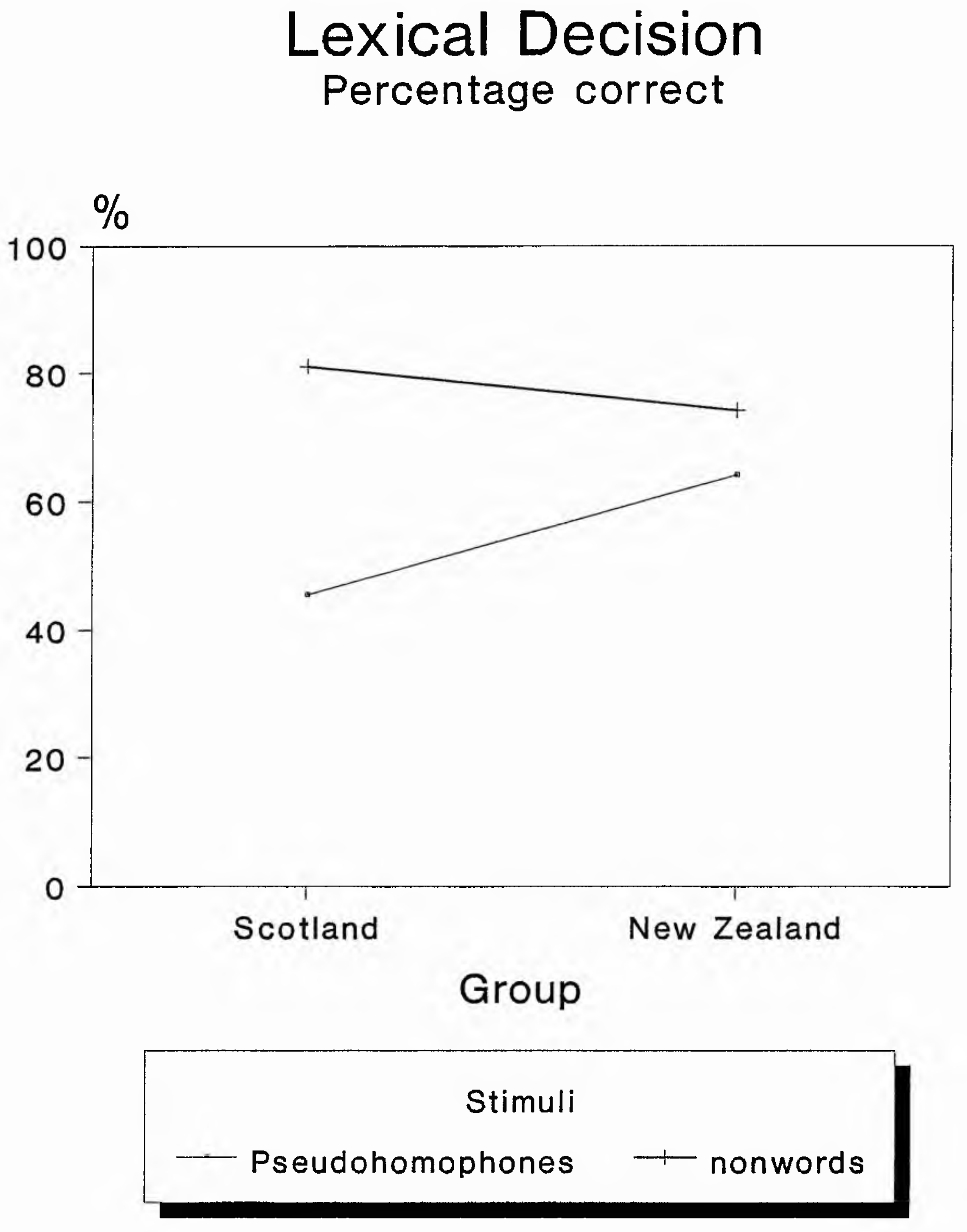
Mean percentage correct for type of word

(Standard Deviations in brackets)

	Scotland	New Zealand
Pseudohomophones	45.56	64.118
	(19.166)	(23.200)
Nonwords	81.111	74.118
	(21.113)	(21.811)
Words	55.556	45.294
	(16.881)	(23.814)

No significant main effect of Group was found, ($F<1$). A significant main effect of Stimulus Type was found, ($F(1,33)=35.97$, $p<0.01$), but the interaction of Group by Stimulus Type was also significant, ($F(1,33)=11.32$, $p<0.01$). A Newman Keuls post-hoc test showed that the Scottish sample identified significantly more ($p<0.01$) nonwords correctly than they identified pseudohomophones correctly. The New Zealand sample did not show a significant difference between the identification of nonwords and pseudohomophones. The Scottish sample identified significantly less ($p<0.01$) pseudohomophones correctly than the New Zealand sample but showed no significant difference in the amount of nonwords identified compared to the New Zealand sample.

The Scottish sample showed a pseudohomophone effect while the New Zealanders did not. This was as predicted.


Lexical Decision
Percentage correct
%
100
80
60
40
20
0
Scotland
New Zealand
Group
Stimuli
Pseudohomophones
nonwords

Graph 5.1

Homophone Decision Task

Subjects

As for the Lexical Decision task.

Materials

The pseudohomophones and nonwords that were used in the lexical decision task were used in this task (See appendix 3) but without the filler words. They were randomised by shuffling prior to the testing of each child.

Procedure

This task was administered one week after the lexical decision task. The experiment was conducted individually and in quiet conditions. Each child was told that some of the nonwords sounded the same as real words but that others did not. The children were told to sort the items into 2 boxes labelled "Sounds the same as a real word" and "does not sound the same as a real word". Assistance and correction of classification errors were given with 3 practice items. There was no time limit on the task.

Results

Responses were scored according to the extent to which each of the pseudohomophones and nonwords were classified as homophones. See Table 5.2 overleaf for means and standard deviations. An analysis of variance was carried out with the between subjects factor of Group (Scotland and New Zealand) and the within subjects variable of Stimulus Type, (Pseudohomophones and nonwords).

There was no significant main effect of GROUP ($F<1$) but there was a main effect of Stimulus Type ($F(1,33)=15.5$, $p<0.01$) in that more pseudohomophones were classified as sounding like real words than the ordinary nonwords. The interaction of Group by Stimulus Type was not significant, ($F(1,33)=2.26$, $p>0.05$) however. The New Zealanders can use phonological information when necessary, as they are scoring at an equivalent level to the Scottish children.

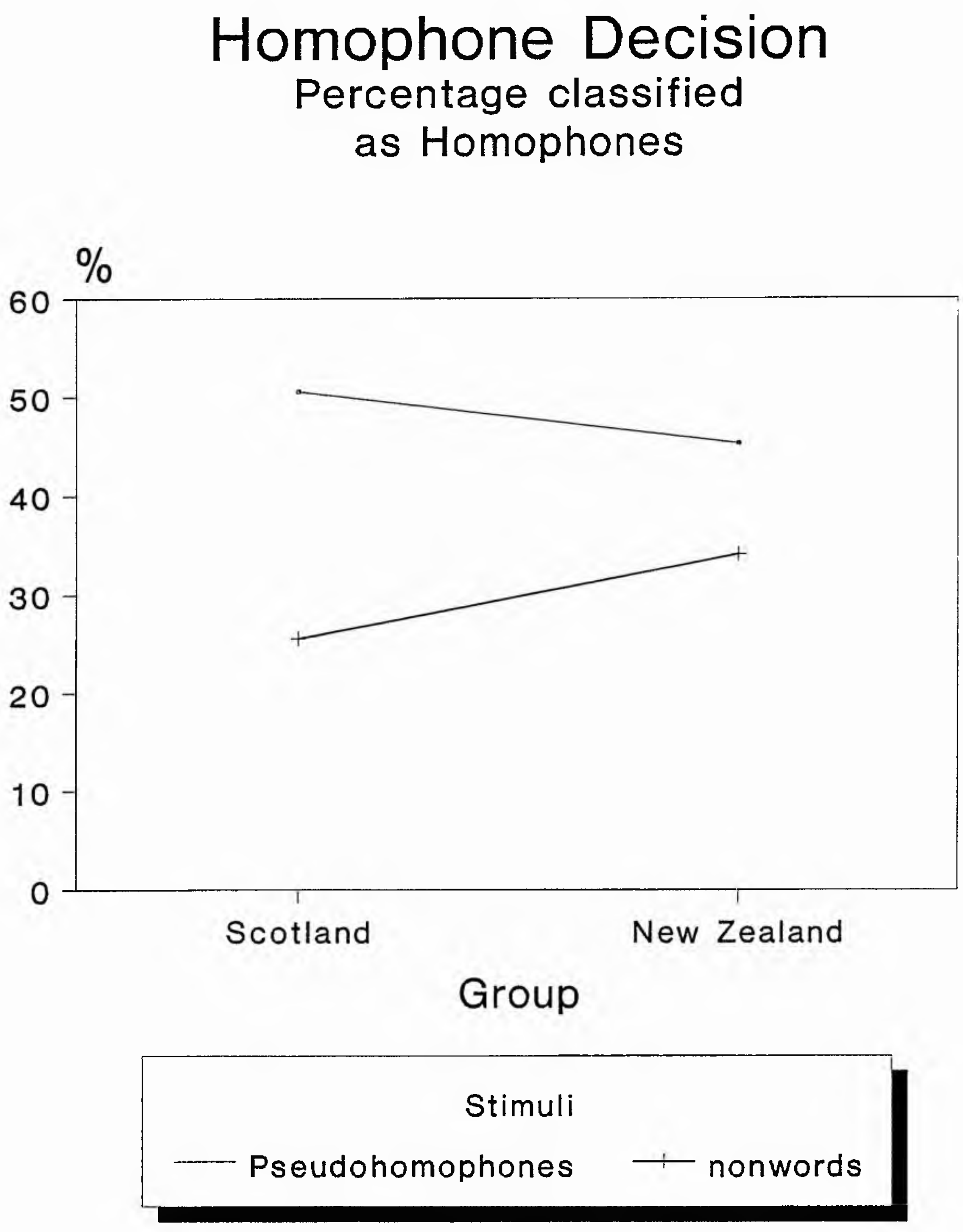
Table 5.2

Homophone decision task

Mean percentage of items classified as Homophones

(standard deviations in brackets)

	Scotland	New Zealand
Pseudohomophones	50.556	45.294
	(29.400)	(24.778)
Nonwords	25.556	34.118
	(12.472)	(31.036)


Homophone Decision
Percentage classified
as Homophones
%
60
50
40
30
20
10
0
Scotland
New Zealand
Group
Stimuli
Pseudohomophones
nonwords

Graph 5.2

Sentence decision task

Subjects

The two year 1 groups from the matched sample carried out this task. There were 18 Scottish children in year 1 and 17 New Zealand children.

Materials

Forty sentences were presented to the children that had been used previously by Johnston et al 1988. Twenty of these items were derived from ten words selected on the basis that they had at least one other homophone in the English language, for example "road". Then, using Weber's (1970) graphemic similarity index, the visual similarity of the homophone "rode" to the original word was calculated. This new item was used in a sentence that sounded meaningful, for example, "she ran down the rode." For the meaningless sentence , a word was chosen which yielded similar levels of graphemic similarity to the original item, but which did not sound meaningful in the sentence, for example "she ran down the rose". The mean graphemic similarity score for the homophonic items was 521 (standard deviation 130), and 560 (standard deviation 124) for the non-homophonic items.

The other twenty items out of the forty were filler items which required "yes" responses to counterbalance the first twenty items, all of which required "no" responses.

As each homophonous sentence had a matching sentence which was identical except for the critical word, the materials were divided into two blocks in order to keep these items separate (see appendix 4). Half the subjects received set A first and half received set B first, the second block being presented one week after the first. Each sentence was printed in lower case letters onto a white index card, and each set was shuffled prior to testing each child.

Procedure

Two cardboard "postboxes" were put in front of the child; these differed in that one was marked with a tick, the other with a cross. The child was told that they were going to play a posting game. A number of practice items were used to demonstrate the task. First a correct sentence was shown to the child, read out, discussed, and then placed into the box marked with a tick by the experimenter. Then a sentence that sounded meaningless was dealt with in the same way, and placed in the box marked with a cross. Finally, a sentence containing a homophone was examined; the experimenter pointed out that the sentence sounded correct, but that one of the words was spelt incorrectly, and it should therefore go into the box with the cross on it.

The child was then given the entire pack of randomised experimental cards, and asked to sort them out and post them in the appropriate boxes. The experimenter noted down the responses. The experiment was carried out individually and in quiet conditions. There was no time limit on the children to complete the task.

Results

Percentage correct scores for sentences which sounded meaningful or meaningless were calculated for each subject. Means and standard deviations are shown in Table 5.3. An analysis of variance was used to analyse the results with Groups (Scotland and New Zealand) as the between subjects factor and sentence type (meaningful and meaningless) as the within subjects factor.

There was a significant main effect of Group, ($F(1,33)=4.11$, $p=0.05$) which was due to the New Zealanders being better across both stimulus types at classifying the sentences correctly. There was also a significant main effect of Stimulus Type, ($F(1,33)=31.33$, $p<0.01$) in that "sounds meaningless" sentences were more accurately

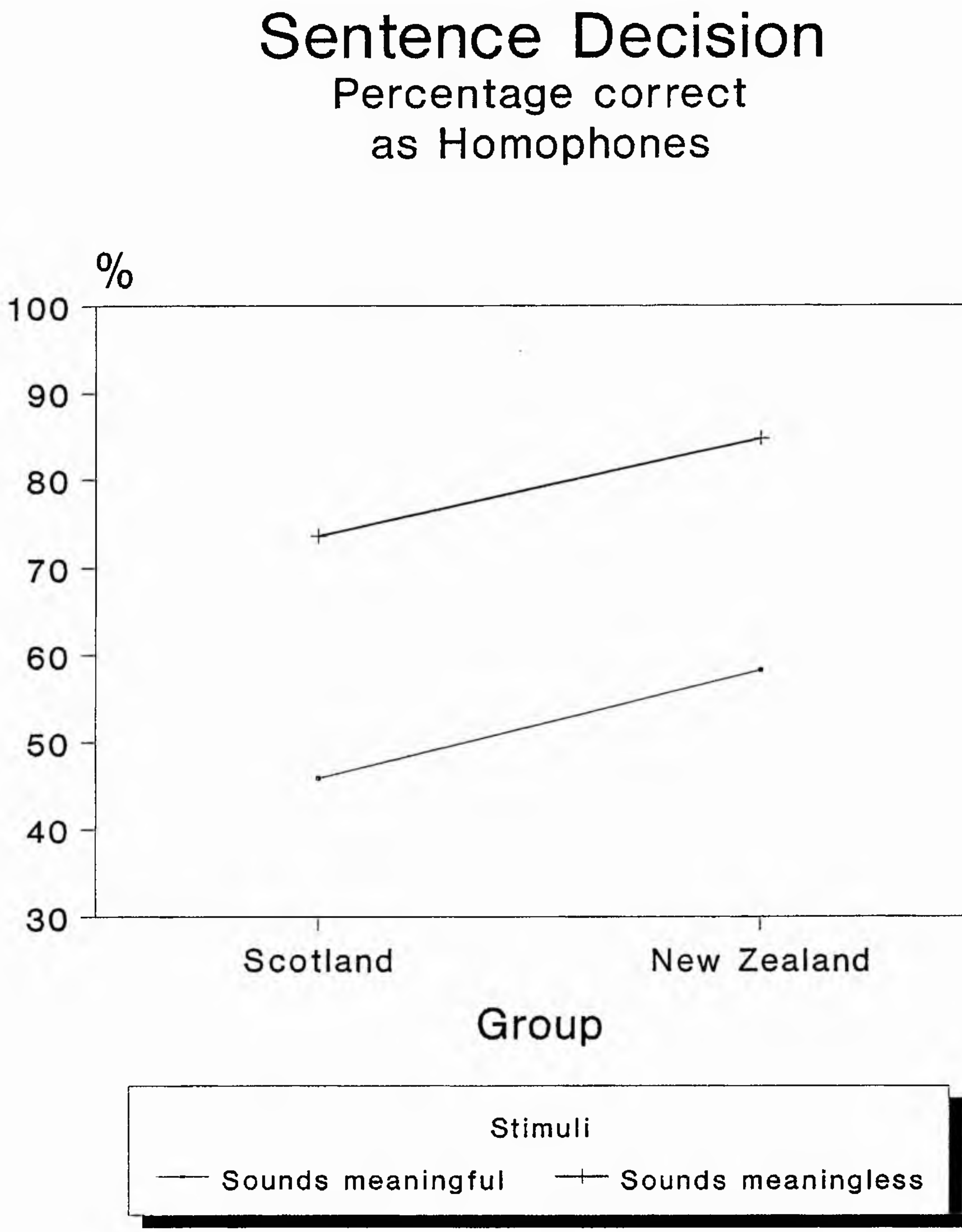
Table 5.3

Sentence Decision Task

Mean Percentage correct for each category

(standard deviation in brackets)

	Sentences	
	Sounds meaningful	Sounds meaningless
Scotland	45.833	73.611
	(31.213)	(21.815)
New Zealand	58.235	84.706
	(18.787)	(12.805)


Sentence Decision
Percentage correct
as Homophones
%
100
90
80
70
60
50
40
30
Scotland
New Zealand
Group
Stimuli
Sounds meaningful
Sounds meaningless

Graph 5.3

categorised than "sounds meaningful" sentences across both groups. The interaction of Group by Sentence Type was not significant, ($F<1$). This shows that although the New Zealand children were more accurate at judging sentences, the two groups showed a homophone effect of equal magnitude.

Non word naming

Subjects

The four groups matched on the BAS test were used in this task. The Scottish Year 1 group had 14 subjects rather than 18 in this task while the New Zealand Year 1 group had their full complement of 17. The Scottish year 2 group had 23 subjects while the New Zealand Year 2 group had 21 subjects rather than 24 due to absence at the time of testing. The missing subjects did not affect the original reading match.

Materials

These consisted of a list of 10 pseudohomophones and 10 nonwords. The stimuli are listed in Appendix 3. The words were constructed by Johnston and Thompson (1989) using Taft's 1982 criteria. Two visually similar words with differing vowel pronunciations e.g. move and dove were taken and the vowel sound replaced in each by the same alternative spelling to create a matched pseudohomophone and nonword e.g. 'moove' and 'doove'. The pseudohomophones and nonwords were generated from lists of words with similar mean frequencies (nonword mean frequency of 244, standard deviation of 239, pseudohomophone mean frequency of 304, standard deviation of 746).

All of the items were piloted by Johnston and Thompson with adults as to whether they sounded like words or not for Scottish and New Zealand speakers.

The nonwords were clearly printed in lower case in the middle of white index cards. The set of cards was shuffled for each subject. Three practice items were generated in order to explain the task to the subjects.

Procedure

The experiment was carried out in isolation and in quiet conditions. It was explained that the experimenter was going to hold up cards with words on them and that the child should try to read them out loud. It was explained that the first set of stimuli were totally made-up words and the trial ensued. At the end of the trial further instructions were given to inform the child that the second trial contained stimuli which although still fabricated may sound like real words when read aloud (the pseudohomophones). Nonwords were always presented before pseudohomophones so that the child would not be predisposed to respond with a homophone in the nonword condition.

Results

Responses to pseudohomophones and non words were expressed as percentage correct and the means for each class are given in Table 5.4 below:

Table 5.4-Naming of pseudohomophones and nonwords
Percentage of Correct Responses
(standard deviations in brackets)

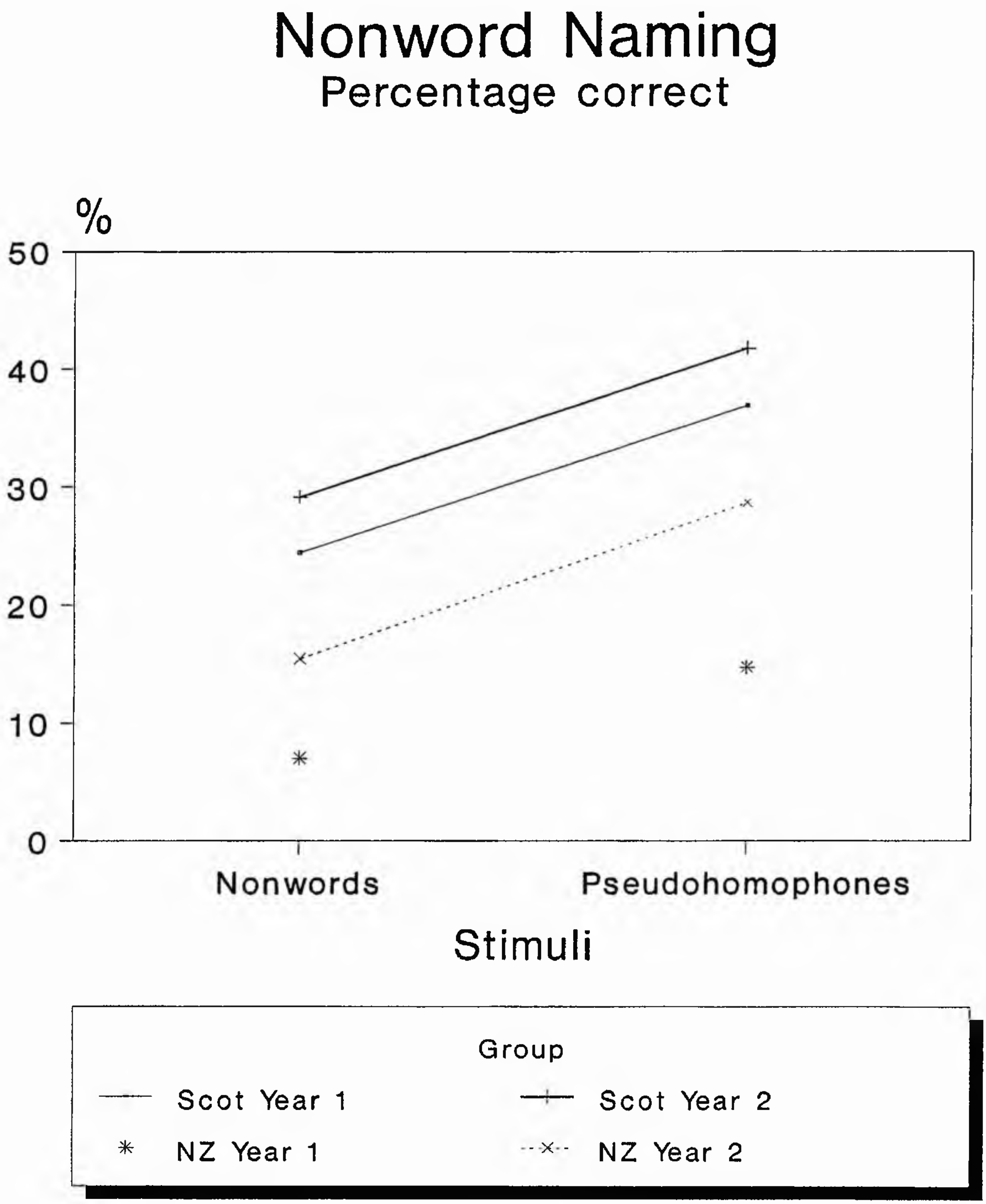
Year 1

	Nonwords	Pseudohomophones
Scotland	24.375	36.875
	(16.317)	(23.866)
New Zealand	7.059	14.706
	(12.127)	(15.459)

Year 2

	Nonwords	Pseudohomophones
Scotland	29.130	41.739
	(18.319)	(22.493)
New Zealand	15.455	28.636
	(15.346)	(23.130)

The results were subjected to analysis of variance with two between subjects variables, Group (Scotland and New Zealand) and age (year 1 or year 2) and one within subjects variable, Stimulus Type (Pseudohomophones and nonwords).


Nonword Naming
Percentage correct
%
50
40
30
20
10
0
Nonwords
Pseudohomophones
Stimuli
Group
Scot Year 1
Scot Year 2
NZ Year 1
NZ Year 2

Graph 5.4

There was a significant main effect of Group, ($F(1,74)=18.86$, $p<0.01$) and of age ($F(1,74)=4.38$, $p<0.05$). The Scottish sample were more accurate at naming all the stimuli than the New Zealanders, and the year 2 children were better at naming the stimuli than the year 1 children. A significant difference in Stimulus Type was also found, ($F(1,74)=33.57$, $p<0.01$) with pseudohomophones being more accurately pronounced than ordinary nonwords. None of the interactions in the analysis were significant.

The results of the task were correlated with the BAS test scores and are shown in Table 5.5.

We can see that those who are good at word reading on the BAS are also good at reading both kinds of nonwords and that those who are good at reading both nonwords and BAS words are also likely to be the older children in each group.

Table 5.5-Correlation of nonword and pseudohomophone naming performance with scores on BAS Test by Group

Year 1

	Scotland	New Zealand
	BAS	BAS
Nonwords	0.63*	0.56*
Pseudohomophones	0.78**	0.63**

Year 2

	Scotland	New Zealand
	BAS	BAS
Nonwords	0.55*	0.56*
Pseudohomophones	0.73**	0.55*

Combined groups

	Scotland	New Zealand
	BAS	BAS
Nonwords	0.54**	0.61**
Pseudohomophones	0.66**	0.64**

By age

	Year 1	Year 2
	BAS	BAS
Nonwords	0.43*	0.51**
Pseudohomophones	0.52**	0.62**

* $p<0.05$ ** $p<0.01$

Error Analysis

The same error analysis that was used for the BAS reading tests was again used to study the errors made by the children during the nonword reading tasks. This was to see if there were qualitative differences in the errors made by the New Zealand children and Scottish children. The analysis was also designed to assess whether children make different kinds of errors to the two classes of nonword (There was a difference in accuracy between naming pseudohomophones and nonwords, is this difference reflected in the errors the children made when reading each category of nonword?).

Table 5.6 below gives the average percentage of error types produced when the errors are classified into real word, nonword and refusal categories.

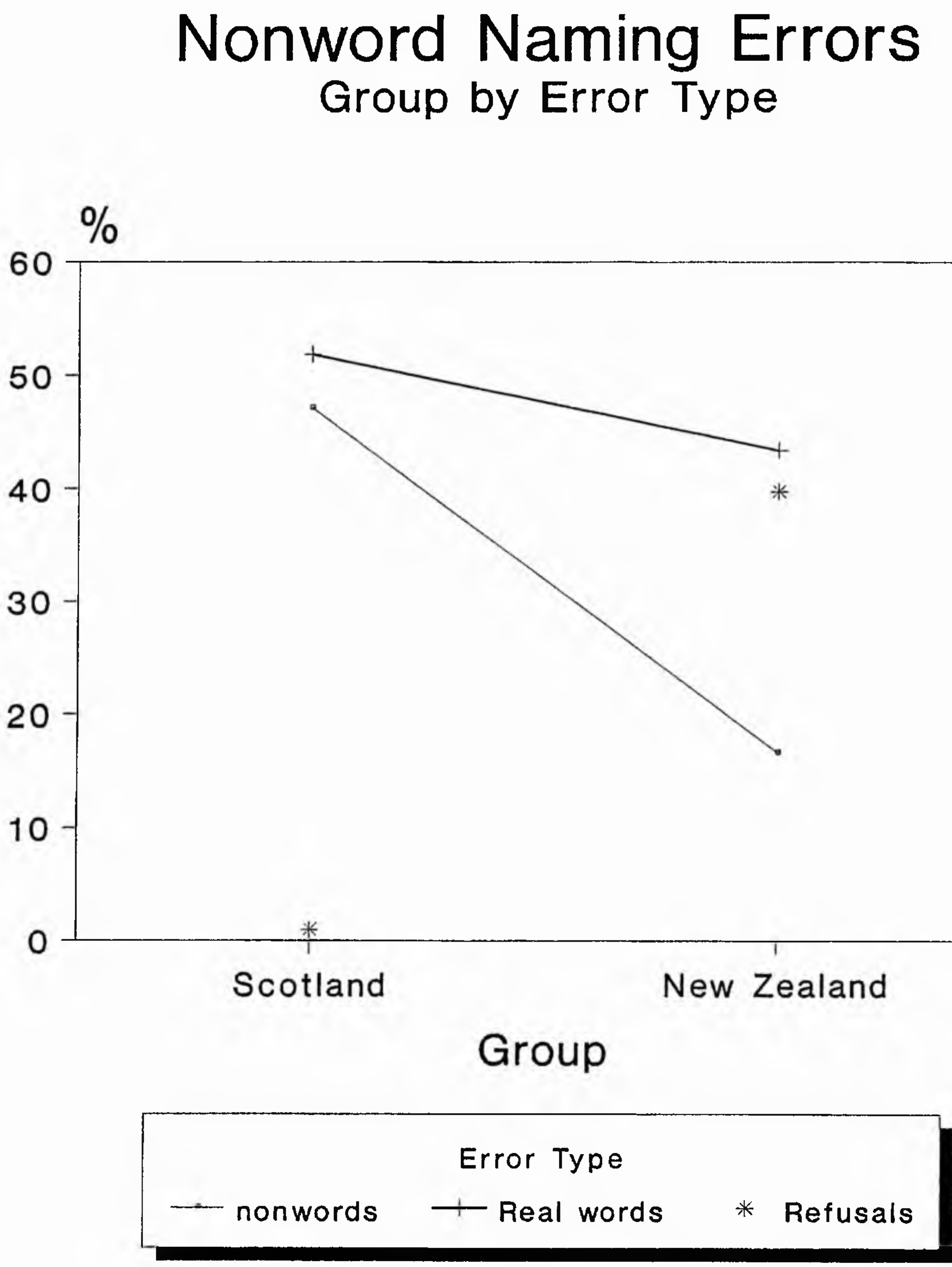
Table 5.6-Error Types as percentage of total errors (Standard deviations in brackets)

Scottish children

	Year 1		Year 2	
	nonword naming	pseudo naming	nonword naming	pseudo naming
Errors:				
Refusals	2.1	1.6	0.0	0.0
	(8.0)	(5.9)	(0.0)	(0.0)
Real words	48.5	58.9	45.3	54.5
	(23.8)	(22.0)	(18.6)	(20.6)
Nonwords	49.1	39.5	54.6	45.5
	(23.6)	(23.4)	(18.7)	(21.7)

New Zealand children

	Year 1		Year 2	
	nonword naming	pseudo naming	nonword naming	pseudo naming
Errors:				
Refusals	48.4	48.7	28.0	33.9
	(43.6)	(44.1)	(34.1)	(39.2)
Real words	33.5	38.0	51.9	50.2
	(34.7)	(36.9)	(30.8)	(32.9)
Nonwords	17.9	13.3	19.5	16.1
	(19.6)	(17.5)	(24.3)	(19.0)


Nonword Naming Errors
Group by Error Type
%
60
50
40
30
20
10
0
Scotland
New Zealand
Group
Error Type
nonwords
Real words
Refusals

Graph 5.5

An analysis of variance was performed on these data with two between subjects factors, Group (Scottish or New Zealand) and Age (year 1 and year 2). There were two within subjects factors, nonword type (nonword and pseudohomophone) and Error Type (Refusal, Real word and Nonword). A significant main effect of Error Type was found ($F(2,142)=15.8$, $p<0.01$) but there was no main effect of Group ($F<1$) or of Age ($F<1$). There was a significant interaction of Group by Error type ($F(2,142)=26.48$, $p<0.01$) and of nonword type by Error Type ($F(2,142)=4.22$, $p<0.05$) but no other significant interactions. A Newman Keuls test on the interaction of Group by Error type (see Graph 5.5) revealed, as in the BAS tests, that the Scottish children produce significantly more ($p<0.01$) nonword errors than the New Zealanders, who in turn produce far more refusal type errors than the Scottish children across both the nonword naming and pseudohomophone naming conditions ($p<0.01$). A Newman Keuls analysis of the interaction of Nonword type by Error Type revealed that there were significantly more nonword errors for nonword naming than for pseudohomophone naming. This would be expected due to the simple fact that the children were told at the start of the experiment that the nonwords were going to sound like nothing they had heard before whereas they were told that they would recognise the pseudohomophones when read out loud. There are also many real word responses to pseudohomophones that are correct.

The results from this error analysis were correlated with the number of items correct in the task. See Table 5.7 below.

Table 5.7-Correlations between percentage of error types and performance on the naming tasks

Nonword Naming

	Error Types		
	Real Words	Nonwords	Refusals
Scotland	0.03	0.03	-0.26
New Zealand	0.05	0.43**	-0.29

Pseudohomophone Naming

	Error Types		
	Real Words	Nonwords	Refusals
Scotland	-0.18	0.21	-0.22
New Zealand	0.51**	0.16	-0.50**

* $p<0.05$ ** $p<0.01$

There were no significant correlations for the Scottish children in either task, which is quite different to the results for the BAS word reading test where nonword error production was correlated with good performance on the BAS. The New Zealanders errors do correlate with success at each particular task. Nonword errors correlate with nonword reading while real word errors correlate with pseudohomophone naming. This again would make sense when it is related to the instructions that the children received for the task, however, it does not explain why the Scottish children's errors did not correlate with performance. Could it be that, since all the Scottish children are making only real word and nonword errors (only 1% refusal errors), they are effectively swamping any correlation that may have been related to performance? The New Zealanders on the other hand are making a fair proportion of refusal errors, which in pseudohomophone reading is negatively correlated with performance, so it can be assumed that their poorer performers on this task refuse to read many of the stimuli. Those who are better at reading the stimuli are thus those who produce nonword errors in the nonword naming task and real word errors in the pseudohomophone task. In this sense the correlations of particular error responses with success at the task in hand can be explained in a way similar to that of the BAS tests.

In a further replication of the error analysis employed for the BAS tests, Table 5.8 overleaf gives the mean amount of error types produced when the errors are classified in terms of whether the error is a word from the child's reading set or not (See page 93 for a more detailed description of these categories).

Table 5.8

Error Types as percentage of total errors

(Standard deviations in brackets)

Year 1 Comparison

Nonword naming

	Refusals	In Set	Out of Set
Scotland	2.14	12.73	78.26
	(8.02)	(10.09)	(25.36)
New Zealand	48.45	12.42	39.03
	(43.64)	(18.54)	(37.80)

Year 1 Comparison

Pseudohomophone Naming

	Refusals	In Set	Out of Set
Scotland	2.14	25.19	73.19
	(8.02)	(19.71)	(19.39)
New Zealand	48.45	23.81	27.49
	(43.64)	(20.48)	(27.83)

Year 2 Comparison

Nonword naming

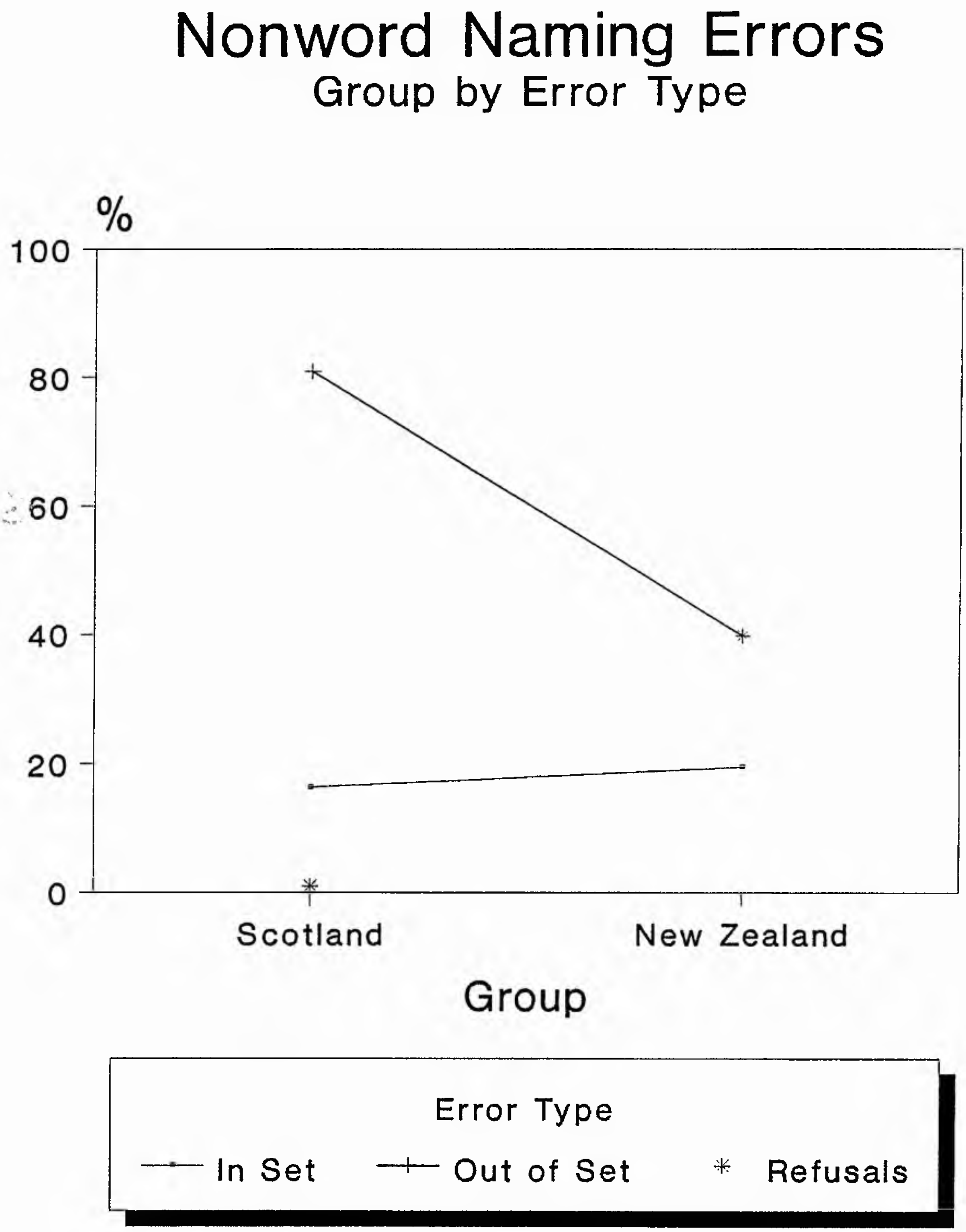
	Refusals	In Set	Out of Set
Scotland	2.14	10.67	89.30
	(8.02)	(11.29)	(11.30)
New Zealand	48.45	15.82	52.91
	(43.64)	(16.66)	(33.87)

Year 2 Comparison

Pseudohomophone Naming

	Refusals	In Set	Out of Set
Scotland	2.14	25.19	73.19
	(8.02)	(19.71)	(19.39)
New Zealand	48.45	23.81	27.49
	(43.64)	(20.48)	(27.82)

An analysis of variance was performed on these data with two between subjects factors, Group (Scottish or New Zealand) and Age (year 1 and year 2). There were two within subjects factors, Nonword type (nonword and pseudohomophone) and Error Type (Refusal, In set error and out of set error). There was a significant main effect of Error Type ($F(2,142)=54.28$, $p<0.01$) but no main effect of Group ($F<1$) or of Age ($F<1$) or of Nonword Type ($F(1,71)=1.89$, $p>0.05$). The interaction of Group by Error type was significant ($F(2,142)=38.29$, $p<0.01$) as was the interaction of Nonword Type by Error Type ($F(2,142)=10.6$, $p<0.01$). No other interactions were significant. A Newman Keuls analysis of the interaction of Group by Error Type (see Graph 5.6) showed again that, as in the BAS tests, the Scottish children produced significantly more ($p<0.01$) errors that are not in their reading set than the New Zealanders who produce significantly more ($p<0.01$) refusals across both the nonword naming and pseudohomophone naming tasks. The Scottish and New Zealand children did not differ in the



Nonword Naming Errors
Group by Error Type
%
100
80
60
40
20
0
Scotland
New Zealand
Group
Error Type
In Set
Out of Set
Refusals

Graph 5.6

amount of "in set" errors that they produced across both nonword conditions.

Newman Keuls analysis of the interaction of nonword type by error type revealed that significantly more "in set" errors were made in the Pseudohomophone naming condition than in the nonword naming condition, and that significantly more ($p<0.01$) "out of set" errors were produced in the nonword naming condition than in the pseudohomophone condition. This is understandable as more nonword errors were produced for the nonword naming task and these would be considered "out of Set" errors.

A correlational analysis of the amount of errors produced, with performance on the two naming tasks, is reproduced in Table 5.9. This is a very similar pattern of correlations to those of the nonword and real word errors illustrated earlier. The Scottish children again are producing errors that do not correlate with performance on either of the tasks while the New Zealanders are. This is probably due to the reasons outlined before on page 147. The successful New Zealanders at the pseudohomophone task produce more errors that are in their reading set, i.e.

Table 5.9-Correlations between errors and performance

Nonword Naming

	Error Types		
	Refusals	In Set	Out of Set
Scotland	-0.26	-0.12	0.03
New Zealand	-0.29	-0.13	0.45**

Pseudohomophone Naming

	Error Types		
	Refusals	In Set	Out of Set
Scotland	-0.21	-0.11	0.15
New Zealand	-0.50**	0.56**	0.24

* $p<0.05$ ** $p<0.01$

that are real words, while the New Zealanders successful at nonword reading produce more errors out of their reading set, i.e. errors which can include nonwords. Therefore the underlying pattern of these results is still like that of the BAS tests.

The errors were then further analysed by looking at the difference between the target and the error and so putting the errors into one of the eight categories that were introduced in the BAS test section (See page 99 for more detail on these categories).

Table 5.10 gives the mean percentage of errors that fell into each of the eight categories for the nonword naming and pseudohomophone tasks.

An analysis of variance was performed on these data with two between subjects factors, Group (Scottish or New Zealand) and Age (year 1 and year 2). There were two within subjects factors, Nonword type (nonword and pseudohomophone) and Error Type (Type 1 to Type 8). There was a main effect of group ($F(1,71)=30.57$, $p<0.01$) and of Error Type ($F(7,497)=88.85$, $p,0.01$) but not of Age ($F(1,71)=2.3$,

Table 5.10-Error types as percentage of total errors

(Standard deviations in brackets)

Year 1 comparison

Nonword Naming

Error Type->	1	2	3	4	5	6	7	8
Scotland	3.65	7.45	15.37	27.59	0.79	8.12	36.87	0.00
	(10.8)	(9.0)	(13.7)	(18.1)	(2.9)	(10.7)	(22.6)	(0.0)
New Zealand	2.35	3.78	11.89	14.25	0.00	1.17	19.04	0.00
	(6.6)	(8.6)	(17.5)	(20.1)	(0.0)	(3.3)	(23.9)	(0.0)

Year 1 comparison

Pseudohomophone Naming

Error Type->	1	2	3	4	5	6	7	8
Scotland	0.71	9.69	5.21	30.52	4.23	6.05	41.07	0.00
	(2.6)	(13.9)	(7.9)	(20.9)	(8.6)	(7.5)	(21.4)	(0.0)
New Zealand	0.73	4.33	1.31	19.71	0.73	0.00	17.57	0.00
	(3.0)	(10.7)	(11.0)	(23.3)	(3.0)	(0.0)	(15.9)	(0.0)

Year 2 comparison

Nonword Naming

Error Type->	1	2	3	4	5	6	7	8
Scotland	1.08	8.95	9.54	30.36	0.00	10.54	38.38	0.54
	(5.2)	(11.9)	(13.1)	(17.6)	(0.0)	(14.0)	(21.2)	(2.6)
New Zealand	0.53	2.12	8.86	24.99	0.00	0.53	29.53	5.81
	(2.4)	(4.5)	(12.3)	(20.1)	(0.0)	(2.4)	(19.3)	(20.3)

Year 2 comparison

Pseudohomophone Naming

Error Type->	1	2	3	4	5	6	7	8
Scotland	2.21	3.78	8.83	26.30	1.26	7.69	49.44	0.43
	(5.1)	(7.7)	(9.5)	(19.1)	(4.2)	(13.6)	(25.8)	(2.1)
New Zealand	0.00	0.79	15.40	17.38	0.68	5.44	30.15	0.68
	(0.0)	(3.6)	(22.9)	(13.7)	(3.1)	(21.8)	(21.3)	(3.1)

$p>0.05$) or of Word Type ($F<1$). There was a significant interaction of Group by Error Type ($F(7,497)=6.38$, $p<0.01$) and of Age by Word Type by Error Type ($F(7,497)=2.6$, $p<0.05$). A Newman Keuls analysis on the Group by Error Type interaction revealed similar results to those of the BAS tests. The Scottish children, across both nonword naming and pseudohomophone naming, produced significantly more type 4 ($p<0.01$), type 6 and type 7 ($p<0.01$) errors than the New Zealand children, whereas the groups were equivalent on the other error types. Newman Keuls analysis of the Age by Word Type by Error Type interaction revealed that Year 1 children produced significantly more ($p<0.01$) Type 3 errors when reading nonwords than they did when reading pseudohomophones, but that the Year 2 children did not show a difference in Type 3 errors between nonwords and pseudohomophones. The year 2 children did however produce significantly more Type 4 errors when reading nonwords than they did when reading pseudohomophones while the Year 1 children did not show a difference in the Type 4 errors between nonwords and pseudohomophones. The Year 2 children made significantly more Type 7 errors when reading pseudohomophones than when reading nonwords, whereas there was no difference for the Year 1 children in amount of Type 7 errors produced between nonwords and pseudohomophones.

Table 5.11-Correlations of amount of error types with performance on the naming tasks

Nonword Naming

Error Type->	1	2	3	4	5	6	7	8
Scotland	-0.29	-0.06	-0.34*	0.19	-0.16	-0.01	0.22	-0.07
New Zealand	-0.18	-0.16	-0.39*	0.45**	.	-0.16	0.57**	-0.02

Pseudohomophone Naming

Error Type->	1	2	3	4	5	6	7	8
Scotland	-0.22	-0.41**	-0.10	-0.07	-0.35	-0.02	0.47**	-0.28
New Zealand	-0.13	-0.04	0.24	0.01	-0.02	0.26	0.34*	-0.02

* p,0.05 ** p<0.01

The results from this error analysis were again correlated with the number of items correct in the task. The results from this are reproduced in Table 5.11. Yet again, the pattern of correlations follow a similar pattern to that of the BAS tests for the New Zealand children, while the Scottish sample show very little correlation between error production and performance on the naming tests.

The types and quantities of errors produced by the children when reading pseudohomophones or nonwords do not seem to differ enormously. The only real difference in errors produced to pseudohomophones or nonwords can be explained by the children using their knowledge of the test to give the expected answers, for example, ensuring that answers to the pseudohomophone naming task sound like real words. The main differences would again seem to be cross national, not between stimuli types, with major group differences being found with refusal errors and nonword errors.

It was decided to examine whether the amount of error types produced had varied between the BAS test and the naming tasks. Overall nonword naming errors were compared with the BAS test errors.

An analysis of variance was run on the data sets concerning the production of real, nonword and refusal errors. There were two between subjects factors, Group (Scotland and New Zealand) and Age (year 1 and year 2) and two within subjects factors, test type (BAS and Nonword naming tests) and error type (Real words, nonwords and refusals). There was no main effect of Group ($F<1$), age ($F<1$) or of Test ($F<1$) but there was a main effect of error type ($F(2,142)=110.7$, $p<0.01$). The interactions of Age by Error Type ($F(2,142)=4.75$, $p<0.01$), Group by Error Type ($F(2,142)=34.73$, $P<0.01$) and Test by Error Type ($F(2,142)=5.22, p<0.01$) were all significant. No other interactions reached significance. Newman Keuls analyses of the interactions revealed that in the Group by Error Type interaction that the Scottish samples produced significantly more ($p<0.01$) nonword responses than the New Zealanders for both the BAS test and the naming tasks, and that the New Zealand children produced significantly more ($p<0.01$) refusals than the Scottish children for both the BAS and the naming tasks. Results from a Newman Keuls analysis of the Age by Error type interaction showed that significantly more refusals were produced by the year 1 children than the year 2 children in both tasks. Finally, the Newman Keuls analysis of the interaction of Test type by Error type revealed that significantly less refusals, but more real word responses (due to the pseudohomophones in the task), were made in the naming tasks than in the BAS test.

The results from the comparison of "in set", "out of set" and refusals between the BAS and the naming tasks was very similar. An analysis of variance was run on the data sets with two between subjects factors, Group (Scotland and New Zealand) and Age (year 1 and year 2) and two within subjects factors, test type (BAS and naming tests) and Error Type (in set, out of set and refusals). There were no significant main effects of Age ($F(1,71)=1.07$, $p>0.05$), Test ($F(1,71)=11.02$, $p>0.05$) or Group ($F(1,71)=11.04$, $P>0.05$). There was a significant effect of Error Type, ($F(2,142)=62.88$, $p<0.01$) and significant interactions of Age by Error type ($F(2,142)=8.35$, $p<0.01$), of Group by Error Type ($F(2,142)=46.77$, $p<0.01$) and of Test by Error Type ($F(2,142)=4.95$, $p<0.01$). No other interactions reached significance. Newman Keuls testing revealed that in the group by error types interaction that the Scottish children produced significantly more ($p<0.01$) "out of set" errors across both tasks than the New Zealanders, while the New Zealanders had significantly more ($p<0.01$) refusals across both tasks. It was also revealed using Newman Keuls tests on the interaction of Age by error type that the year 2 sample produced significantly more ($p<0.01$) "out of set" errors than the year 1 samples while also producing significantly fewer refusals. Newman Keuls test on the interaction of Test by Error Type showed that there were more refusals in the BAS test than the nonword naming tasks. The amount of "in set" and "out of set" errors was slightly higher for the naming tasks but did not reach significance.

Examination of the data sets, of the error types 1 to 8, from both the BAS and the naming tasks, revealed a similar pattern of results to the comparisons made above. The analysis of variance had two between subjects factors, Group (Scotland and New Zealand) and Age (year 1 and year 2) and two within subjects factors, test type (BAS and naming tests) and Error Type (Type 1-8). There was no significant main effect of Age ($F(1,71)=5.82$, $p>0.05$), but there was a significant effect of group ($F(1,71)=39.21$, $p<0.01$) and Test type ($F(1,71)=8.29$, $P<0.01$), there was also a significant effect of Error Type, ($F(7,497)=143.22$, $p<0.01$). There were significant interactions of Age by Error type ($F(7,497)=5.36$, $p<0.01$), of Group by Error Type ($F(7,497)=11.94$, $p<0.01$) and of Test by Error Type ($F(7,497)=9.05$, $p<0.01$). No other interactions reached significance. Newman Keuls tests revealed that the Group by

Error Type interaction was due to the Scottish children producing significantly more Type 4 ($p<0.01$), Type 6 and Type 7 ($p<0.01$) errors; there were no differences for any of the other error types. The interaction of Age by Error Type was due to more Type 7 errors ($p<0.01$) being produced by the Year 2 children and the interaction of Test by Error type was due to more production of type 3 errors in the BAS while there was more production of type 4 errors in the Nonword naming task.

The differences between the errors made for the BAS test and those of the nonword naming tasks were therefore minimal. The same basic pattern of cross national differences between Scotland and New Zealand was found for words and nonwords. The error types that the Scottish children are producing correlate both with good BAS word reading but also with good nonword reading. Older readers in both national groups make more errors that are correlated with success in reading. The tests themselves differ in the amount of refusals produced, with more occurring in the BAS test, more real word errors for the nonword naming (due to the pseudohomophones). There are also more type 4 errors produced in the nonword naming tasks than in the BAS test. It is not clear why this is so but could be due to the fact that some of the real words in the BAS test are quite complex, and so only the first few letters of a complex digraph may be attempted.

Discussion

The results from this section are very similar to those found by Johnston and Thompson (1989) and Coltheart and Laxon (1990). The Scots show a pseudohomophone effect in the lexical decision task but they are much better at nonword naming. The New Zealanders do not show a pseudohomophone effect but would appear to be able to use phonological information when they need to as they are just as good at classifying nonwords and pseudohomophones in the homophone decision task. Just as in the Coltheart and Laxon (1990) study it would appear that the non-phonic trained children are more accurate at rejecting meaningless sentences than the phonics trained children. Or is it that they are simply better at reading sentences overall? The effect of Group was only just significant and there was no interaction with sentence type so it would appear likely that the New Zealanders were more accurate at sentence reading overall than the Scottish children. Both groups in this task showed a pseudohomophone effect in that the "sounds meaningful" sentences were more difficult to reject than the "sounds meaningless" sentences. Both groups would seem to be using phonological processing to some degree but do the New Zealanders have an advantage when reading sentences due to their training in the use of contextual cues? This matter is further investigated in Chapter 10.

The error analysis shows that the reading strategy used for nonword reading is the same as is used for ordinary word reading in both groups. This is further evidence that the two groups are affected by the type of instruction that they receive. We have seen that the New Zealanders can use phonology to some degree but they still persist in using a strategy that is not optimal for reading nonwords. The error analysis also provides further evidence that the Scottish children are using a more phonological strategy in their reading than the New Zealanders. This also helps explain why the Scots are better at reading nonwords than the New Zealanders. They are using the optimal strategy for the task and they are more practised at using it.

The New Zealand children do appear to have phonological knowledge available. This knowledge is not readily provided by the form of instruction they receive so must either be innate or comes from experience with reading itself. This matter is further investigated in Chapter 8. If the New Zealanders do have phonological knowledge available, why do they exhibit such a drop in performance on the nonword naming task in comparison to the homophone decision task? Do they use a more phonological strategy for homophone decision and a more visual approach for nonword naming? This would seem unlikely as nonword naming would seem more demanding of phonological skills so it would seem logical to apply more phonological knowledge in that task. The stimuli in both tasks are the same so why do the New Zealanders perform well at homophone decision? In the homophone decision task there are three strategies available to the subject. The stimuli can be sounded out according to GPC rules and allocated to a category. The subject can guess which category the word belongs to with a 50% chance of success or the subject can use a combination of both approaches to help them decide on the category of word. In the nonword naming task there is only one strategy available and that is to attempt to read the words according to GPC rules. If this is not done properly then they will be wrong. Nonword naming is therefore a more stringent test of phonological knowledge than homophone decision. There is a minimal element of chance in the task. The fact that the Scots do much better in this task than the New Zealanders illustrates that the Scottish children have a greater grasp of GPC rules than the New Zealanders.

We can conclude that the Scottish children do appear to automatically activate phonological skills pre-lexically, as Johnston and Thompson (1989) suggested. The New Zealanders do have a limited facility to access pre-lexical phonological information as well but their main reading strategy would appear to be based on cues like context, which are non-phonological.

Chapter 6-Irregular Word Reading

"The alternation of Red and White is perhaps not so strictly observed as it might be."

It has been demonstrated in the section on nonword naming that the Scottish children would appear to have an advantage when it comes to processing words that are obliged to be read using an alphabetic strategy. Would the New Zealanders have an advantage compared to the Scots when required to process words where an alphabetic strategy may be a disadvantage? Irregular words which do not correspond to spelling sound rules cannot be properly pronounced using only spelling sound rules, a more visual strategy is needed to correctly identify them. A difference in the ability to correctly name irregular words would be further evidence that the Scottish children are using an alphabetic strategy while the New Zealanders are less dependant on spelling sound rules and whose reading may be more visually based.

There has, however, been much debate over what constitutes irregularity in spelling. Over the last twenty years the definition of irregularity has narrowed from the broad views of Barron (1975) and Coltheart (1978) to a point where researchers like Glushko (1979), Waters, Seidenderg and Bruck (1984) and Orden, Pennington and Stone (1990) have been able to demonstrate that the consistency of orthographic-phonologic correspondence is as much a potent variable in naming performance of irregular words as humble GPC regularity. This has led to the splitting of irregular words into two classes, exception words such as "have" (which have irregular pronunciations) and strange words such as "aisle" (which have irregular spellings and pronunciations). It has also been found that the frequency of irregular words can play a part in how they are recognised. Andrews (1982) and others (i.e. Backman et al 1984, Seidenberg 1985, Seidenberg et al 1984, Waters et al 1984) found that there was no accuracy difference between high frequency regular words and high frequency irregular words in skilled readers. Waters, Seidenberg and Bruck (1984) found that this was also true in grade 5 children, but not in grade 3 children where there was a difference between high frequency regular words and high frequency irregular words in overt pronunciation tasks.

The reading of irregular words of both high and low frequency in the New Zealand children and the Scottish children is compared in this section. It is hypothesised that the Scottish children, with their reliance on an overt phonological strategy, will struggle on this task while the New Zealand children who depend less on phonology for reading, should do better. The errors that the children make will also be examined to see if there is any tangible difference in error production between the groups in this task. It is hypothesised that the error patterns found in the BAS test (which a preponderance of regular words) and the nonword reading test will still be prevalent in the irregular word reading data presented here. The effects of instruction on reading strategies used by the children should still apply even with words that are incompatible with the rules the Scottish children are learning. This would further reinforce the argument that instruction does influence reading strategy even in reading situations where such influences may be negative.

Subjects

The Year 2 subjects, as described in Chapter 3, were used for this particular study. One New Zealand subject was not included in this study as she missed one of the testing sessions. This absence did not affect the reading and other matches of the year 2 groups. The Year 1 subjects were not included as a large number of them found the task too difficult to manage adequately.

Design

This particular reading match involves a post hoc integration of two reading tasks which contained irregular items. Ten words were taken from the task where the children read aloud words they would later spell, five from the BAS word reading test and five from the vocal reaction time task. Presentation of all items was identical for both groups for each subset of words.

Materials

These consisted of 20 irregular words, classified according to Venesky's (1970) analysis. There were nine high frequency words (rated over 1000 by Carol et al Grade 3 norms 1971) and eleven lower frequency words (rated under 1000 by Carol et al Grade 3 norms 1971) in the list. The stimuli are reproduced in Appendix 5.

Procedure

The words were read over three sessions by the children. The first session consisted of ten words, the second and third sessions of five words each. Each child was asked to read out loud each word put before them.

Results

Table 6.1
Mean percentage of words read correctly
(standard deviations in brackets)

	Percentage words read correctly
Scottish Sample	50.435
	(15.441)
New Zealand Sample	59.346
	(21.014)

The New Zealanders scored higher on average than the Scottish children. To evaluate this irregular word reading comparison statistically an analysis of variance was performed on the reading scores. There was one between subjects factor, Group (Scotland and New Zealand) and one within subjects factor, irregular reading performance. There was no significant main effect of Group ($F(1,44)=2.69$, $p=0.1$) although the New Zealand children had a 9% advantage.

It was noted however in the raw data set that there appeared to be a difference in performance between the low frequency irregular words and the high frequency irregular words.

Table 6.2

Mean percentage of words read correctly

(standard deviations in brackets)

	Low Frequency	High Frequency
Scotland	25.709	80.152
	(17.479)	(20.385)
New Zealand	42.687	80.157
	(23.311)	(27.622)

The data was subjected to an analysis of variance with one between subjects factor, Group (Scotland and New Zealand) and one within subjects factor, word frequency (low and high frequency). This revealed, as suspected, a main effect of word frequency, ($F(1,44)=159.82$, $p<0.01$). There was no Group effect ($F(1,44)=2.34$, $p<0.01$), but there was a significant interaction of Group by Frequency ($F(1,44)=5.45$, $p<0.05$). A Newman Keuls analysis revealed that the New Zealanders were significantly better ($p<0.01$) at pronouncing low frequency irregular words than the Scottish children. There was no difference in accuracy between the groups for the high frequency irregular words.

Correlation of performance on the low frequency words with performance on the high frequency words showed that the two tasks correlated significantly across both national groups ($r=0.37$, $p<0.01$)) but did not correlate significantly when the New Zealanders were looked at in isolation ($r=0.37$, $p>0.05$) and the two tasks only just correlated significantly for the Scottish group ($r=0.46$, $p<0.05$). This is an interesting result as one would predict that the New Zealand children's results on high and low frequency irregular words should correlate significantly with each other. It would be predicted from some models of reading that the New Zealanders would be able to use superior lexical knowledge to identify the high frequency words and the low frequency words due to a larger sight vocabulary. The fact that there is no related correlation poses problems for such an interpretation.

Error Analysis

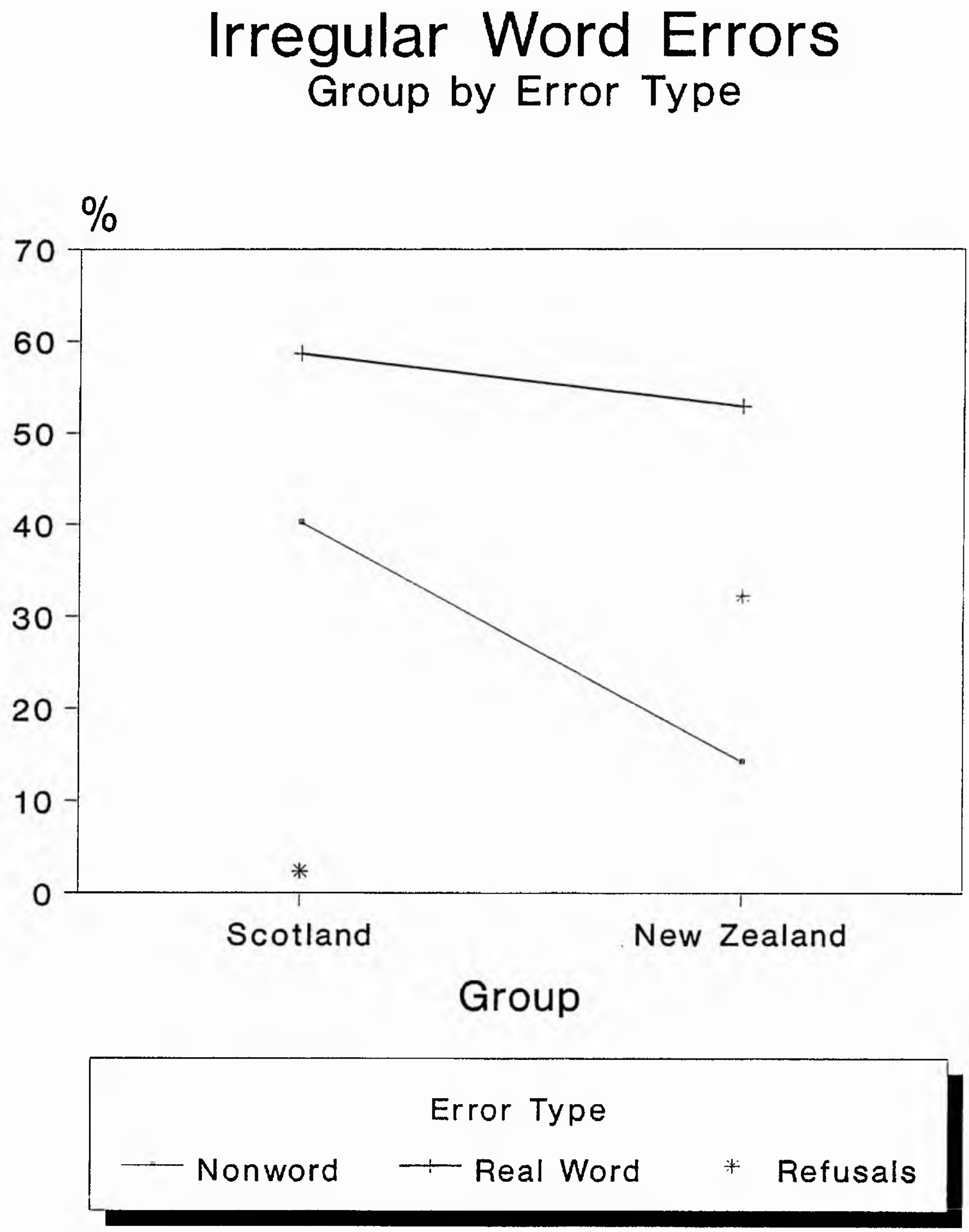
An error analysis identical to that used on the BAS word reading test data was carried out on the errors for the low frequency irregular words only. The children in both samples were too close to ceiling performance to carry out a worthwhile error analysis for the irregular high frequency words. Firstly the errors were categorised into one of the three possibilities of :

1) Refusal to attempt word
2) Error is a real word
3) Error is a non-word

Table 6.3-Error type as percentage of total errors (standard deviations in brackets)

	Refusal	Real Word	Nonword
Scotland	2.409	58.617	40.274
	(6.893)	(21.415)	(22.101)
New Zealand	32.200	52.835	14.213
	(32.489)	(26.308)	(18.363)

An analysis of variance was performed on these data with one between subjects factor, Group (Scotland and New Zealand) and one within subjects factor, Error Type (Refusal or Real word or Nonword). No main effect of Group was found ($F<1$) but there was an effect of Error Type ($F(2,88)=24.3$,


Irregular Word Errors
Group by Error Type
%
70
60
50
40
30
20
10
0
Scotland
New Zealand
Group
Error Type
Nonword
Real Word
Refusals

Graph 6.1

p<0.01). The interaction of Group by Error type was also found to be significant, ($F(2,88)=12.22$, $p<0.01$) (see Graph 6.1). A Newman Keuls post hoc analysis of the interaction revealed that the Scottish sample produced significantly more ($p<0.01$) nonword errors than New Zealanders did. On the other hand the New Zealanders made significantly more ($p<0.01$) refusals than did the Scots. The two samples did not differ significantly in the amount of real word errors they produced. This is the same pattern of performance as was seen in the BAS and nonword reading tasks. The Scottish sample produced significantly more nonwords than they produced refusals and significantly more real word errors than nonword errors. The New Zealand sample had significantly more real word errors than refusals and the amount of refusals produced was significantly more than the amount of Nonwords produced.

Correlation of performance on the irregular word reading test by error type is shown in Table 6.4 below:

Table 6.4-Correlations of Error type with irregular word reading skill

	Refusal	Real Word	Nonword
All	-0.07	0.19	-0.18
Scotland	-0.06	-0.03	-0.02
New Zealand	-0.45*	0.45*	0.06

* $p<0.05$ ** $p<0.01$

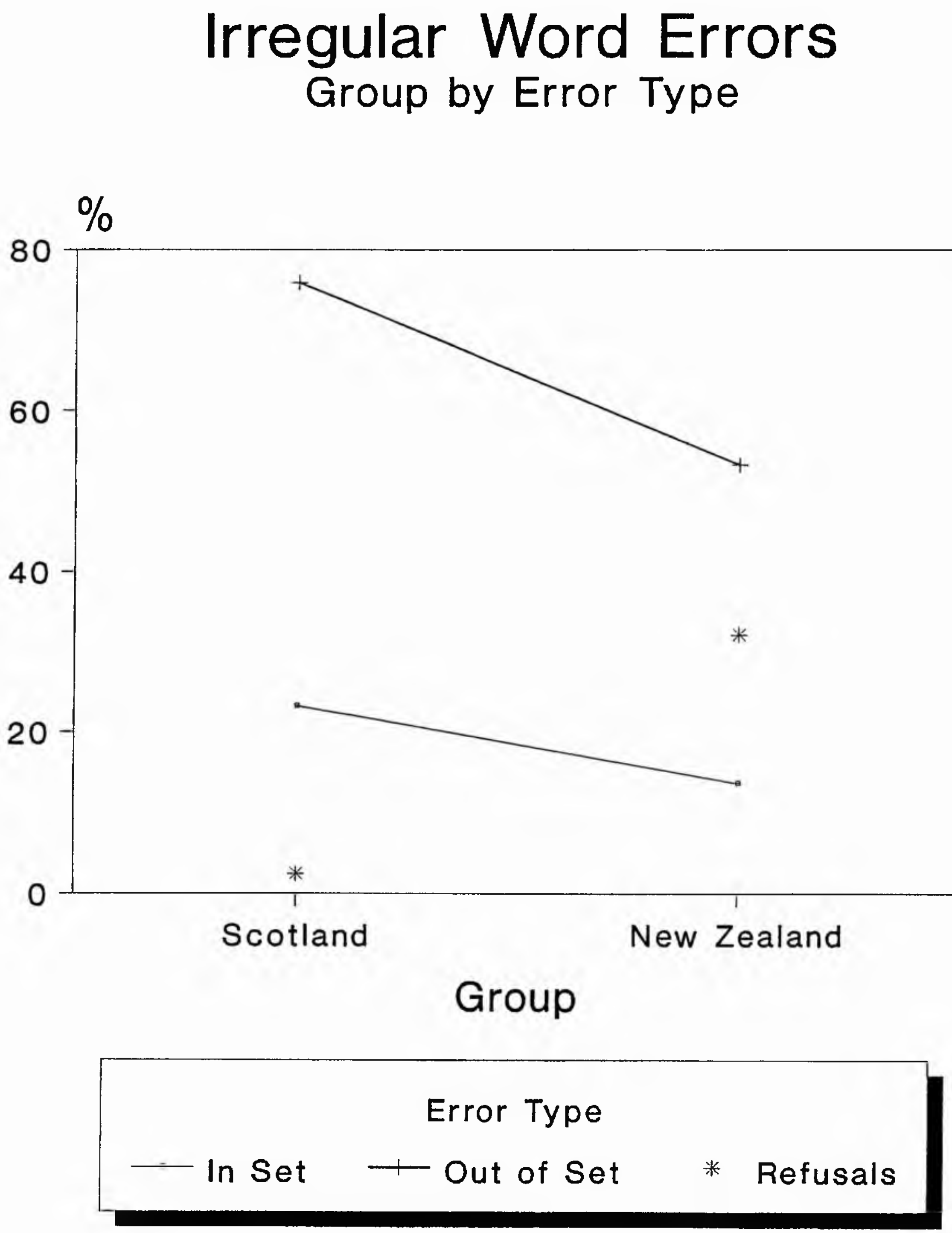
These results are quite different to the correlations that were typical of the BAS reading and nonword reading tasks. The Scottish children's errors do not correlate with irregular word reading at all, in either direction. The New Zealand children do have a pattern to their error data though, in that refusals correlate negatively and real word errors positively with performance on the task. This contrasts with the BAS reading data where nonword error production did correlate with word reading in both New Zealand and Scottish children. The proposed phonological strategy behind the production of nonword errors does not appear to operate when reading irregular words.

The error set was then re-classified into the following three categories:

1) Refusal to attempt word
2) Error was from taught reading scheme word set
3) Error was not from taught reading scheme word set

Table 6.5-Error Types as percentage of total errors (standard deviations in brackets)

	Refusals	In Set	Not in set
Scotland	2.409	23.252	75.830
	(6.893)	(14.301)	(14.963)
New Zealand	32.200	13.735	53.313
	(32.489)	(16.263)	(35.836)


Irregular Word Errors
Group by Error Type
%
80
60
40
20
0
Scotland
New Zealand
Group
Error Type
In Set
Out of Set
Refusals

Graph 6.2

An analysis of variance was carried out on these data with one between subjects factor, Group (Scotland and New Zealand) and one within subjects factor, Error type (Refusal or In Set or Not In Set). No significant main effect of Group was found, ($F<1$) but there was a significant main effect of Error type, ($F(2,88)=44.41$, $p<0.01$). The interaction of Group by Error type was also significant, ($F(2,88)=11.34$, $p<0.01$) (see Graph 6.2). Newman-Keuls tests on the interaction brought to light a number of interesting differences. The Scots produced less refusals ($p<0.01$) and much more "Not in Set" errors ($p<0.01$) than the New Zealanders. There was no significant difference in the amount of "In Set" errors the two samples made. This again is a strikingly similar pattern of error production to that of the BAS and nonword reading tasks. The Scottish sample produced significantly more "In Set" errors than they did Refusals. They also produced many more "Not in Set" errors than "In Set" errors. The New Zealand sample produced more "Not in Set" errors than Refusals. The amount of Refusals produced by the New Zealanders did not differ significantly from the amount of "In Set" errors they produced.

Correlation of performance on the Irregular word reading test by error type is shown in Table 6.6 overleaf.

This table of correlations reveals a similar trend to that of the real word and nonword error correlation data presented earlier. The Scots children show no pattern in their error production that correlates with irregular word reading. The New Zealanders do show a distinctive pattern, with strong correlations in all the error categories.

Table 6.6-Correlation of error type with irregular word reading skill

	Refusals	In Set	Not in set
All	-0.07	-0.28	0.16
Scotland	-0.06	0.18	-0.19
New Zealand	-0.45*	-0.44*	0.56**

* p<0.05 ** p<0.01

The successful New Zealand reader in this task is producing errors that are real words but that are not drawn from the original word reading set. The Scottish child who produces a lot of nonword errors (even though they are from outside the reading set) does not succeed in this task. The correlations of nonword error production with success at word reading previously seen have been lost in the Scottish children because their phonological strategies do not work when reading irregular words.

The actual letter differences between the target and the error were classified using the eight categories of error that were used for the BAS reading tests. The results are reproduced overleaf.

Table 6.7

Mean percentages of Error Types

(standard deviations in brackets)

Error Type->	1	2	3	4	5	6	7	8
Scotland	1.59	4.07	6.79	23.41	3.41	3.70	56.94	0.0
	(5.3)	(9.1)	(10.4)	(14.3)	(6.3)	(6.6)	(17.1)	(0.0)
New Zealand	0.5	0.48	8.3	20.4	0.0	0.0	35.7	0.0
	(2.3)	(2.3)	(12.6)	(17.1)	(0.0)	(0.0)	(20.7)	(0.0)

An analysis of variance was carried out on these results. There was one between subjects factor, Group (Scotland and New Zealand) and one within subjects factor, Error type (Types 1 to Type 8). A significant main effect of Group was found ($F(1,44)=26.0$, $p<0.01$) and a significant main effect of Error Type was also found, ($F(7,308)=108.33$, $p<0.01$) as well as a significant interaction of Group by Error Type, ($F(7,308)=5.21$, $p<0.01$).

The interaction Newman-Keuls posthoc tests disclosed a number of interesting results. The Scottish sample produced more significantly more Type 7 errors than any other error type except for the Type 4 error. No other error types differed significantly from each other within the Scottish sample. The New Zealand sample produced similar results in that they made more Type 7 errors than any other type of error, followed by the Type 4 error which was also significantly more numerous than all the other error types. No other error types were significantly different within the New Zealand sample. Comparing the two samples it was observed that the Scots produced significantly more Type 7 errors than the New Zealanders ($p<0.01$) while not statistically differing in the amount of Type 4 errors they both produced. The Type 3 error frequencies and all the other error types were not significantly different between groups either. This is more evidence that the pattern of error production has not changed despite the different words used in this task.

Correlations of performance on the irregular word reading test with Error type are shown in table 6.8 below:

Table 6.8-Correlations of error type and irregular word reading skill
(standard deviations in brackets)

Error Type->	1	2	3	4	5	6	7	8
All	0.06	-0.29	-0.23	0.13	-0.49**	0.04	0.13	--
Scotland	0.07	-0.45*	-0.60**	0.05	-0.66**	0.36	0.59**	--
New Zealand	0.28	0.28	-0.08	0.26	--	--	0.29	--

* p<0.05 ** p<0.01

The correlational analysis above is very similar to the previous analyses of the BAS and nonword naming correlation data. The Type 7 error in the Scots children still correlates with success at reading. This result is a bit of an anomaly when compared to the correlations already reported for the previous error categories in the irregular word reading task. The type 7 error was presumed to be indicative of a successful phonological strategy. Yet in the previous error categories reported in this section, phonological type errors were not correlated significantly with reading success in the Scottish children because of the nature of the task. Yet the type 7 error is correlated with success in a non phonological reading task. Does this mean it is not indicative of a phonological strategy but instead typical of a more visual/orthographic strategy?

Irregular Word Reading and Nonword Reading

Since the reading of nonwords is generally accepted as a stringent measure of alphabetic reading it should provide a good contrast with irregular word reading where use of alphabetic information may be a disadvantage. This is especially so considering that the Scots did better at the nonword reading while the New Zealanders were better at the irregular word reading.

It was found that reading success in the nonword naming task correlated significantly with success in the irregular (low frequency) reading task for the Scottish children ($r=0.66$, $p<0.01$) but not for the New Zealand children ($r=0.36$, $p>0.05$). The opposite effect was found for the high frequency irregular words. Scottish success at reading nonwords did not correlate significantly with reading high frequency irregular words ($r=0.36$, $p>0.05$) while New Zealand success at reading nonwords did ($r=0.53$, $p<0.01$).

The types of errors produced by both samples in both tests were compared to see if there were any underlying differences. Analysis of variance was applied to the data from the nonword reading and irregular (low frequency) word reading when the errors were classified into real word nonword and refusal type errors. There were two within subjects factors, Group (Scotland and New Zealand) and Test (nonword reading and irregular word reading) and one between subjects factor, error type (real words, nonwords and refusals). No significant main effect of Group ($F<1$) or Test ($F<1$) was found but a significant main effect of Error type ($F(2,82)=27.6$, $p<0.01$) was. There was a significant interaction of Group by Error type ($F(2,82)=15.7$, $p<0.01$) and of Test by Error type ($F(2,82)=3.4$, $p<0.05$) but not of Group by Test ($F<1$) or of Group by Test by Error Type ($F(2,82)=1.06$, $p>0.05$). Newman Keuls post hoc testing of the interaction of Group by Error type showed that over both tests the Scots produced significantly more ($p<0.01$) nonword errors than the New Zealanders, who in turn produced significantly more ($p<0.01$) refusals. Newman Keuls analysis of the interaction of Test by Error Type revealed that significantly more nonword errors were made in the nonword reading test than in the irregular word reading test. This was probably due to the fact that it was a nonword reading test. No other significant differences were found.

Analysis of variance was also carried out on the data from the classification of errors into "in set" and "not in set" errors. Again, however, it should be realised that a nonword reading test by its very nature may produce less "not in set" errors. There were two between subjects factors, Group (Scotland and New Zealand) and Test (Nonword reading and irregular word reading) and one within subjects factors, Error type (in set, not in set and refusals). There was no significant main effect of Group ($F(1,41)=1.37$, $p>0.05$) or Test ($F<1$) but there was a significant main effect of Error type ($F(2,82)=83.9$, $p<0.01$). The interaction of Group by Error type was significant ($F(2,82)=17.2$, $p<0.01$) but the interactions of Group by Test ($F<1$), Test by Error type ($F(2,82)=1.7$, $p>0.05$) and Group by Test by Error type ($F(2,82)=2.5$, $p>0.05$) were not significant. A Newman Keuls post hoc test on the only significant interaction revealed that the Scots produced significantly more ($p<0.01$) "not in set" errors than the New Zealanders over both tests and that the New Zealanders produced more ($p<0.01$) refusal errors than the Scots over both tests.

Analysis of variance was also applied to the error data from nonword and irregular word errors for the Types 1-8 error classification. There were two between subjects factors, Group (Scotland and New Zealand) and Test (nonword reading and irregular word reading) and one within subjects factor, Error type (Type 1-8). There was no significant main effect of Test ($F<1$) but there were significant main effects of Group ($F1,41)=25.3$, $p<0.01$) and of Error type ($F(7,287)=95.3$, $p<0.01$). The interaction of Group by Test ($F<1$) was not significant while the interactions of Group by Error type ($F(7,287)=3.9$, $p<0.01$) and Test by Error Type ($F(7,287)=5.8$, $p<0.01$) were significant. The interaction of Group by Test by Error type was not significant ($F(7,287)=1.61$, $p>0.05$). Newman Keuls post hoc tests on the two significant interactions revealed some interesting differences. In the Group by Error type interaction the New Zealanders produced significantly more Type 6 errors than the Scots but significantly less ($p<0.01$) Type 7 errors over both tests. The Test by Error type interaction showed that more type 4 errors were produced in the nonword reading test than in the irregular test and that more ($p<0.01$) Type 7 errors were produced in the irregular reading test than in the nonword test.

Discussion

The results presented in this section reinforce the idea that the instructional technique employed to teach children to read can have an effect on the strategies they consequently use to read. The Scottish children, despite being matched for word recognition, vocabulary, age etc., were found to be worse at correctly pronouncing low frequency irregular words. This is in direct contrast to nonword naming where the Scots children were found to be better than the New Zealand children. In nonword naming the use of a phonologically based strategy is obligatory, in irregular word naming it is a disadvantage. Therefore, it would appear that the Scottish children are using a phonologically based strategy to read unknown words while the New Zealanders are using a more visual approach. Further evidence for this conclusion was obtained from the error analysis data presented. There was no difference in the proportions of error types produced by the children in the nonword naming task and the low frequency irregular word task. This would seem to show that the children are employing the same strategies across both tasks. Errors associated with a phonological strategy, such as nonword error production, correlated with success in the nonword naming task (and in the BAS test which consists of mostly regular words) but not in the irregular naming task. Errors that could be associated with a more visual approach to reading, such as real word errors, do not correlate with nonword naming but do correlate with successful irregular word reading (in the New Zealand sample at least).

The disparity in success that was found in reading high frequency irregular versus low frequency irregular words is similar to the findings of Seidenberg et al (1984). They also found a large difference in success which could be accounted for by frequency effects. Seidenberg proposed that all high frequency words are dealt with in a similar way by readers. The familiarity of a high frequency word is important in overcoming the effects of other factors in word recognition like regularity and consistency. Seidenberg suggested that high frequency words are recognised on the basis of visual information. We have no evidence for this in this observation but it was apparent that common, familiar words throughout the whole study were dealt with quickly and efficiently by the children in both countries.

The way that Type 7 errors (which have been described as phonological) still correlated with reading success even in an irregular word reading task, makes the point that they may be indicative more of an orthographic strategy rather than just a phonological one. This would fit in with the ideas of researchers like Perfetti (1992) and Goswami and Bryant (1990) that orthographic skill is developing from the very beginning of reading.

Due to the post-hoc nature of the analyses we could not make a properly balanced comparison of irregular word reading and regular real word reading. One would hypothesise that there would actually be very little difference in regular word reading between the two groups, for high frequency words anyway. The high frequency words would be read automatically and the low frequency words could be read by either a phonological strategy or a visually based strategy. The Scottish children may show a regular word advantage (as they did in nonword naming) with low frequency words due to their reliance on phonology.

In the next section we shall examine how readers from both countries deal with familiar words and how automatic their processing of such words are. The kinds of cues that the readers may use in their reading of familiar words will also be examined in the next chapter, particularly the potential role of word shape cues.

Chapter 7-Word shape and reading acquisition

"Why, it's a looking-glass book of course! And if I hold it up to a glass, the words will all go the right way again."

There has been fierce debate in modern psychology about the contribution that word shape makes to the reading process in skilled and novice readers. Cattell (1886) and Erdman and Dodge (1898) were among the first to suggest that word shape may be involved in word recognition. These researchers worked in an era when the emphasis of investigation was on the physical, seen structure of words as represented by contrast, spatial frequency, angularity and similar constructs. The emphasis of researchers in more recent years has, however, been on the linguistic qualities of words and there would appear to be a tacit understanding nowadays that "beyond initial decoding stages, visual features of letters and words play a minimal role in the processing of verbal material" (Lewis and Walker 1987, p.241). The influence of the visual details of words are assumed to have little, if any impact, on reading. The abstract letter code which gains access to a lexical representation is presumed not to preserve visual details like the print size, typeface or case of the word (e.g. Adams 1979, Besner, Coltheart and Davelaar 1984, Paap, Newsome and Noel 1984). Despite this prevailing view many researchers still cannot resist the thought that word shape must have something to do with the reading process and controversy about the role of word shape in reading persists.

Word shape and the lower case effect

How can word shape be defined? Paap, Newsome and Noel (1984) define word shape in terms of the following:

> "The shape of any letter string can be described in terms of the holistic pattern formed by the sequence of ascending, descending and neutral letters... Words printed in lowercase have characteristic shapes that can be defined in terms of [these] ascending, descending and neutral letters."
>
> (Paap et al 1984 p.413)

This definition therefore excludes words printed in upper case, as these are all printed to the same height, and the overall holistic shape is thought not to vary overly. Many researchers have taken this difference between upper and lower case words as a point from which to try and evaluate the impact of shape on word recognition processes. Wordsworth (1938) reported that words in lowercase were named more rapidly than upper case words. Smith (1969) and Fisher (1979) showed that naming speeds were slower for uppercase words. Baron and Strawson (1976) and Coltheart and Freeman (1979) also found that some classes of words presented in upper case were named more slowly than lower case words. Underwood and Bargh (1982) reported that in adults lower case words were named faster than upper case words (while within incongruous sentences) and that they found a regularity effect in upper case presentation. This they hypothesised was due to the subjects being forced to use GPC rules to decode the upper case words as the visual aspects of them had been reduced by being put into uppercase.

Healy and Cunningham (1992) had children from 4th grade and 7th grade and some college students proofread passages which contained words which were misspelled by the removal of one of their letters. The passages were printed either wholly in lower case or upper case. They found that more proof-reading errors were made when the letters were in uppercase. They also reported an interaction between letter case and the type of letter deleted in the misspelling. In lower case print more proof-reading errors were made on the deleted letters 's' and 'c' which retained word shape than on the deleted letters 'k' and 'p' which did not alter word shape. There was no interaction reported between age and performance on upper and lower case word reading.

Paap et al (1984) substituted the letters in lower case words so that the shape of the word was not overly affected. The replacement letters were either similar visually to the original letters or were quite dissimilar but still preserved the word envelope. Adult subjects were then asked to proofread passages containing these words. It was found that the visually similar substituted letters were more often missed during proof-reading than the visually dissimilar letters. Paap et al argued that since word shape was preserved then the proof-reading errors were to do with effects at the letter level not the word level. This may be valid but it can also be argued that changes at the letter level are also inevitably changes at the word level. Walker (1987) also points out that Paap et al used a display size for their words and letters in which the ascenders and descenders only differ by two dots from the size of four dot neutral letter stimuli. This is not a very prominent stimulus difference when apparently investigating word shape.

Word shape and alternated case

Monk and Hulme (1983) also found that misspellings which maintained word shape in lower case words were less likely to be noticed in a proof-reading task than misspellings that did change word shape. They then took the original proof-reading passage and randomly changed 50% of the lower case letters to upper case. These alternated case stimuli did not show the same proof-reading results when the same letters were deleted as before. No word shape effect was found. Monk and Hulme postulated that this showed that the effect of word shape in their lower case condition could not be put down to non-visual differences, as the linguistic and phonemic qualities of the alternated case words were identical to the original lower case passage.

Smith (1969) also used alternating case to investigate the role of word shape. He found that the mean reading time of words is slowed in alternating case. He also examined the effects of letter size as a function of word shape. He alternated the cases of the letters but used uppercase letters whose height was identical to that of the neutral lower case letters. The envelope of the word was therefore disrupted but so were the size cues for the identity of individual letters since the ascenders and descenders were not reliably salient. Reaction times showed no difference compared to the lower case conditions. Smith pointed out that this may have been because the shape changes in this condition were a lot less than in the ordinary alternated case, so preserving a word shape explanation. Many other researchers have found that alternating case affects the reading of words. Mason (1978) found that alternating case increased the time from initial visualisation to the initial vocalisation of a word. Adams (1979) found that alternating case words, pseudowords and irregular words were disrupted compared to wholly lower case stimuli.

Smith (1969) however also proposed that his results may have been due to the possibility that any transformations would reduce the psychophysical familiarity of the ascenders and descenders of the lowercase alphabet. Therefore once letters were equated in size, alternated case would not significantly slow performance. This would then place any explanation of alternate case words at the letter level and not the whole word level.

McConkie and Zola (1979) presented adult subjects with a passage in alternating case. During the 20 milliseconds of the eyes saccadic movements they changed the case of the alternating case words (i.e. 'a' becomes 'A', 'B' becomes 'b'). McConkie and Zola reported that subjects did not perceive the change. This led them to propose that the visual system very quickly abstracts out word level information when reading. They reasoned that if the visual system stored the image then the change of image from one fixation to the next should have disrupted the reading. This study has been taken as evidence against word shape effects in word reading by many researchers (e.g. Henderson 1982, 1987, Besner 1989, Adams 1991). The study, however, only compared alternating case words with other alternating case words. No base line of normal reading performance was taken and the subject population was small (n=8). Rayner, McConkie and Zola (1980) did further work on this area and found that changing lower case words to upper case words and vice versa across saccade times did not alter reaction times significantly either way. This again would seem to be negative evidence for the role of word shape in reading. Rayner et al (1980) also report, though, that the eye parafoveally can only recognise two to three letters of the next word. Therefore in their experiments where the case of words are changed then the subject would only be exposed to the case change of the first two to three letters of the word and not of the whole word. This may be enough to confound results if the stimulus words have neutral letters at the beginning, as the shape itself would not have changed perceptually to the reader. It is interesting considering this that the alternated case condition in Rayner et al (where shape of the first two to three letters would change despite neutral letters) do show increased reaction times compared to the pure upper and lower case conditions.

Rudnicky and Kolers (1984) also gave skilled readers alternating case words to read. They controlled carefully for size and the amount of case change. The subjects were presented with four different types of text to read; same case, same size; same case, different size; different case, same size; and different case, different size. They found that size did affect reading more than case alternation but they concluded that this was because the size manipulations they had engineered actually disrupted word shape more than alternating case. They also noted that a single case change in a word had the same effect on reading as any number of case changes and that predictability and anticipation of case alternation had no effect on disruption. They concluded that skilled readers are sensitive to the shape of a word and that this is not just a letter level effect. If case change was a letter level effect then the amount of case change in words and the level of regularity and anticipation of it would have a feedback into reaction times. One case change just as effectively destroys word shape and slows reaction times as much as many case changes do.

Paap et al (1984) suggest that the effects of case alternation may also be due to case mixing inducing a letter by letter reading process. They cite Bruder (1978), who showed that words in lower case displayed a smaller length effect than when the same words were presented in alternated case. They hypothesised that the longer reaction time for the alternated case presentation was due to the necessity to process each letter serially. Eichelman (1970) also found a very similar result to that of Bruder. However, even if it is the case that letter by letter processing is induced, this in itself does not deny the existence of word shape, but merely suggests what strategy is induced when word shape is destroyed.

Besner has shown in a number of experiments (Besner, Davelaar, Alcott and Parry 1984, Besner and Johnston 1987, Besner and McCann 1987) that nonwords seem to be more affected by alternated case than real words. Reaction times to nonword stimuli are increased by a larger margin in alternated case than the increased margin in real words. Besner claims that if word shape has an important role in reading words then alternated case should show larger effects in real words than nonwords. This is a powerful case against word shape being a powerful element in word recognition, but does not wholly destroy the case for a limited role for word shape in conjunction with other recognition capabilities. Nonwords are unfamiliar stimuli and nonwords in alternated case are no doubt even more unfamiliar. This may in itself account for differences in reaction times rather than an account based solely on the break up of word shape.

Word shape and function words

Taylor and Taylor (1983), in a review of the role of word shape, concluded that they thought the role of word shape in reading most words was minimal but that it may have a role in reading short high frequency function words. Healy (1976) provided evidence for this viewpoint by showing that word substitution was more difficult to spot in short function words like "the", provided that a semblance of word shape was maintained. Haber and Haber (1981) have also pointed out that words like "by" and "the" have unique word shapes in the English language. They hypothesise that since these words are over learned through the enormous amount of times they are seen then readers will instantly respond to the shape of them.

Besner (1989) examined reaction times to function words and control words in lower and alternated case. He hypothesised that if these function words are reacted to in terms of shape then when that shape is disrupted they should be more disrupted than other control words that are not reliant on shape. Rather he found that function words were less impaired than control words in a reaction time task. Besner claims that this is evidence against the use of word shape cues. However, if one examines his control words, which are nonword anagrams of the function words (e.g. they-->yhet, the-->hte) then it may not be surprising the control words took longer to read. The stimulus "hTe" is much more unfamiliar than "tHe" in alternated case. Besner repeated the experiment with normal content words replacing his nonwords and found the same result again. Function words were still reacted to faster than control words even in alternating case. Besner takes this again as evidence that such words are not recognised by shape. Besner then uses this to justify the idea that there is no role for word shape in reading at all, whereas what his experiments did show was that word shape does not have an overwhelming part to play in reading function words rather than no role at all.

Walker (1987) analysed the distinctive word shapes of all the three to seven letter long words in the Kucera and Francis (1967) word list. He concluded from the analysis that word shape itself was not a very reliable predictor of words but when combined with knowledge of some of the orthographic features of a word it could be very helpful at identifying the word. The most reliable information to have about a word in conjunction with word shape knowledge was the identity of the first and last letters. The amount of words completely identified by these features were between 19% and 33% depending on the length of the word. The amount of words that shared these features with less than nine other words in the list ranged from 87% to 100% depending on the length of the word. Walker concluded that the "utility of word shape is extremely high when...it is combined with complete knowledge of the identities of the two extreme letters." (Walker 1987 p.688).

Reading and the retention of visual detail

The idea that the visual details of a word are only of a minor initial importance has been investigated over the last three decades using some very simple experiments. Lewis and Walker (1989) report that many experiments have employed a kind of reverse stroop paradigm in which it has been shown that the colour of ink in which a word is written can ultimately interfere with the extracted meaning of the word (Gumunik and Glass 1970, Morikava 1981, Uleman and Reeves 1971). Lewis and Walker also report that there have been a number of experiments where the details of size and typeface seem to have influenced word perceptions (Foltz, Poltrock and Potts 1984, Reich and Cherry 1979, Seymour and Jack 1978, Jacoby and Hayman 1987). Lewis and Walker themselves demonstrated that words printed in typeface which were deemed consistent with their meaning were reacted to faster than words in typeface deemed inconsistent with their meaning. They had subjects read animal names and asked them to decide as quickly as possible whether the animal was "heavy" or "light" in weight. The "heavy" animals whose names were printed in dark typeface and the "light" animals names' were printed in light typeface; the typefaces were rated as appropriate by independent subjects in a previous experiment. The appropriate typefaces were reacted to faster by subjects. They hypothesised that the visual details of words may not be abstracted and instantly removed in word recognition processes after all.

We have seen therefore, that despite many years of research that there is still no definitive answer to how much influence word shape and the visual detail of words have on skilled word recognition. The proofreading studies (e.g. Monk and Hulme 1983) and the lexical decision type studies (e.g. Besner 1989) would appear to show that word shape may have more of a role in contextual reading rather than single word reading. One of the problems of experiments in this field would appear to be the initial attitude of the experimenters themselves in formulating their hypotheses. Those who claim to show that word shape has no role base many of their conclusions on "all or nothing" hypotheses. They seek to show that if word shape is important then it will be impossible to read words without it. They do not seem to entertain the idea that there may be more than one route operating at the same time to help in reading words. Those experimenters who do see a role for word shape in reading tend not to be "all or nothing" hypothesisers, but do seem to ignore possible alternative explanations for their results, for example, the possibility of letter level effects. They instead concentrate on criticising the technical aspects of the experiments that claim to find no role for word shape. From an evaluation of the evidence presented above it would appear that there is a limited role for word shape in skilled reading but that reading can proceed relatively unimpaired with gross distortions to that shape. Let us now turn to the role that word shape may play in the developing reader. The influence of visual factors may be much more important in this area and would seem doubly so in relation to the New Zealand children who would appear to display signs of a more visual approach to reading than the Scottish children.

Visual processing and word shape in children's reading

Posnansky and Rayner (1977) gave 12 first, third and sixth grade children a picture word interference task and measured the naming latencies of the words presented. They presented a variety of words with the pictures. These words ranged from the actual correct labels of the pictures through to a set of nonwords (both these sets preserved or altered beginning and end letters and/or word shape) through to a set of real words which were completely unlike the proper picture labels (except in terms of frequency). The correct label word was responded to the fastest, the improper label the slowest and the nonwords in between. In the nonword conditions they found that when both end letters and word shape were preserved, reaction times were faster than if only one of these features was retained. When word shape and beginning and end letters were removed the resulting reaction times were the longest of all the nonword conditions. It was also found that the older the child the faster the reaction times to all stimuli. However the effect of word shape and end letters did not vary with age. Posnansky and Rayner claimed that these results showed that automatic word processing used word shape in recognition procedures.

Guttentag (1981) followed up this early work and was inspired by Baron's work on individual differences in children's reading (Baron and Strawson 1976, Baron 1979) and their use of sound correspondence rules. Guttentag also used a nontachistoscopic picture word interference task but with some of the words printed in alternated case. He looked at children who were good or poor at using spelling sound rules in a nonword naming task in the third and fifth grades. It was found that good decoders were not affected by the alternating case manipulations and processed words automatically in both third and fifth grade. The poor decoders were affected by alternated case at both grade levels. They were significantly slower at responding to alternated case words compared to normally presented words. Guttentag therefore hypothesised that poorer readers were more dependant on word shape as a cue than skilled readers, who could rely more on decoding skills to overcome visual distortions. Guttentag does not really consider the possibility though that the effects may be due more to poor reading skills per se than an over reliance on word shape.

Healy and Cunningham (1992) examined the evidence above and predicted that word shape contributes more to word recognition in poor than in good readers and that the magnitude of word shape effects would be similar independent of age. The subjects were fourth and seventh grade children and college age adults. It was found that proof-reading errors decreased with age and reading skill but that all groups made significantly more errors when word shape was preserved. They found no correlation between reading skill and the type of errors made, unlike Guttentag (1981).

They interpreted these results as showing that word shape has a role in all reading that has developed some automaticity (all the words in the task were familiar to third and fourth grades). Healy and Cunningham's subjects were a bit older than the subjects we are studying in this study though (between 10 and 11 year of age).

Seymour and Elder (1986) studied a class of new school entrants aged between 4.5 and 5.5 years of age. The children received whole language teaching which emphasised the formation of a sight vocabulary. Seymour and Elder were interested in whether the children would act like logographic readers, as described by Frith (1985), because of the teaching they had received. Logographic reading in Frith's scheme involves the sight recognition of whole words based on the salient graphic features of the words. Seymour and Elder had also noted that initially the children's reading had seemed very concrete and that they could only read words presented in a specific context (i.e. in their reading books). The children's reading seemed later to become more abstract as they could read the same words in different contexts (i.e. in their reading and on computer screens). Seymour and Elder therefore decided to test what effect visual distortion of word shape would have on reading to evaluate logographic reading, and to examine the concreteness of words in different formats. They presented words to the children on a computer screen in either a normal, zigzag or vertical format:

Figure 7.1 Seymour and Elder (1986) format distortions

yellow	y l o	y
	e l w	e
		l
		l
		o
		w

(From Seymour and Elder 1986 p.20)

It was found that distortion did affect the amount of words correctly identified, but that it did not wipe out reading altogether, in fact far from it. The better readers in Seymour and Elder's sample were less affected by the word shape distortions while the poorest readers were the most affected, scoring 50%-80% less in the distorted formats.

Distortion also affected the reaction times to the words. However there was no word length effect apparent in the reaction times for normal or distorted words. Seymour and Elder concluded from this that the children were using a "logographic lexicon" which recognises words based on a "process of feature discrimination rather than Gestalt recognition". They list three main features upon which they hypothesise word recognition at this stage is dependant. These are length of the word, the shape of salient letters and the position of those salient letters. This they claim would explain why the children were able to read distorted words, as the distortions themselves did not affect word length and that the salient letter features, "other than those capitalising on the adjacency of two or more letters" (Seymour and Elder 1986, p.29) were also not particularly affected. Word shape therefore was seen as having a minimal effect on logographic reading. However, Seymour and Elder did not fully discuss why there was a delay in processing distorted words if all the recognition features were generally unchanged. Was it due to the unusualness of the stimuli and perhaps a slight delay in finding the appropriate salient features in a strangely formatted word?

Paap et al (1984), as we noted earlier, hypothesised that distortions of word shape in fact led to letter by letter reading. This would contradict the Seymour and Elder logographic lexicon explanation. If Paap et al were correct it would be logical to hypothesise that subjects who were more skilled at using spelling to sound correspondences would be better at letter by letter reading. There is limited evidence that this was the case in the Seymour and Elder study.

In Seymour and Elder's Experiment 3, which is concerned with the dichotomy between spelling and reading, the subjects were placed into three groups according to their performance. The first group was applying a definite alphabetic strategy in reading and spelling (n=5), the second group showed signs of trying to apply alphabetic strategies (n=6) and the third group showed no sign of applying an alphabetic strategy in reading or spelling (n=13). There was no statistical comparison reported in their paper between how those children displaying a more alphabetic strategy did at reading the distorted words unfortunately. However a re-analysis of their results reveals that the subjects in the two groups showing evidence of an alphabetic strategy read a significantly smaller proportion of distorted words incorrectly than the group who showed no sign of an alphabetic strategy ($t=2.11$, $p<0.05$).

It would therefore seem logical to predict that the Scottish sample in this study should be better at responding to distorted words than the New Zealanders if a letter by letter or some sort of phonetic strategy is induced by distortion. An experiment looking at word distortion effects could help assess whether the New Zealand children are reading logographically and whether this logographic reading is influenced by word shape. If it is influenced by word shape then the New Zealanders should be hampered by the shape destruction caused by a zigzag format. If reading is hampered what strategy are the New Zealand children using to read the distorted words? If they become much slower than the Scottish children at reading the distorted words, and the fastest of the New Zealander subjects also show high phonological skills, then distortion may indeed induce letter by letter or phonetic based reading. This would be contrary to the Seymour and Elder (1986) viewpoint. These questions and ideas lead naturally to a number of specific hypotheses relating to a word shape distortion experiment with the Scottish and New Zealand samples.

Firstly, the Scottish children should be slower at reading normal format words than New Zealand children due to their "phonetic" approach to reading. Consequently they may also show a word length effect in terms of slower responses to longer words. The New Zealand children should read faster and show no indication of a word length effect if they are reading "logographically". There should be no difference in accuracy for normal words between the Scots and New Zealand samples as they are already matched for word recognition, but the New Zealand children should be greatly affected by word shape distortion if they are reading logographically as described by Frith (1985). This is because the New Zealanders, if they resort to a phonetic strategy in reading distorted words, would be less accurate and much slower than the Scottish children due to their less practised skills in this area. If the Scottish children are reading phonetically, however, they should not be greatly affected by format distortion as they can still work their way through the word phonetically. But if the New Zealanders read distorted words in a similar way to that proposed by

Seymour and Elder (1986) then they should be faster but as accurate as the Scottish children in reading distorted words as the recognition features will still be present.

Method

Subjects

These were the same four groups as were used in the BAS reading test match. There was one Scottish child missing from this experiment due to absence from school and five Year 1 Scottish children had to be dropped from this experiment due to problems with an over-sensitive voice key (it reacted to low flying aircraft!). Therefore, there were 13 Scottish children and 17 New Zealand children in the Year 1 age groups and 22 Scottish children and 24 New Zealand children in the Year 2 age groups. The omissions did not affect the reading matches ($F<1$ in both cases) with the Year 1 Scottish and New Zealand children having mean scores of 22.23 and 22.87 items correct on the BAS test respectively, and the year 2 Scottish and New Zealand children having mean scores of 33.39 and 33.75 items correct on the BAS test.

Materials

The stimuli were forty words of varying lengths from two letters to four letters (See appendix 6). There were 10 two letter words, 5 with a vowel at the beginning of the word (e.g. at) and 5 with a vowel at the end of the word (e.g. me). There were 10 three letter words, 5 with vowels in the medial position (e.g. but) and 5 with a mix of vowels at the end and beginning of the word (e.g. are). There were 20 four letter words. 5 of these words consisted of consonant blend, vowel and consonant (e.g. stop) while 5 had a consonant, vowel and consonant blend (e.g. help). 5 words had a consonant, vowel digraph and consonant pattern (e.g. look) while the final 5 words had a "silent e" at the end of the word (e.g. make). The set of words therefore contained a large mix of words with complex phonic rules but which were not considered too long for "logographic" reading.

The words selected appeared in both Scottish and New Zealand reading books during the children's first year at school according to the GINN 360 Level 1 and 2 Teachers' Resource Book (1988) and Thompson's (1982) study of the frequency of words present in reading schemes in the New Zealand first year of school.

The Grade 3 norms of Carroll et al (1971) indicated that the mean frequency of the different groups of words were as follows - two letter words 4444.1 (SD 4492.9) ;three letter words 9899.7 (SD 18067) (mean of 4259.6 without "the" in the list) ; four letter words 1723.2 (SD 1557.74).

Procedure

An Amstrad Portable Personal Computer (512K RAM) and a Microvitec CUB monitor (12 inch display) were used to present the stimuli to the subjects and collect response data. The PC was interfaced with a verbal response unit via an analogue sensitivity controller which allowed adjustment to accommodate the normal speaking voice level of individual subjects.

The stimuli letters were designed using software produced for the PC on a matrix of 20 (x) by 30 (y) pixels. All letters were in lower case and based on those typically found in early reading materials. Additionally, an asterisk character was used as a fixation point. Reaction times were measured in 1/100ths of a second by the PC's internal clock. The stimuli and response data for each subject were stored in on-line disk files for later analyses. The experimental sessions were also recorded on audio cassette tape for accuracy analysis.

Subjects were seated 0.6m from the computer display, with the microphone directly in front of them. (At this distance, letters displayed on the monitor subtended a visual angle of approximately 2 degrees.) All stimuli appeared at the centre of the monitor display and were preceded by a central fixation point (asterisk) for 0.5 seconds. One half of the experiment involved the child reading words which were presented normally on the centre line, reading from left to right. In the other half of the experiment the same words were presented zigzagged (See Figure 7.2). Subjects were randomly assigned to do either the normal or zigzag conditions first.

Figure 7.2 Presentation of words in distortion task

Normal presentation	zigzag presentation
stop	s o t p

When the child said the word, they tripped the verbal response unit and the screen would go blank. Presentation of subsequent stimuli was controlled by the experimenter pressing the space bar on the computer console.

The 40 stimuli were randomised by the software for presentation. All subjects participated in four practice trials. The children were told that they were going to see some words on the screen and that they had to try and make them disappear by saying them out loud. They were asked to do this as quickly but as carefully as they could. Each subject carried out half the normally presented words condition or the zigzagged words condition and then the other half of both one week later.

Accuracy results

The raw data were expressed in percentage accuracy.

Table 7.1-Mean percentage accuracy Scores
(Standard Deviations in brackets)
Normal condition

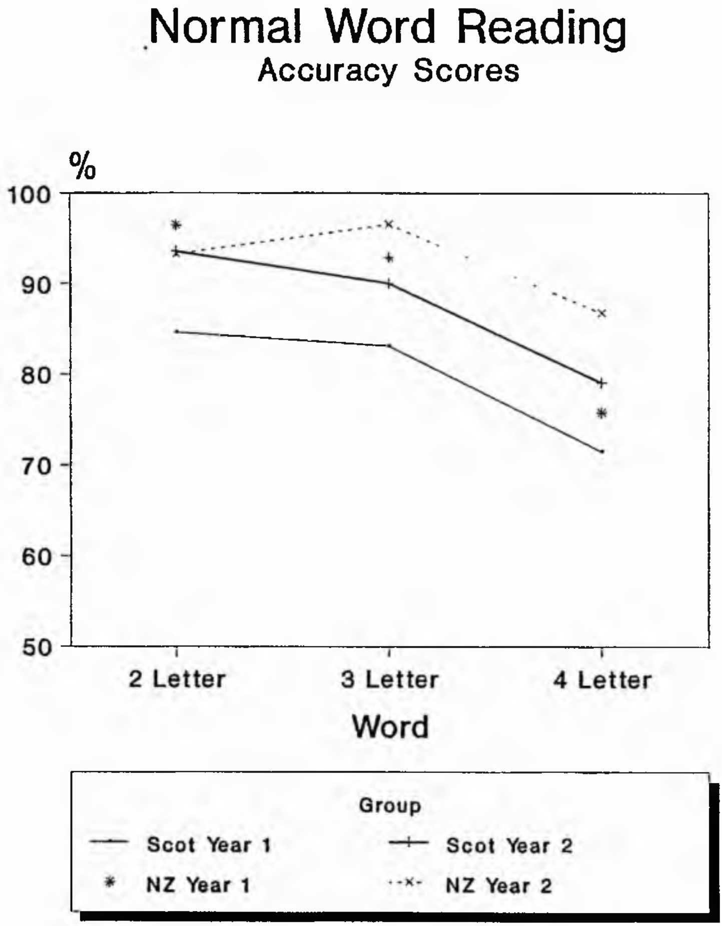
	Year 1		Year 2	
	Scotland	New Zealand	Scotland	New Zealand
2 letter	84.6	96.5	93.6	93.3
	(9.7)	(6.1)	(7.3)	(9.2)
3 letter	83.1	92.9	90.0	96.6
	(14.3)	(9.8)	(15.1)	(7.6)
4 letter	71.5	75.8	79.1	86.8
	(13.9)	(19.8)	(15.3)	(10.8)

Zigzag condition

	Year 1		Year 2	
	Scotland	New Zealand	Scotland	New Zealand
2 letter	86.2	94.2	89.1	95.4
	(11.9)	(8.7)	(11.5)	(6.6)
3 letter	65.4	83.5	77.3	84.6
	(18.1)	(19.6)	(17.7)	(13.5)
4 letter	54.2	68.24	66.4	75.4
	(22.6)	(22.6)	(15.8)	(12.9)

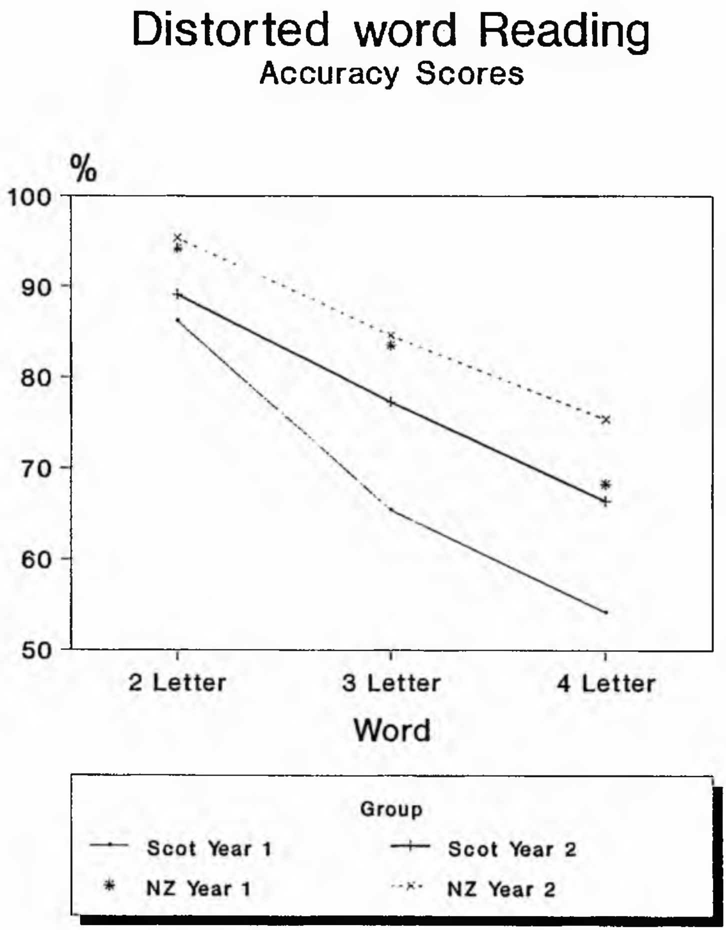
An analysis of variance was carried out on these scores with two between subjects factor, Group (Scotland and New Zealand) and age (year 1 and year 2) and two within subjects factors, distortion (normal presentation or zigzagged presentation) and word length (two, three and four letter word types). The main effect of Group was significant, ($F(1,72)=13.9$, $p<0.01$) as were the main effects of age, ($F(1,72)=6.7$, $p<0.01$), distortion ($F(1,72)=83.4$, $p<0.01$) and word length ($F(2,144)=89.3$, $p<0.01$). The interaction of Group by age by distortion by word length was significant ($F(2,144)=3.1$, $p<0.05$). A Newman Keuls post hoc test on this interaction revealed a number of interesting differences.

For year 1 children on the normal word condition the New Zealanders were more accurate ($p<0.01$) than the Scots at identifying the two and three letter words. In the year 2 samples on the normal word condition there were no differences between the Scots and New Zealanders in accuracy levels. The year 1 New Zealand children in the zig zag



Normal Word Reading
Accuracy Scores
%
100
90
80
70
60
50
2 Letter
3 Letter
4 Letter
Word
Group
Scot Year 1
Scot Year 2
NZ Year 1
NZ Year 2

Graph 7.1



Distorted word Reading
Accuracy Scores
%
100
90
80
70
60
50
2 Letter
3 Letter
4 Letter
Word
Group
Scot Year 1
Scot Year 2
NZ Year 1
NZ Year 2

Graph 7.2

condition were significantly better at identifying the three and four letter words than the year 1 Scottish children. The year two New Zealand children in the zigzag condition were better at identifying the four letter words than their Scottish counterparts.

Within national groups the Newman Keuls analysis revealed that the Scottish children in Year 1 were less accurate at identifying three and four letter words in the zigzag condition than the normal condition. The New Zealanders were also less accurate at identifying three and four letter words in the zigzag condition than in the normal condition.

Since some of the New Zealanders were better at the normal word reading condition it was difficult to establish whether the size of the distortion effects were equivalent or not when comparing single means between national groups. A quick glance at the means would seem to indicate that there was a larger distortion effect in the Scottish groups than in the New Zealand groups. Newman Keuls analysis could not adequately examine the potential differences in effects so Scheffe tests were used to compare the differences between pairs of means. The Scheffe tests revealed that there were no significant differences between the Year 1 Scottish and Year 1 New Zealand children in the size of the distortion effect they showed, nor between the Year 2 Scottish and New Zealand children in the size of their distortion effect.

The accuracy results have shown that the year 1 New Zealand children have a very good working knowledge of the words in their readers. Despite being matched for word recognition ability they recognised more normally presented words than their Scottish counterparts. However, the distortion of word shape affected both groups to the same extent in terms of accuracy. The same was true of the Year 2 groups. These data do not fit in well with the Paap et al (1984) theory that distortions induce letter by letter reading. The New Zealanders, rather than being more impaired, are in fact no more affected than the Scots by distorted words.

Table 7.2 Correlations of accuracy with other measures

Normal words

Scottish Groups	BAS words	Rosner test	Nonword naming	Irregular word naming
2 letter words	0.51**	0.09	0.05	-0.19
3 letter words	0.50**	0.02	0.28	0.16
4 letter words	0.69**	0.35*	0.56**	0.31

Normal words

New Zealand Groups	BAS words	Rosner test	Nonword naming	Irregular word naming
2 letter words	0.04	-0.19	-0.30	0.17
3 letter words	0.38*	0.17	0.28	0.40**
4 letter words	0.65**	0.33	0.27	0.64**

* p<0.05 ** p<0.01

Zigzag words

Scottish Groups	BAS words	Rosner test	Nonword naming	Irregular word naming
2 letter words	0.47**	0.39*	0.30	0.20
3 letter words	0.35*	-0.11	0.03	-0.06
4 letter words	0.66**	0.44*	0.48*	0.01

* p<0.05 ** p<0.01

Zigzag words

New Zealand groups	BAS words	Rosner test	Nonword naming	Irregular word naming
2 letter words	0.27	0.35*	0.32	0.25
3 letter words	0.32	0.17	0.05	0.42*
4 letter words	0.48*	0.42*	0.31	0.63**

* p<0.05 ** p<0.01

In the Scottish samples it is those children who are good at reading words on the BAS test, who perform well at reading nonwords (Table 7.2) and who are good at the Rosner task that have the highest accuracy scores for normal and distorted words. These correlations are what we would expect from a sample who are using a phonological approach to reading. In the New Zealand sample it is those who are generally good at reading words from the BAS and who are generally good at the Rosner task but who are very good at reading irregular words that are the best at reading words in normal and distorted formats here. It is interesting to see that the visual skills supposedly needed to read irregular words correlate with the skills at reading distorted and normal words in this task. This is more evidence that the New Zealand children are not using a phonological strategy when reading the distorted words (although performance did correlate with skill at the Rosner test).

Reaction Time Results

Reaction time data analysis is a very contentious area. Analysing the data using measures such as the arithmetic mean can be misleading. Reaction time data tends to be positively skewed "due its propensity to magnify stimulus anticipation and lapses of attention" (Duncan 1991 p.155). This situation is worse when small children are used as subjects. The median therefore is often used in this area as it is more resistant to atypical values and skew (e.g. Milner 1986). Miller (1988) and Duncan (1991) have stated that sample median times are fine provided one is comparing experimental conditions with the same amount of trials. Median bias becomes larger with the less scores that it is based upon. In this experiment only reaction times to correct responses have been analysed so there are varying numbers of trials for each subject.

Therefore, to minimise statistical artefacts in the data set, the geometric mean reaction time for each type of word was calculated for each subject. This method is recommended by Duncan (1991) for its capability to handle skewed data. Calculating the geometric mean involves finding the antilogarithm of the arithmetic mean of the logarithms of the data set and so make the distribution of positively skewed data more symmetrical.

The results in Table 7.3 show the arithmetic means of the geometric mean reaction times for each type of word. The arithmetic mean is used as it is assumed that any skew in the data will have been dealt with by the geometric mean and so the arithmetic mean can be used as normal.

An analysis of variance was carried out on these data with two between subjects factors, Group (Scotland and New Zealand) and age (year 1 and year 2) and two within subjects factors, Distortion (normal presentation and zigzagged presentation) and Word length (two, three and four letter words). There were significant main effects of group ($F(1,72)=51.6$, $p<0.01$), of distortion, ($F(1,72)=40.7$, $P<0.01$) and of word length, ($F(2,144)=25.3$, $p<0.01$). The interactions of group by distortion ($F(1,72)=5.0$, $p<0.05$), group by words ($F(2,144)=7.3$, $p<0.01$) and distortion by word length ($F(2,144)=5.5$, $p<0.01$) were all significant. No other interactions reached significance. A Newman Keuls post hoc test on the interaction of group by distortion revealed that the Scottish children showed a significant distortion affect, taking significantly longer ($p<0.01$) to react to the zig zag words than they did to the normal words, while there was no significant difference in reaction times between normal and zig zag words for the New Zealand sample. The Scots also took significantly longer to react to all stimuli

Table 7.3

Mean Reaction Time Data (msecs) of Types of Words

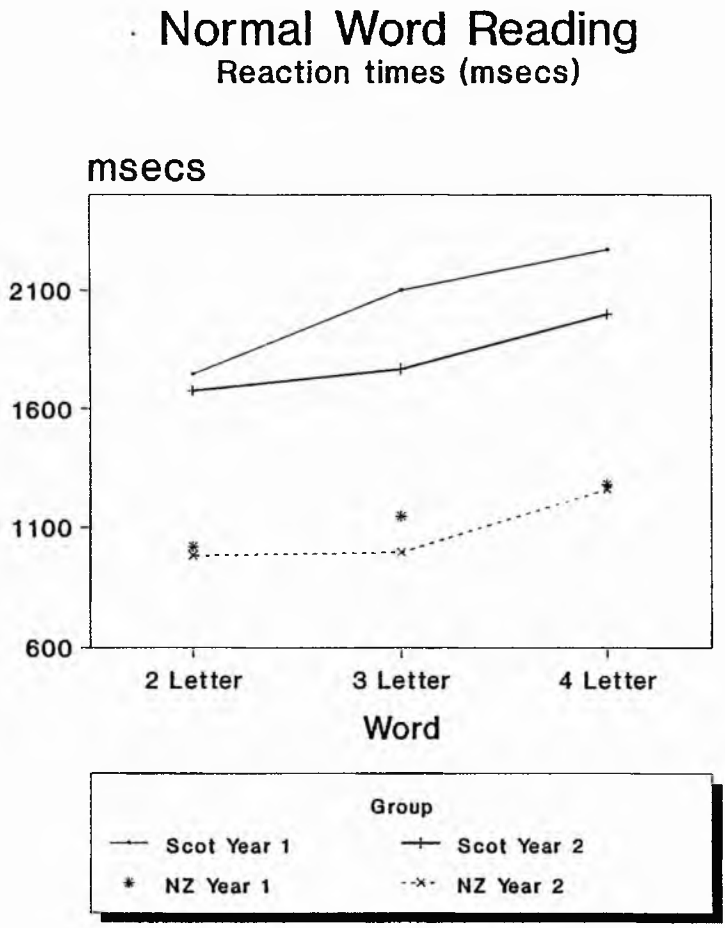
(Standard Deviations in brackets)

Normal condition

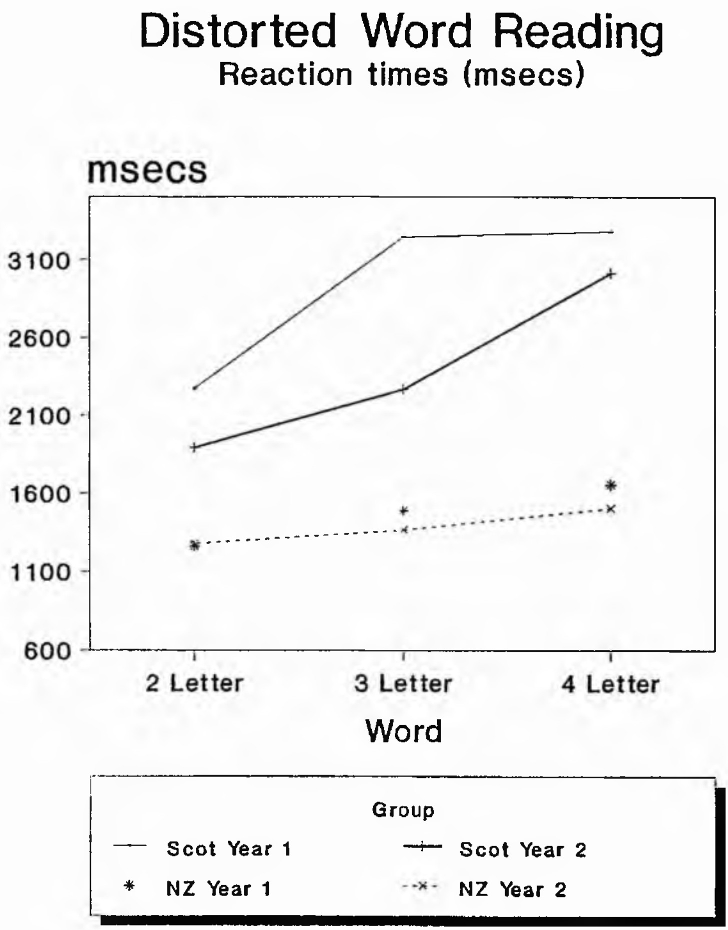
	Year 1		Year 2	
	Scotland	New Zealand	Scotland	New Zealand
2 letter	1749	1019	1678	983
	(784)	(275)	(664)	(356)
3 letter	2099	1148	1768	995
	(1033)	(401)	(600)	(446)
4 letter	2269	1281	2001	1261
	(1166)	(424)	(1013)	(410)

Zig zag condition

	Year 1		Year 2	
	Scotland	New Zealand	Scotland	New Zealand
2 letter	2272	1260	1891	1277
	(803)	(416)	(674)	(449)
3 letter	3247	1487	2270	1365
	(1234)	(451)	(955)	(430)
4 letter	3283	1656	3011	1503
	(2251)	(728)	(1727)	(539)


Normal Word Reading
Reaction times (msecs)
msecs
2100
1600
1100
600
2 Letter
3 Letter
4 Letter
Word
Group
Scot Year 1
Scot Year 2
NZ Year 1
NZ Year 2

Graph 7.3


Distorted Word Reading
Reaction times (msecs)
msecs
3100
2600
2100
1600
1100
600
2 Letter
3 Letter
4 Letter
Word
Group
Scot Year 1
Scot Year 2
NZ Year 1
NZ Year 2

Graph 7.4

compared to the New Zealand samples. A Newman Keuls analysis of the distortion by word length interaction showed that the three and four letter zig zag words were reacted to more slowly ($p<0.01$) than the normally presented three and four letter words. There was no significant difference in reaction times between the two letter zigzag and normal words. Analysis of the group by word length interaction showed that the New Zealanders did not show a significant word length effect, there being no significant differences in reaction times between two, three and four letter words in either the zigzag or the normal presentation. The Scottish children did show a significant word length effect. Two letter words were reacted to the fastest by the Scots, followed by the three letter words, and the four letter words took the longest to react to across both normal and zigzag conditions. Thus the Scots showed a word length effect while the New Zealanders did not.

The main result of the reaction time data would seem to indicate that our hypothesis that the Scottish children would be slower reading normally presented words, due to reading phonetically, was upheld, as the Scottish children show a word length effect. The hypothesis that the Scottish children would be faster than the New Zealand children at the zigzagged presentation was not upheld though. The hypothesis that the visual distortion of word shape would lead to letter by letter reading in the New Zealanders would not appear to have been confirmed as there was no word length effect for the New Zealand children. The idea of Seymour and Elder (1986) that a visual approach to reading may depend on features like word length and salient letter cues, which are not changed with zigzagging, would appear to be vindicated by the lack of a word length effect and the absence of any reaction time difference between distorted and normal words for the New Zealand subjects.

The reaction time data were correlated with the accuracy data to see if the subjects who recognised the most words were the fastest readers as well. The results of this analysis are in Table 7.4 below:

Table 7.4

Correlations of reaction times with accuracy scores by word size

Scottish groups	2 letter	3 letter	4 letter
Normal words	-0.43**	-0.45**	-0.32
Zigzag words	-0.24	-0.40**	-0.06

* p<0.05 ** p<0.01

New Zealand groups	2 letter	3 letter	4 letter
Normal words	-0.02	0.04	-0.48**
Zigzag words	-0.18	-0.03	-0.45**

The most accurate readers in the Scottish sample for the two and three letter words were generally the fastest in both the normal and zigzag conditions. This did not appear to be true of the four letter word conditions, where speed did not correlate highly with accuracy. In the New Zealand samples the opposite appeared to be true, with the two and three letter accurate readers not necessarily being the most rapid but that those who scored highly on the four letter words were generally the most accurate in that category. This makes sense as far as the four letter words are concerned if one accepts that the New Zealand children are reading visually, but it does not explain why there are no significant correlations for the two and three letter words if they are also being read visually.

The reaction time results were also correlated with the same measures that were correlated with the accuracy data in Table 7.2 above. The results of this analysis are shown in Table 7.5 below. There is a similar, if somewhat reduced, pattern of correlations here as was found with the accuracy data. The New Zealanders who are the fastest are those who are good at BAS word reading and at irregular word reading (and in the case of normal word stimuli at nonword reading as well!).

Table 7.5 Correlations of reaction times with other measures

Normal words

Scottish groups	BAS words	Rosner test	Nonword naming	Irregular word naming
2 letter words	-0.24	-0.04	-0.20	-0.14
3 letter words	-0.32	-0.19	-0.09	0.01
4 letter words	-0.31	-0.10	-0.05	0.01

Normal words

New Zealand groups	BAS words	Rosner test	Nonword naming	Irregular word naming
2 letter words	-0.20	-0.20	-0.43**	-0.21
3 letter words	-0.34*	-0.19	-0.29	-0.27
4 letter words	-0.46**	-0.17	-0.38*	-0.41**

* $p<0.05$ ** $p<0.01$

Zigzag words

Scottish groups	BAS words	Rosner test	Nonword naming	Irregular word naming
2 letter words	-0.42**	-0.16	-0.14	0.00
3 letter words	-0.27	-0.12	-0.20	0.09
4 letter words	-0.07	0.16	0.06	0.23

* $p<0.05$ ** $p<0.01$

Zigzag words

New Zealand groups	BAS words	Rosner test	Nonword naming	Irregular word naming
2 letter words	-0.19	-0.16	-0.23	-0.05
3 letter words	-0.23	-0.06	-0.03	0.04
4 letter words	-0.44**	-0.14	-0.26	-0.39*

* $p<0.05$ ** $p<0.01$

The Scottish children who are fastest at reading the stimuli generally exhibit a small trend (which is non significant) towards being good at the BAS and not much else. This is then more evidence that the New Zealanders are unaffected by visual distortions but seem to be relying on a visual strategy for reading.

Discussion

The results from visually distorting words in our experiment would seem to run counter to our original hypotheses. The New Zealand "visual" readers would seem to be less affected by word shape distortion than the Scottish "phonic" readers.

We saw from our review of the role of word shape in skilled reading that there is still great controversy over the role of word shape in reading. What we did conclude though was that word shape does play some role in reading but that it does not have an overwhelming role and that it is used in conjunction with many other features to aid word recognition. Therefore it is not surprising that all of the children in the experiment still manage to read some of the words despite the severe distortion (the lowest mean score was 54% correct in the zigzag condition). The New Zealand year 1 children scored especially highly in the normal condition, which would indicate that they knew their reading scheme pool of words extremely well. This is one of the characteristics of visual reading that Seymour and Elder (1986) showed in their study. Their visual readers did not know many words but the words they did know were drawn from a taught set and seemed to be overlearned. This overlearning may have accounted for a lot of the accuracy differences between the Scots and New Zealanders. However one of the tenets of this study is the concept that both national groups were matched for word recognition. This was achieved using standardised word reading tests which test breadth of reading knowledge. The New Zealanders we have matched with the Scots in the year 1 sample would thus appear to have the same breadth of knowledge as the Scots as they are equivalent on the BAS word reading test, but additionally they have an advantage in reading familiar words from their reading scheme books. Method of instruction may have to be taken into account in experimental situations in the future where a reading match is of great importance.

The lack of a word length effect in the reaction time data of the New Zealand samples, and the absence of slowed reaction times to zigzag words, would indicate that they are pursuing a fundamentally different reading strategy from the Scottish children for both normal and distorted words. Seymour and Elder (1986) found that their subjects did not show a word length effect and they ascribed this to the children reading visually. The New Zealand readers in this study who are successful at reading the distorted words would also seem to be those who are more successful at the visual aspects of reading such as recognising irregular words. How can this dichotomy be explained? Seymour and Elder also found that their "logographic" readers were not seriously affected by word shape distortions. They hypothesised that the visual reader identifies words on the basis of length, salient letters and the position of the salient letters. All of these features are relatively unaffected by word shape distortion. This idea would appear to receive support from the results here. If the New Zealanders read all words in that way then success at this task will correlate with ordinary word reading as well as irregular word reading. It should not however correlate with nonword reading, as those words would not have the familiar features of known words. This was the picture shown by the correlational analysis.

Distortion of word shape affected all the groups to the same extent in terms of decreased accuracy, but it was only the Scots who were affected in reaction time by distorted words. The Scottish children, we hypothesised, should have been quite fast at reading in a letter by letter fashion due to their experience of phonics teaching and so should have been less disrupted by word distortion. This may have been a flawed hypothesis since the phonics teaching the Scottish children receive in fact very rarely encourages letter by letter decoding. The emphasis for the Scottish children was on letter clusters and how to blend them together. This was especially true of longer words, where letter by letter blending would result in only a very approximate analogy to the correct answer. The Scots were particularly slow at reading the four letter words, which had a number of consonant and vowel blends that were broken up by zig-zagging (e.g. shop, look). If the Scots do rely on blending these clusters to read, then a condition which breaks them up would be expected to produce increased reaction times.

Therefore, the word length effect in the reaction time data for the Scots and their slow performance with zigzag words may indicate that they do not rely on letter by letter decoding to read words but on the recognition of some higher unit like consonant and vowel clusters (e.g. oa, sc, ch) to read words.

Therefore this experiment has shown that word shape distortions may have more effect on readers who read phonetically than readers who use a more visual approach. This apparent contradiction suggests that visual readers rely less on word shape and more on other features of words, and that phonetic readers are not letter by letter readers but may rely on the identification of vowel and consonant clusters for blending.

Chapter 8-Phonological awareness and instructional technique

"If there's no meaning in it," said the king "that saves a world of trouble, you know, as we needn't try to find any."

Phonological awareness has been described as the cognitive ability to consciously categorise similar sounds and manipulate phonemes in spoken language (Stanovich 1986). It is demonstrated by successful performance on tasks such as tapping out the number of sounds in words, reversing the sounds in words, deleting the sounds in words and putting together isolated sounds to make up words (Wagner and Torgesen 1987). There is a very large body of research concerned with the relationship between phonological awareness and reading development (See Wagner and Torgesen 1987, Goswami and Bryant 1990 and Adams 1990 for reviews).

It was noted in Chapter 5 that the Scottish and the New Zealand children had different levels of phonological skill available to them to deal with tasks like lexical decision and nonword naming. Are these differences also reflected in different levels of phonological awareness? Do the different instructional regimes produce differing levels of this awareness? The interest in phonological awareness dates back to the 1970's. It was proposed that with an alphabetic system which builds language from the phoneme level, the acquisition of literacy may be dependant on an explicit understanding of the role of phonemes in words. The alphabetic system would not otherwise make sense to the child (Rozin and Gleitman 1977, Liberman and Shankweiler 1979). The beginning reader was seen as having two basic facts to learn - printed symbols depict units of speech, and the unit of speech that is represented is the phoneme.

Explicit phonological knowledge was also seen to be crucial in enabling the child to use the phonological reading route hypothesised in the Dual Route model of reading which was prevalent at the time (Coltheart 1978). This phonological route has come to be seen as an important component in theories of how children begin to read (e.g. Marsh et al 1981, Frith 1985, Stuart and Coltheart 1988, Seymour and Evans 1992, Byrne 1992). This led indirectly to the belief that the child who does not have good phonological skills will experience difficulties in learning to read (Coltheart 1983).

Early studies of the relationship between phonological awareness and learning to read seemed to confirm this belief. Liberman, Shankweiler, Liberman, Fowler and Fischer (1977) reported that the poorer readers in their sample of second grade readers had done badly at a test of phonemic awareness the year before. All the good readers in their sample, however, had done well at the same test, which involved tapping out the number of phonemes in a word, the year before.

Fox and Routh (1975) claimed to have demonstrated that phonological awareness began to develop before schooling and reading instruction had began. They said a number of simple experimental words to pre-school children and asked them to segment the words so that they would only say "just a little bit" of them. They found that even three year olds could segment at least some of the words into initial and final sounds and that by age five the children could identify the first and last sounds in at least half of the words presented. Fox and Routh (1980) went on to conclude that phonological awareness was an important factor in learning to read by showing that children's ability in reading correlated highly with their performance in tasks which involved segmenting syllables into phonemes. They suggested that phonological awareness might have some sort of predictive validity in terms of reading acquisition.

Share, Jorm, Maclean and Mathews (1984) tested children at school entry on their ability to segment words into their constituent phonemes. The test scores correlated very highly with reading achievement in kindergarten (0.66) and first grade (0.62). Mann and Liberman (1984) conducted a longitudinal study to investigate the connection between phonological awareness and reading ability. Phonological awareness was assessed in May of the kindergarten year with a task requiring the children to tap out the number of syllables in words they listened to. Sixty two children were tested and their reading achievement was measured one year later. There was a significant correlation between how the children did in the syllable tapping and their reading skill (0.4). Mann (1984) followed the previous study up with more similar longitudinal work. Children in their kindergarten year were given both a syllable task and a phoneme reversal task to carry out. A year later the same children were tested on word recognition and word attack skills. Contrary to Mann and Liberman (1984), the syllable task did not correlate with reading ability but the phoneme reversal task correlated very highly indeed (0.75) with reading ability. Wagner and Torgesen (1987) re-analysed this data taking into account the IQ of the children. The correlation between the phoneme reversal task and reading ability remained the same.

Lundberg, Olofsson and Wall (1980) also carried out a longitudinal study of the relationship between phonological awareness and subsequent reading skill. They used a number of different tasks to measure phonological awareness. They measured the 143 Swedish children's ability to segment and blend syllables and phonemes, their ability to determine when a target phoneme was located in a word, their ability to reverse phonemes and their skill at rhyme in kindergarten (which is at age 7 in Sweden). Twelve and eighteen months after the phonological tests were administered (i.e. in first and second grade), the children were given tests of reading and spelling. Lundberg et al found that the tasks that required analysis of phonemes, as compared to syllabic analysis, were more strongly predictive of reading ability. They found that skill at reversing the order of phonemes had path coefficients of 0.56 and 0.40 for the first and second grade reading. To a lesser degree rhyming ability (with path coefficients of 0.19 and 0.14) was also a predictor of reading skill. Lundberg et al claimed that these results showed that phonological awareness had a strong causal role in reading development. These correlational results have been replicated in many other studies (e.g. Bradley and Bryant 1983, Bryant, Maclean, Bradley and Crossland 1990, Kirtley, Bryant, Maclean and Bradley 1989, Stuart and Coltheart 1988, Vellutino and Scanlon 1987).

These longitudinal studies have not been received without criticism, however. It has been claimed that many of the studies did not take into account the pre-school reading skills of the children involved (Wagner and Torgesen 1987). Early reading skills are to be expected in these studies since kindergarten education (especially in the United States) introduces very basic reading skills before the children actually begin formal education. If pre-schoolers had some reading ability then the phonemic awareness skills could be the result of early reading development. Any predictive effect of phonological awareness could in fact be due to a correlation between pre-school reading and first grade reading. Mann and Liberman (1984) and Mann (1984) did not measure pre-reading skills in their samples.

Wagner and Torgesen (1987) implemented a re-analysis of the Lundberg at al (1980) data, taking as a covariate the kindergarten reading skills of the children before they did the phonological awareness tasks. Lunbergs' nine significant correlation coefficients dropped to non significant levels in all but two cases. Differences in original levels of reading proficiency did seem to be responsible for the relationship between phonological awareness and reading acquisition.

A more complex appreciation of the relationship between phonological awareness and reading acquisition began to emerge throughout the 1980's. Bradley and Bryant (1983, 1985) contributed greatly to the understanding of the relationship with their longitudinal and training studies. They hypothesised, using the correlational results from their 1983 study, that if training in phonological awareness can be shown to improve success in early reading then it could be supposed that phonological awareness has a causal role in reading. Bradley and Bryant (1985) studied 65 children who had been poor at a test of phonological skills in the 1983 study. The 65 children were allocated to one of four training groups. Groups 1 and 2 received phonological training in rhyme and alliteration but group 2 also received training in letter sound relationships. Group 3 received control training in conceptual categorisation and Group 4 did not receive any training at all. Two years of training revealed that rhyme and alliteration training only did not have an effect on later reading skills independent of variables like intelligence. It was only group 2 who had rhyme and alliteration training in combination with letter sounds who showed any significant improvements and lasting effects.

Ehri (1989) argued that the Bradley and Bryant (1985) study did not show that training in phonological awareness on its own has any advantage when it comes to reading. The real difference between the groups was attributable to the teaching of letter sound correspondences. Ehri pointed out that preliterate children may acquire a familiar knowledge of letter names and sounds which may be enough for them to develop rudimentary phonological awareness skills. Before school entry children may be exposed to activities in the home like looking at books, playing rhyming games and writing simple words which may actually increase phonological sensitivity. Phonological awareness would develop through exposure to pre-school print. Hatcher, Hulme and Ellis (1994), in a training study similar to that of Bradley and Bryant (1985), also found that phonemic awareness skill only enhances reading skill if it is in conjunction with training about letter sounds.

Lundberg, Frost and Peterson (1988), however, trained preliterate children with very limited letter name knowledge in phonological awareness skills without the use of letters. These children and a control group were given reading and spelling tests in first and second grade. The training group outperformed the control group in spelling in first grade and reading and spelling in the second grade. Unfortunately, as some of the children did know some letter names and sounds prior to their training, Lundberg et al's (1988) claim that phonological awareness training can help reading acquisition without letter training cannot be seen to be conclusive.

Byrne and Fielding-Barnsley (1989) reported, contrary to Ehri (1989), that pre-schoolers with no knowledge of reading or the sounds of individual letters were not able to reach criterion on a word naming task when only taught letter sounds. The group that was taught letter sounds and phonological segmentation skills, however, did reach criterion levels of performance. Ball and Blackman (1991) trained two groups of kindergarten children in letter sound correspondences. One of the groups also received phonological segmentation training as well and this was the group that showed significant gains in spelling and reading performance. Byrne (1992), in a review of his work, concluded that the relationship between phonological awareness and reading acquisition was of a special sort. He thought that phonemic awareness was necessary but not sufficient for reading, letter sound knowledge was needed in addition to it.

With the realisation that there is no simple unidirectional pathway from phonological awareness to reading or vice versa, many authors have come to the conclusion that a lot of the complex results found in phonological awareness testing may be due to the fact that some phonological awareness tests measure different aspects of phonological awareness from others. This leads on to the idea that there may be different levels of phonological awareness in children.

Morais, Alegria and Content (1987) proposed that phonological awareness can be thought of at three different levels:

1) Awareness of phonological strings
   the ability to ignore meaning and to concentrate upon the phonological aspects of speech

2) Phonetic awareness

the awareness of speech as a sequence of phonetic segments or phones, which is highly influenced by perceptual or articulator properties

3) Phonemic awareness

a more abstract awareness of speech as a sequence of phonemes which is achieved by disregarding irrelevant phonetic variations and can be influenced by orthography

Morais et al hypothesised that different measures of phonological awareness test different levels of skill. Tests of rhyming would measure performance at level 1. Level 2 would be assessed by phoneme tapping and "odd one out" type tasks while phoneme deletion would provide an indicator of level 3 abilities. Interaction effects are predicted from this model in that while phonemic awareness would depend upon exposure to alphabetic script, phonetic awareness could in some cases precede learning to read.

This interactionist viewpoint is consistent with the evidence that children show little evidence of possessing any great phonemic segmentation skill before they learn to read. Bruce (1964), in a now classic experiment, showed that children with a mental age of seven years and less performed poorly on a task requiring the deletion of phonemes from spoken words. Morais, Cary, Alegria and Bertelson (1979) compared a group of illiterate adults with a group of ex-illiterates in Portugal. They hypothesised that if reading helps promote phonological awareness than there should be a sharp difference in ability between both groups. The experimenter's gave both groups two tasks. One was to add a sound to a word and the other was to subtract a sound from a word. They used both real words and nonsense words. The people in the illiterate group could manage some of the words in the addition task (illiterates 46% correct compared to 91% correct for the ex-illiterates for real words) but were particularly bad at the deletion task and with nonsense words in general (illiterates 19% correct in nonsense word deletion compared to 71% for ex-illiterates). These results appeared to confirm Morais et al's hypothesis that reading instruction accounts for a lot of the development of phonological awareness. It should be noted, however, that the illiterates did have some ability to segment words into their constituent parts.

A number of problems have been noted with this study though (Goswami and Bryant 1990, Wagner and Torgesen 1987). The literates and illiterates may have been self selected to a certain degree and so could be said to be atypical subjects. Goswami and Bryant (1990) claim that the real problem of the illiterates could be to do with the concept of nonsense words per se and not with phonological awareness. This would seem unlikely, as in the deletion task the illiterates still only scored 26% on the real word stimuli compared to the 19% correct in the nonsense word stimuli. The Morais et al (1979) results have been replicated by a number of other researchers (e.g. Marcel

1980, Byrne and Ledez 1983, Liberman, Rubin, Duques and Carlisle 1988).

Morais, Claytens, Alegria and Content (1986a) followed up their original research by replicating the 1979 results on more illiterates whilst also demonstrating that there was no difference between illiterates and ex-illiterates in a musical segmentation task. Bertelson, DeGelder, Tfouri and Morais (1989) studied illiterate Brazilian adults and reported that their performance at consonant deletion was at floor level whereas ex-illiterates had very little difficulty with the task.

Morais, Content, Bertelson, Cary and Kolinsky (1988) did show, however, that there are ways to help illiterates in phonological tasks. The subjects were given a deletion task but were also given feedback on the correct answers to each problem. The scores became much higher (69% in a phoneme deletion task) but still not quite as high as that of the literates. This jump in performance may have been due to adult levels of intelligence, motivation, and communication skills present in the illiterates which may not necessarily be present in young children.

Other studies have tried to get around these problems with adult illiterates by comparing subjects who are literate in either an alphabetic or non-alphabetic script. Read, Zhing, Nie and Ding (1986) compared readers who knew only the traditional Chinese logographic script with readers who knew only the alphabetic pinyin script. They were both given a consonant deletion task, and those taught in the logographic script were similar in performance to the Morais illiterates, whereas the alphabetic group resembled the ex-illiterates. Read et al concluded that it was not learning to read per se that promoted phonological awareness but that it was learning to read in an alphabetic script that made the difference.

Mann (1986) compared the phonological awareness of American and Japanese school children in grades one through four. The Japanese learn two types of script, kanji, which is logographic, and kana, in which each symbol represents a syllable. The Japanese children should then be less skilled at phonemic tasks than the Americans. This is indeed what Mann found in the younger Japanese children which is consistent with the idea that experience with an alphabetic script can promote phonological awareness. The older Japanese children did, however, show comparable levels of phonological awareness with the Americans but this was probably due to the long term benefits of using a syllabic script which encourages paying attention to the sounds in words.

Ehri and Wilce (1980) showed that the phonological awareness of nine and ten year old children was influenced by knowledge of the spelling and reading system. When these children were given phonologically similar but orthographically different words (e.g. pitch and rich) they tended to ascribe more phonemes to the longer words. The children were more likely to make such mistakes if they knew how to spell the word correctly. Tunmer and Nesdale (1985) confirmed the Ehri and Wilce results by asking six year olds to tap out the number of sounds in real words and nonwords. Some of the words contained digraphs which represented single phonemes (e.g. book) others did not (e.g. man). They predicted correctly that children would overestimate the sounds in the words with digraphs.

The above studies have shown that phonological awareness and reading are interlinked in some way and that the start of the formal teaching of reading has a large influence on these two interrelated factors. Alegria, Pignot and Morais (1982) tried to show *how* teaching reading may influence the development of phonological skills. They examined the effects of phonics and whole word methods of reading instruction upon phonological awareness in two groups of six year olds. Both groups were in first grade and had received about four months of instruction in reading. The children had to demonstrate their ability to segment a word into either phonemes or syllables in the first task. The second task was more difficult and involved reversing the order of syllables in disyllabic words or nonwords and reversing the order of phonemes in monosyllabic polyphonemic words or nonwords.

The results indicated that there was no difference in the first task of syllable or phoneme segmentation between the two groups. There was a very interesting interaction in the second task, reversing phonemes and syllables however. On the syllable reversal task the two groups performed similarly, with the phonics taught class scoring 73.5%

correct and the whole word taught class scoring 67.5% correct. This was not a significant difference. By contrast the phoneme reversal data showed a massive difference between the two groups. The phonics groups was correct on average 58.3% of the time while the whole word group could only manage a poor average of 15.4% correct, a difference five times larger than that of the syllable reversal task.

Morais et al concluded that the awareness of phonetic segments is dependant on the nature of the instructional method and that the phonic method will lead to better scores in segmentation tasks, at least during the first few months of reading instruction. This conclusion was reinforced by the correlation of estimated reading ability with performance on the phonological tests. The phonics group's reading skills correlated highly with performance on the reversal tasks (0.65) while the whole word group's did not (0.11).

The conclusions of Morais et al do have to be examined with a measure of caution however. The two groups were not matched on reading ability (for the correlational analyses, reading ability was assessed by the class teacher on a five point scale for each individual). We have seen already that reading ability has a strong correlation with phonological awareness. The differences in performance may reflect the better reading skills of the phonics group rather than a more developed level of phonological awareness.

Stuart-Hamilton (1986) looked at the effect of phonological awareness on how children read words. He studied 20 matched pairs of children who had the same word recognition ability and were of the same age but who had different levels of phonological awareness. He then studied the errors that those with and without phonological awareness made when reading words. He used the Biemiller (1970) error scheme to evaluate the children's reading strategies. Those children with little or no phonological awareness made many more refusal type errors than those who did posses phonological awareness. The phonologically aware children made 54% graphemic errors compared to 46% non-graphemic errors while the phonologically unaware made 39% graphemic errors compared to 61% non-graphemic errors. These differences were significant.

The present study detailed here therefore investigates the effects of different reading instruction on the phonological awareness skills of children of matched reading ability. As in Morais et al (1982), two tasks were given to the children, one to test simple phonological awareness and the other to test complex phonological awareness. It was hypothesised that the Scottish groups should be better at both measures of phonological awareness than the New Zealanders due to the explicit instruction they receive in school about the phonemic structure of language. As in the many other studies detailed above there should be a strong correlation between success at reading and performance at the two phonological awareness tasks. The correlations should be smaller for the New Zealanders as they are assumed to rely less on sound information based strategies for reading. However, if phonological awareness precedes reading then there should still be evidence of a strong relationship between reading and skill at these two tasks that is independent of instructional technique. Older children are also hypothesised to do better than younger children due to the interaction of growing reading skills with phonological awareness. There should be strong age correlations of performance at the two tasks across both nationalities.

Following on from Stuart-Hamilton's (1986) study it should be found that the group with the expected higher phonological skills (i.e. the Scottish groups) should show positive correlations between ability on the phonological tasks and phonological type errors in reading and nonword reading ability. The hypothesised group with the lower phonological skills should show more refusal type errors in reading than the higher phonological skill group.

Yopp Singer Phoneme Segmentation Test

Subjects

These were the same four groups used in the BAS Reading test match, except for two New Zealand children from the Year 1 age groups who were absent on the day of the test. Therefore there were 18 Scottish children and 15 New Zealand children in the Year 1 age groups, and 23 Scottish and 24 New Zealand children in the Year 2 age groups. Neither the reading match nor any of the other matches were affected by this small change (See chapter 3 for details of matching).

Design

This is a test which measures the ability to articulate the sounds (phonemes) of a word separately in the correct order. An awareness that words are made up of individual sounds is called Phonological Awareness. There are various levels of this awareness. A child who knows that two words can rhyme and therefore have a sound in common but cannot tell you what that sound is, is phonologically aware to a basic degree, while the child that can take out the 'c' in "score" to make "sore" is a lot more advanced in understanding how sounds make up words.

The test word list is contained in appendix 7a. The word list was devised by Yopp (1988) with consideration for word familiarity and feature commonality. All words occurred at least one hundred times per million (very frequent) using Thorndike and Lodge's norms. The feature analysis criterion was based on an analysis of component sounds. All commonly occurring places and manners of articulation of English language consonants were represented on the list, as well as all heights and locations of vowels.

Yopp (1988) claims the test has a very high reliability coefficient (Chronbachs Alpha=0.95) and that it was significantly correlated to a criterion nonword learning test ($r=+0.67$, $p<0.01$). The test should therefore have a good predictive value for reading and spelling achievement.

Yopp also reported that the test gave the highest loading on what she described as simple phonemic awareness i.e. the knowledge that words are made up of phonemes like "sh", "ch", "a", "b", "ee" for example (It should be remembered that we are referring purely to sounds here, not the letters that map onto the sounds, for illiterates can be taught to do this task without ever knowing how to read, e.g. Morais et al 1979. The test does not show that the children can use this knowledge but simply that they are aware of phonemes).

It is hypothesised that a teaching regime in which letter sounds within words are emphasised, and where children are encouraged to be aware of them, is more likely, to lead to higher levels of phonological awareness. The Scottish samples were predicted to do better at this test than the New Zealand samples. Older children should also do better than younger children at this test due to the influence of exposure to print and reading instruction.

Procedure

The child was told at the beginning of the test that they were going to hear a word and that they had to say all the sounds that were in the word. Three examples were then worked through with the child, "ride", "go" and "man".

Only words that the child responded to accurately on their own were scored as correct. Scores had a possible range from zero to twenty-two.

The test took approximately three to four minutes to administer.

Results

The mean number of correct answers given by each of the four groups is shown in Table 8.1 below:

Table 8.1 Mean correct answers for the Yopp (1988) Phoneme Segmentation task.
(Standard deviations in brackets)

	Year 1	Year 2
Scotland	16.333	16.348
	(4.14)	(3.24)
New Zealand	15.933	12.292
	(5.09)	(4.69)

The five to six year olds that Yopp tested scored an average of 12 correct on the test.

An analysis of variance was carried out on the scores with Group (Scotland versus New Zealand) and age (Year 1 versus Year 2) as the between subjects factors. There was a significant effect of Group ($F(1,76)=5.22$, $p<0.05$) but not of Age ($F(1,76)=3.46$, $p>0.05$) nor of the interaction of Group by Age ($F(1,76)=3.52$, $p>0.05$). The Scottish children overall were better at the task than the New Zealand children.

The results then would appear to uphold the hypothesis that those taught in a phonics rich environment may have a greater gasp of phonemic awareness. The lack of an effect of age on the task though is a strange result as one would expect the skill at this task to grow with increasing awareness of words and how they are made up of sounds.

Yopp found that performance on her test correlated significantly with reading performance. The results shown below in table 8.2 show that this was not the case with word reading for the groups tested here:

Table 8.2 Correlation of Yopp-Singer task with BAS word reading scores

	Year 1	Year 2
Scotland	0.42	0.37
New Zealand	-0.06	-0.06

The Scottish groups correlation's were significant at the 0.1 level but not to any stricter criterion, due most likely to the small amount of subjects in each cell. (It would appear from these results that the Scottish groups word reading may be tied in somehow with the ability to segment words into their constituent parts since their correlational data is just below significance level. The New Zealand groups word reading would appear to be totally unconnected with this skill. This may be evidence that the Scottish and New Zealand groups are pursuing fundamentally different word reading strategies in their first two years at school.)

The ability of the four groups at the nonword naming task was correlated with the Yopp Singer task and the results of these tests can be seen in Table 8.3 below:

Table 8.3 Correlation of Yopp singer task with Nonword Naming

	Year 1	Year 2
Scotland	0.26	0.52*
New Zealand	0.32	0.29

* $p<0.05$

Here, as in the BAS correlational data shown previously, there appears to be only very limited non-significant evidence in favour of a relationship between nonword naming and performance on the Yopp task. There is only one significant correlation and that is for the year 2 Scottish sample. There is a slight trend in the New Zealand data which may indicate a small positive relationship between nonword naming and phoneme segmentation. However this is only a slender hope considering the small size of the correlations. The underlying skills tapped in the Yopp task do not underpin the New Zealand children's reading skills. In fact the same could be said about the majority of the Scottish children, particularly in the Year 1 sample who showed no significant correlations between reading nonwords, real words and the Yopp task.

Stuart-Hamilton (1986) showed that the group with the higher phonological awareness was the group with the lowest amount of refusal errors in a reading test. This study confirms those results as the Scottish sample produced fewer refusal errors than the New Zealanders in the BAS and nonword reading tests.

The pattern of correlations found when the results from the phoneme segmentation test were correlated with the amount of error types produced on the BAS word reading test was quite strange. These correlation's are shown in table 8.4 below:

Table 8.4 Correlation of Yopp Singer task with error types from BAS word reading test.

Year 1

	Error Type				
	nonword	real word	in set	out of set	refusals
Scotland	0.27	0.25	0.12	0.29	-0.31
New Zealand	-0.16	-0.77**	-0.69**	-0.33	0.67**

Year 2

	Error Type				
	nonword	real word	in set	out of set	refusals
Scotland	0.37	-0.47*	-0.25	0.26	0.09
New Zealand	0.13	0.14	-0.04	0.16	-0.16

* p<0.05 ** p<0.01

The Scottish children in Year 1 show correlations in the expected direction but they are not significant between the errors associated with success in reading (e.g. nonword errors, out of set errors) and phoneme segmentation. This trend is apparent (but still non-significant)in year 2 as well. The New Zealanders in Year 1, however, show an unexpected positive correlation of performance at phoneme segmentation with the amount of refusal errors produced. They also show strong negative correlations of the Yopp Singer results with those errors types not associated with success at word reading (i.e. real word errors and in set errors). It would appear that in year 1, at least, the New Zealand children who can segment words into phonemes are those who choose not to answer when presented with a strange word to read. This may imply that the New Zealand children have the rudiments of a phonological strategy in Year 1 but have neither the confidence nor the training to implement their knowledge. By year 2, the relationship between the phoneme segmentation task and the errors associated with reading performance appears to reduce to chance levels. The opportunity to transfer phoneme segmentation knowledge to help reading seems to have dwindled in the Year 2 New Zealanders. This may be a consequence of receiving no positive feedback about sounding out words or paying attention to the sounds of words in New Zealand reading instruction.

The Rosner Test of Auditory Analysis Skills

Subjects

As for the Yopp-Singer Phoneme Segmentation task.

Design

This is a test of what Yopp (1988) described as compound phonemic awareness. That is, the ability to manipulate the sounds in words. This test was rated most difficult by Yopp in her study of ten phonological awareness tests. It involves the child picking out the relevant phoneme then reassembling the word without that phoneme. This is, as Adams (1991) describes, a feat of memory "gymnastics" for the young child. Performance on such phoneme deletion tasks, as they are called, have yielded strong correlations with reading skill in a large number of studies (Lundberg et al 1980, Mann 1984, Rosner 1971, Calfee 1973, Alegria et al 1982, Yopp 1988). Adams (1991) comments that such a task is generally found to be "beyond the reach of children before the very end of first grade",(equivalent to primary 2 in terms of chronological age). The test also has a quite high reliability coefficient (Chronbachs Alpha = 0.78)

As in the Phoneme segmentation task, it is hypothesised that the children in Scotland will do better at this task as they receive more tuition which emphasises sounds in words.

d in appendix 7b.
th syllable and phoneme
takes a few minutes to
mple syllable elisions from
ine" and progresses to more
ng a syllable from a multi-
phoneme from the beginning
ere are 15 items; 2 training
ildren are given similar
following this model: "Say
word. "Now say 'play' again
cts score was the number of
core of 13. If the child was
ses then testing was stopped

orrect on the Rosner test for
overleaf in Table 8.5:
verage score for the age of
about five or six items
dren in our samples are
vel for their age.
carried out on these scores
rs, Group (Scotland and New
d Year 2). There was no
(F(1,76)=1.15, p>0.05) or

Table 8.5 Mean correct answers on Rosner Test

(Standard Deviations in brackets)

	Year 1	Year 2
Scotland	6.056	5.391
	(3.94)	(3.65)
New Zealand	5.75	7.522
	(3.92)	(3.61)

of Age (F>1). The interaction of Group by Age was also non-significant ($F(1,76)=2.04$, $p>0.05$). Therefore, the hypotheses that the Scottish children would do better at the Rosner test, and that the older Year 2 children would score better than the Year 1 children, were not realised.

With the mean scores ranging from five to seven items correct this shows that the majority of the children can segment words into syllables (tested in items 1-3) and remove the first sound in a simple word to make another word (tested in items 4-6). Some children can also remove the final sound from a word successfully. Most of the children, though, cannot split consonant blends at the beginning of words.

If we look at the relationship between skill at the Rosner task and skill at word reading we can see a stronger relationship than was observed between reading and phoneme segmentation. The correlation's between the scores on the Rosner test and scores for the BAS test are shown in Table 8.6 overleaf.

Table 8.6 Correlation of Rosner task with BAS word reading scores

	Year 1	Year 2
Scotland	0.57**	0.33
New Zealand	0.41	0.32

** $p<0.01$

The New Zealand groups results on the Rosner task do not correlate significantly with BAS performance but they are showing much more of a positive relationship with phoneme deletion than they did with phoneme segmentation. Yopp (1988) found that the Rosner test, which was indicative of what she called compound phonemic awareness, was more strongly related to subjects' performance in a reading task than the phoneme segmentation Yopp Singer task which was a measure of simple phoneme awareness. This is probably because the Rosner task is much more dependant on the child having available complex memory and orthographic skills which can probably only be acquired once someone has actually begun to read. Therefore, it is much more likely to be associated with successful reading than more simple tests and therefore phoneme deletion is more likely to be a product of learning to read.

Yopp (1988) found that the Rosner test did not correlate particularly highly with the Yopp Singer test, and concluded that they appeared to be measuring two different aspects of phonological awareness. The correlation between the Rosner test and the Yopp singer test was also low (R(77)=0.216, p>0.05) in the data presented here.

The correlations of performance on the Rosner test with nonword naming are shown in table 8.7 below:

Table 8.7 Correlation of Rosner task with Nonword Naming

	Year 1	Year 2
Scotland	0.43	0.34
New Zealand	0.44	0.55**

** p<0.01

These correlations are stronger than those displayed by the phoneme segmentation task but not by a large margin. In fact the New Zealanders display the only significant correlation of skill at the Rosner task with nonword reading. The Scottish children may not display a very large correlation because they were relatively much more successful at nonword naming than the New Zealanders, therefore any relationship between the nonword naming and the Rosner task may be clouded by ceiling effects.

There were no significant correlations for either nationality between performance on the Rosner task and the types of errors the children made in word reading. There were also no significant correlations between the Rosner results and the age of the children.

Discussion

The two national groups differ in simple phonological segmentation skills (The Yopp test) and so this would seem to confirm the belief that phonics reading instruction can have an effect on the level of phonological ability. However, it should be noted that this means that phoneme segmentability differs between the groups but that word recognition skill still does not. Furthermore, simple phonological segmentation skill did not correlate to any great degree with word reading attainment. This result would appear to be strange considering the Morais et al (1982) study as one would predict that those children subject to a phonics regime would show a significant relationship between phonological awareness and reading skill. The conclusions of Wagner and Torgesen (1987) that "Measures of phonological awareness would thus be better predictors of performance in reading programmes that emphasise a phonics approach than of performance in reading programmes that primarily use a whole word approach" (Wagner and Torgesen 1987, p.208) is not borne out. Tunmer and Nesdale (1985) found that children who had been taught by a phonics regime showed better reading skills than those taught by a whole word regime but that there were no significant differences in phonological segmentation skills between the groups. Phonological segmentation in that study, as in this study, would appear not to be contributing a great deal to the level of reading attainment. This leads to the conclusion that many of the children in this sample do not need a high level of phonological awareness skill to succeed at reading appropriately for their age, regardless of how they are taught to read.

Phonological awareness appears to be more closely linked to how the children read. The level of skill at the Yopp task correlated with the type of reading errors that were most numerous in the Scots children, i.e. Type 7 errors. This may be an indication that simple phonological awareness is associated with GPC skill. There was also evidence of an association between phonological skill and nonword reading, but not with word reading, in the New Zealand sample. This would appear to provide further grounds for assuming that phonological awareness has something to do with GPC processes. The idea that phonological awareness and GPC skill are interlinked is also supported by a number of researchers (e.g. Juel, Griffith and Gough 1986, Stanovich, Cunningham and Feeman 1984, Tunmer 1989, Tunmer and Nesdale 1985, Byrne 1992, Stuart and Masterton 1992, Ehri 1994).

No group differences were found in the Rosner task, which was assumed to be a measure of more complex phonological awareness. It is generally agreed by researchers that this complex level of awareness can only develop after a long exposure to reading (Goswami and Bryant 1990, Adams 1990, Byrne 1992). The results of this task would deem to conform to this view. The instruction that the Scots children received in phonics would not seem to have made a difference on this task compared to the New Zealanders. The skill level at this task is relatively low compared to the skill levels displayed on the Yopp phonological awareness task.

It is strange that there was very little evidence of age related differences in the two phonological awareness tasks. This would seem to contradict the view that instruction affects the level of phonological skill as it would be expected that older children would be more adept at these tests since they have received more instruction in reading. Adams (1990) has pointed out that simple phonological awareness develops more rapidly once reading instruction begins but that more complex phonological awareness takes a lot more time to develop and that tasks like the Rosner " are normally beyond the reach of children before the very end of first grade" (Adams 1990, p.72).

Frith (1985) proposes that the "appearance of phoneme awareness" (Frith 1985, p.308) is one of the main reasons for a child's transition to alphabetic reading. Yet if instruction can affect the level of phonological segmentation skills one can surmise that instruction must also indirectly affect the acquisition of the alphabetic stage. How can stage theories accommodate results which would appear to show that groups matched on reading skill show a different level of a measure of phonological awareness? This would mean that either phonological awareness is not a main motivator of alphabetic reading or that readers can exist at different stages in their theory despite having the same level of development.

So, in conclusion, there is some evidence that the phonics approach enhances simple phonological segmentation skills (as measured by the Yopp task) but not more complex measures of phonological awareness (as measured by the Rosner task) in these age groups. However, if more complex phonological awareness depends on a grasp of the simpler level of awareness then the Scots should ultimately have an advantage over the New Zealand children. However, any future advantage may just be an indicator of good word recognition skill rather than an aid to good word recognition skill.

Chapter 9-Spelling and reading development

"Mine is a long and sad tale!" said the Mouse.

"It is a long tail, certainly," said Alice;

"but why do you call it sad?"

Research into spelling has been a sadly neglected area in the study of literacy development in comparison to the detailed study of reading over the last three decades. This situation is rapidly changing with more researchers now taking the time to look at spelling and its sub-skills (See Brown 1990 for a review). This is particularly true in relation to the complex relationship between early reading and spelling ability which is now being investigated. It has recently been claimed that reading skill and spelling skill are closely interlinked (Adams 1990) and that spelling skill may in fact help reading skill to develop (Ehri 1987, 1989).

The recent history of research into spelling has been dominated, as in reading research, by a dual route view of adult spelling that the developing child must strive to attain (e.g. Ellis 1982). It is claimed that in the adult speller there are two different aspects of word production that are essential for spelling competence. One of these involves the phonological relationships between sounds and letters and the other involves a dictionary-like store of whole word representations or lexical codes in memory (See Frith's 1980 book "Cognitive processes in spelling" for a detailed coverage of this area). Ehri (1987) took this idea further and pointed out that in order to grasp the phonological relationship between sounds and letters, the letters themselves must be well known and that there must be a working knowledge of how the spelling system operates. Knowing about the spelling system knowledge means knowing about phoneme to grapheme relationships and how to segment pronunciations into phonemes. A sufficient lexical code can then develop based upon the sequence of letters in specific words and knowing how these letters symbolise phonemes in the word. All these parts working together allow the skilled adult speller to remember the spellings of irregular and exception words and recall them instantly, and allow the adult to generate good attempts at spelling if the word is not instantly retrievable.

To spell a word utilising these sources of information a skilled speller would first consult their lexical knowledge to check if the particular word is in memory. If not, they can generate a viable spelling by using their letter and spelling system knowledge. The spelling can then be checked by decoding and reading it. The reading of the spelled word can possibly trigger hidden lexical knowledge and allow the spelling to be corrected.

This is very similar to the dual route model of reading in that if a word is not instantly recalled from a lexicon then it will be generated by a kind of reverse decoding procedure. As with the dual route model of reading, the dualist approach to spelling has not been without criticism or posited alternatives (Campbell 1983, Adams 1990, Perfetti

1992, Waters, Bruck and Seidenberg 1985). The dual route assumptions about adult skilled spelling have survived relatively intact despite this but this is more likely due to the paucity of research in this area rather than the merits of the dualist approach.

Spelling Errors and Spelling Development

Children do take some time to develop spelling skills. The process of learning about the spelling system, learning about letters and building up a lexicon is quite slow (Ehri 1987). The systematic study of spelling errors has shed some light on this development, however, and allows us to see children's growing awareness of the spelling system. Foremost in this field have been Read (1986), Perfetti et al (1987), Morris and Perney (1984) and Ehri (1987, 1989). By analysing errors they claim that a more or less common pattern of spelling development has been detected.

Spelling development according to these researchers passes through a number of set stages which can all be identified by particular types of error. The first stage is usually called precommunicative, the next stage semiphonetic, then the phonetic and the final stage is the transitional or morphemic stage. After this spelling is mainly correct.

In the precommunicative stage children's spelling consists of seemingly random letters that usually bear no relation to the sounds in words.

The next stage, semiphonetic spelling begins after children have learned the names or sounds of some letters. They try to spell words using their limited knowledge of these letters. Only one or two letters may correspond to the sounds in the word. Later on in this stage the first or final consonant may be produced correctly. This shows that although the child's spelling does not really conform to conventions the choice of letters is becoming logical and that the child is attempting to work out the correct rules of spelling. Ehri (1987) reported that the same words were spelt differently across two tests at this stage. This would seem to show that memory for correct spelling is unstable at this stage.

In the phonetic stage children are able to produce spellings that contain letters for all the sounds in words. Vowels begin to be produced in noticeable amounts for the first time in this stage. Long vowels are also attempted in this stage but are usually represented only by their letter name. In this stage children presume that every sound they detect in a word requires a letter in the spelling.

The final stage before correct spelling is the transitional stage. Here the child begins to show an awareness that spelling is not merely a matter of converting graphemes to phonemes but also involves learning about orthographic structures and rules. Long vowels may be marked in some way but not necessarily the correct way, for example "made - maad". Morris and Perney (1984) noted that the transitional stage appears at the end of the first year or the start of the second year at school. As in the field of word recognition this structured, universal, stage theory of how children learn to spell has been criticised. A stage model of spelling development carries the same implicit assumptions and disregard for outside factors as the reading theories do.

Frith's model of spelling and reading

Many studies have found high correlations between reading skill and spelling skill in children (Ehri 1987, 1989, Juel 1988, Waters et al 1985). Spelling skill develops as reading skill develops (Adams 1990). Various researchers have put forward theories to try and explain how this happens. Frith (1985) developed a theory of spelling development which she combined with her reading theory (See chapter 2 for a full discussion of this model). Spelling is said to develop in three stages, like reading, although their emergence does not necessarily coincide with the stages in reading development (See Figure 2.1). First is the logographic approach to spelling where only known words can be spelt. Then the alphabetic approach is adopted (initially only in spelling: only when the skill is well developed do alphabetic skills appear in reading). Orthographic spelling strategies develop after orthographic reading has developed.

This disjunction of reading and spelling would appear to be supported by recent evidence. Bradley and Bryant (1979) and Bryant and Bradley (1980) gave six and seven year olds lists of words to read and to write on different occasions. There were words that they could read and spell but other words they could only read and strangely words they could spell but not read.

There was a clear and consistent difference in the types of words which children could read but not spell and which they could spell but not read. Read but not spelt words were like "light", "train", "egg", which are not very easy to sound out. This suggests that the children use letter sound relations to spell these items but not to read them i.e. they are logographic readers. This would then seem to show a striking difference in the way children read and spell.

This apparent differentiation has been criticised recently by Perfetti (1992). He claimed that he was only able to find a very small percentage of words that subjects could spell but not read and that these errors could be understood as misreadings rather than failures of access. He also points out that the Bryant and Bradley (1980) result was altered by task demands, in that the children could read the unread words in a pseudoword list. Therefore, since there was no consistency in the children's performance the unread words could have been actually misread due to a momentary lapse in response to a difficult situation. The Bryant and Bradley evidence also depends on the children reading logographically, and evidence against the existence of this approach to reading was pointed out in Chapter 2.

Gough, Juel and Griffith (1992) took up the idea that the apparent difference between reading and spelling may be due to inconsistency rather than a difference in strategy. They asked twenty beginning readers to read and spell the same 28 words on four separate occasions. They found a similar level of unread but spelled words to Bryant and Bradley's level. However when they examined the data in more detail they also found the same level of errors between reading the list on one occasion and reading it on the other and the same level of errors between spelling the list on one occasion and spelling it on another. They concluded that beginning readers read and spell in the same way but that "they simply do so inconsistently" (Gough, Juel and Griffith 1992, p. 46).

Evidence for a logographic stage in spelling is also weak. Any strategy of this sort must rely on memory for specific sequences of letters. This will allow a rudimentary lexical store to be built up and would be difficult to distinguish from an orthographic approach.

Farnham-Diggory and Simon (1975) tried to show that visual memory is important in spelling. They reasoned that if this was true then if you have just seen a word you will be in a better position to spell it, as the visual image will still be fresh. So children were either shown ten written words briefly or heard them letter by letter. They then had to spell the words. The children did spell more visually presented words correctly. However Henderson and Chard (1980) pointed out that in the visual presentation condition the words were given as "wholes", while in auditory presentation the word was split up. They claimed therefore that the Farnham-Diggory and Simon (1975) results were invalid because words could be identified more easily in the visual condition.

Evidence for an alphabetic or phonological strategy in spelling is a lot harder to refute however. Walters, Bruck and Seidenberg (1985) and others like Doctor, Antorie and Scholnich (1989) found that children made many more mistakes when writing ambiguous and exception words than when writing unambiguous words. Ambiguous words were found to be no harder to read than other words but the children often mis-spelt words in a way that could be correct in other words with the same sound. Treiman (1984) found that third and fourth grade children were better at spelling regular and nonsense words than exception words. She also found that ability at spelling nonsense words correlated significantly with the ability to spell regular words but not with exception words. The better spellers were those who were getting more of the regular and nonsense words correct. It was also noted that the correlation between spelling and what she termed sound-spelling rule use was stronger than the correlation between reading and sound spelling rule use.

Children are affected considerably by concurrent vocalisation when spelling and writing (Bradley and Bryant 1983) so suggesting underlying phonological processes in spelling. However, when the children use a logographic script like Japanese Kanji where there is no phonological code to disrupt (Kimura and Bryant 1983) then concurrent articulation has no effect on performance.

The evidence for Frith's theory of spelling development is therefore very weak. There would appear not to be a case for an initial logographic strategy in spelling. The idea of an alphabetic strategy though does appear more helpful. The question then becomes, when does this alphabetic strategy emerge and how does it relate to the orthographic knowledge that must be acquired to make a good speller? The child cannot spell by using phonology alone in a,language such as English.

Spelling and phonological awareness

Some authors have suggested that young spellers use phonology from the very beginning to help them spell words (Adams 1990, Waters et al 1985, Perfetti 1992, Stuart and Masterton 1992). The child's phonological skills are seen as helping them to spell words at all stages of spelling development and in fact carry on in a predominant role even when they are skilled spellers. This does not mean that the child only relies on phonology (accurate spelling would be very difficult if this were the case) but rather that orthographic knowledge may grow in parallel and supplements the phonological strategies available (Adams 1990).

The intimate link that spelling ability seems to have with phonological awareness is cited as the main evidence for this viewpoint. Stuart and Masterton (1992) found that spelling ability at age ten was predicted by pre-school measures of phonological awareness. Those with high phonological awareness scores in the pre-school also made more of what they termed phonetic type errors than those with low phonological awareness scores. The ten year old spellers were, of course, well past the invented spelling stages discussed earlier in this chapter and were quite skilled.

Lundberg, Frost and Peterson (1988) found that subjects trained in phonological awareness for a year before school were ahead of control groups in spelling after seven months of school. Juel, Griffith and Gough (1986) found in a longitudinal study of children in first and second grade that those with high phonological awareness scores made more phonetic errors than those with lower phonological scores. They also reported that scores on the Bryant test of decoding skills correlated highly with scores on a spelling subtest of the Wide Range Achievement Test. Liberman, Rubin, Duques and Carlisle (1985) and Morris (1981) (as cited in Adams 1990) also found that spelling development was predicted by levels of phonological awareness. This is all strong evidence that children's spelling is strongly influenced by phonetic skills. The way that they spell would seem to be determined by the nature of their phonological awareness.

The reliance on phonology when spelling, as predicted by phonological awareness, is claimed by Ehri (1989) to aid memory for correct spelling. Phonetic spellers have a better memory for correct spellings over prephonetic spellers, Ehri claims, because "knowledge of the spelling system provides schemata that enable spellers to make phonetic sense of individual spellings and hence remember them" (Ehri 1989, p.358). Most words in English are phonetically regular and even most letters in irregular words are phonetically regular (e.g. SWORD). If the spelling system is known this makes remembering them easier. The few letters that are exceptions become easier to remember as they are rare.

The relationship between phonological awareness and spelling is not wholly one sided. There is evidence that increased spelling knowledge influences perceptions of the phonology of words. Ehri (1989) claims that when a spelling system is learned "....it penetrates the child's phonological knowledge in a fundamental way and influences the sounds they believe are in words." (Ehri 1989 p.359). She cites her work (Ehri 1984, 1985, 1987, Ehri and Wilce 1980, 1986, Ehri, Wilce and Taylor 1987) to illustrate this. Ehri and Wilce (1980) showed that children who know how the words 'pitch' and 'rich' are spelt, think they know how many sounds are in the word. The children segmented pitch into four sounds /p//i//t//ch/, which is correct. However they segmented rich into only three sounds /r//i//ch/, missing out the /t/ which is present but not spelt. The spelling does not draw attention to the /t/ sound. The children it seemed, "were analysing words into segments suggested by their spellings." (Ehri 1989 p.359).

The same findings were uncovered in nonword spelling. More sounds were allocated to words with longer spellings generally. It was not simply that sounds were allocated to each single letter as digraphs like /sh/ were not split.

Read (1986) showed that beginning spellers were actually sometimes more accurate phonetically than skilled spellers in segmenting words. Treiman (1985) also found that beginners spelt consonant blends more accurately phonetically than skilled spellers. Learning the spellings of words would seem to influence the perception of sounds in words.

It would appear that spelling and phonological awareness have an important and interactive relationship with one another. It was also reported in previous chapters that there would appear to be a similar relationship between reading and phonological awareness. So do reading, spelling and phonological awareness all affect one another?

Spelling and reading ability

The correlation's between reading and spelling ability are very high in children. For example, Gough et al (1992) reported that Griffith (1987) found a correlation of 0.83 between reading and spelling in the first grades and 0.84 for third graders. So what is the relationship between these two skills?

In a study of pre-school readers in 1966 Durkin observed that in many of the children writing skills seemed to develop before reading skills. She commented that the "ability to read seemed almost like a by product of [the] ability to print and spell" (p. 137). Henderson (1980) reasoned that spelling ability was a skill that contributed significantly to reading development because the same underlying developing word knowledge underpins children's ability to both read and spell. Morris and Perney (1984) hypothesised that if this was the case then an insight into children's reading development could be gained by analysing spelling strategies. They selected 75 first graders and administered an 18 word spelling test to them after 3 weeks at school and after 4 months at school. The spellings were scored according to phonetic quality and stage of development based on the spelling patterns identified by Read (1975). Most of the children produced incorrect spellings (89%) that were in the precommunicative, semiphonetic or phonetic error categories. These spellings however were found to be highly correlated with a subsequent reading test administered after 9 months at school (r=0.68 for the spelling test after 3 weeks and r=0.82 for the spelling test administered after 4 months). The children's knowledge of spelling seemed to be predictive of later reading skill. However, since no measure of reading skill was taken at school entry, there is no way of knowing whether reading or spelling ability developed first. Mann, Tobin and Wilson (1987) replicated the Morris and Perney findings and again showed that the phonetic level of spelling skill had a predictive value in relation to reading development.

Juel, Griffith and Gough (1986), in a longitudinal study of children in first and second grade, concluded that spelling and word recognition depended on the same underlying sources of knowledge- cipher knowledge (sound spelling rules) and lexical knowledge. They found using path analysis that the total R^2 accounted by cipher and lexical knowledge was 0.75 in word recognition and 0.72 for spelling. Waters, Bruck and Seidenberg (1985) showed regularity effects in third graders when they read and spelled the same words. They concluded from this that reading and spelling have the same underlying dependence on sound spelling rules. The children did show a slight difference in the kind of regularity effect shown in reading and spelling. In the both tasks there were two types of regular word. One type had only one possible legal spelling the other type had more than one possible legal spelling. The greatest regularity effect in spelling was for the regular words with only one legal spelling. There was no difference between these two types of regular word on the reading task. Adams (1990) proposed that reading and spelling are both directly dependant on an orthographic processor and that spelling is an output channel from this and reading is an input channel. Perfetti (1992) also takes this view and agreed that both reading and spelling are both served by a single representation system. A natural consequence of this idea would be that attending or learning a word's spelling should strengthen a child's ability not only to write a word but to read it.

Ehri and Wilce (1987) conducted a training study to determine the contribution that spelling skill makes to reading. They taught one group of kindergarteners to spell phonemically transparent syllables while they taught another to match letters to isolated phonemes. The spelling group learned 147 nonsense syllables to perfection and the letter sound group learned 436 letter responses to isolated phonemes. The nonsense syllables were made up of the same phonemes from the letter matching group. After this the children were given a series of post-tests. In two of these tests it was shown that those taught to spell could recognise the spellings of the training syllables better than the letter sounds only children. The third post-test demonstrated that the spelling group did better on a phoneme segmentation task. The fourth test involved the children reading twelve untrained monosyllabic words which were made up of novel combinations of the trained phonemes. The spelling group read more words than the letter sound group. Thus spelling training seemed to improve beginners ability to read words.

Ehri (1989) pointed out that in the Bradley and Bryant studies (1983, 1985) that teaching phonemic awareness by itself did not facilitate learning to read. It was only the group that received phonemic awareness training plus training in how to spell words and to recognise common letters that outperformed control groups on later tests of reading. Ehri explains this phenomenon by claiming that teaching children to spell phonetically will improve their knowledge of the spelling system. This knowledge helps them to recode unfamiliar words to spell. It also helps them in reverse through application of the same basic principles to decode words they read. Connections are formed between the spellings and pronunciations of words in memory. They are able to recognise what letters correspond to what sounds.

"They can probe the pronunciation to find sounds suggested by letters in spellings when the sounds are ambiguous or hard to detect" (p. 359 Ehri 1989)

Eventually associations between pronunciations and entire spellings become complete in memory and so confusion's in reading similar spellings of words are minimised. Therefore, novice spellers who begin to spell phonetically find it easier to learn how to phonologically recode and decode because spelling instruction "teaches most elements of recoding except blending" (Ehri 1989 p.359). Adams (1990) also hypothesises that spelling which involves recoding sound to print information is:

"..essentially a process of phonics."

(p. 397, Adams 1990)

Spelling and Instruction

There has been very little research into the effectiveness of how to teach spelling in the classroom. Brown (1990) in a recent review of the area commented that most evidence from researchers has been anecdotal rather than statistical in form. Adams (1990) reports a rare careful study of spelling instruction by Clarke (1989) in her book "Beginning to Read". Clarke looked at first grade classrooms which either encouraged traditional correct spelling from their children or invented spelling. The invented spelling technique grew out of the theory that spelling develops in the distinct stages described by Read (1986) and others and discussed earlier in this chapter. Gentry (1981, 1982a, 1982b) pioneered the early work on invented spelling. The invented spelling approach promotes spelling through writing prose. In this prose misspellings are ignored under the assumption that children will learn to correct themselves because they will mature through the immutable stages of spelling development. Formal instruction is seen as non-productive because the children will develop spelling competence at their own pace. Clarke describes this methodology in the classroom as follows:

> "Teachers circulated throughout the classroom encouraging effort, discussing ideas....Teachers did not spell. Children were told to sound out the words and print the letters they heard. The teachers emphasised that children were not always going to be right in their letter choice, but that that did not matter just now."
>
> (Clarke 1989 cited in Adams 1990 p.383)

Whereas in the traditional classroom the children were taught very differently:

> "They immediately got out their dictionaries or personal word lists. As soon as they wanted to write a word they were not sure of, they searched for the spelling.... Teachers printed words on the

chalkboard, on the children's story pages, or on their personal word lists, as well as spelled words aloud while children printed the letters...."

(Clarke 1989 cited in Adams 1990 p.383)

Clarke reported that the invented spelling classrooms produced, as expected, more spelling errors in a study of writing samples but that their stories were much longer than those of the traditional spelling classes. The traditional spelling classes wrote with a degree more complexity in their vocabulary and grammar but with much shorter stories. On a test of spelling both the invented spelling and traditional spelling classes had difficulty with high and low frequency irregular words but the invented spelling group was better at spelling both high and low frequency regular words. Clarke also looked at the relationship between spelling and reading in the classroom. She matched the high performers in spelling and speeded word recognition from the traditional classes with the high performers from the invented spelling classes. The same procedure was repeated for the low performers in each class. No differences in reading lists of words of both high and low frequency, regular and irregular were found between the high performers. The low performers did differ in their accomplishments at the word reading tests. The readers from the invented spelling classes were better at reading high and low frequency regular words and at reading nonwords than the children from the traditional spelling classes. This would appear to be evidence for a positive feedback into reading from the promotion of phonetic spelling.

Thompson and Fletcher-Flinn (1993), however, reported that knowledge of phoneme to grapheme correspondences in spelling was lower than grapheme to phoneme knowledge in reading in a study of New Zealand children who had received invented spelling tutoring. These results are not consistent with the viewpoint that invented spelling helps with reading.

The Scots children in our sample received phonics reading instruction with a traditional spelling approach plus a small amount of invented spelling. We have already seen that they are better at nonword naming than the New Zealanders and have a tendency to produce regularisations in their reading. The New Zealanders were taught by a language experience approach in reading but were dominated by the invented spelling approach to writing.

We can hypothesise that if reading instruction and spelling instruction do interact then the Scots will produce more regularisation errors than the New Zealanders and show a bigger advantage for accurate spelling of regular words and nonwords than the New Zealanders. If reading instruction does not interact with spelling performance then the New Zealanders should show more regularisations and a bigger advantage for regular words and nonwords due to their invented spelling practice than the Scots, who receive more traditional spelling instruction.

These hypotheses need to be tempered with the realisation that there will most likely be a very high correlation between reading and spelling words across both nationalities. Since the groups are all matched on word recognition then this may mean that any differences that are present may only be found in a detailed error analysis rather than in terms of items correct. We can also hypothesise that if phonological awareness does play a role in spelling development then correlations with aspects of spelling performance should be high in both the Scottish and New Zealand samples.

Method

Subjects

These were the same four groups used in the BAS Reading test match. Therefore, there were 18 Scottish children and 17 New Zealand children in the Year 1 age groups and 23 Scottish and 24 New Zealand children in the Year 2 age groups (See Chapter 3 for details of matching).

Materials

These consisted of 20 monosyllabic words. These were ten regular and ten irregular words classified according to Venesky's (1970) analysis. These words were known to produce a regularity effect when pronounced by children (Holligan and Johnston 1988, 1991). Half of the items in each category were high in word frequency and the other half low in word frequency according to Carroll et al's (1971) Grade 3 norms (The full list of items is in Appendix 8).

The mean word frequencies of the stimuli were: regular words - 303.6 (high frequency), 26.8 (low frequency); irregular words - 452 (high frequency), 27.2 (low frequency).

Procedure

The stimuli were presented in random order. The children were told that they were going to spell some words and should listen carefully. The experimenter read aloud each word once then included it in a sentence and repeated the word again on its own. To guarantee the child had heard the word, he or she was asked to repeat it before writing it down. The test was conducted at the child's own pace. Testing was conducted in quiet conditions individually. The test was in a single session and lasted about 10 minutes.

Results

The data were expressed in terms of percent correct for each category of word and these results are shown overleaf in Table 9.1.

An analysis of variance was carried out on these data with two between subjects factors, Group (Scotland and New Zealand) and Age (Year 1 and Year 2) and two within subjects factors, Frequency (High and Low) and Regularity (Irregular and Regular). There was no main effect of Group, ($F<1$) or of Age ($F<1$). There was also no main effect of Regularity

Table 9.1 Mean % correct in each category

(Standard Deviations in brackets)

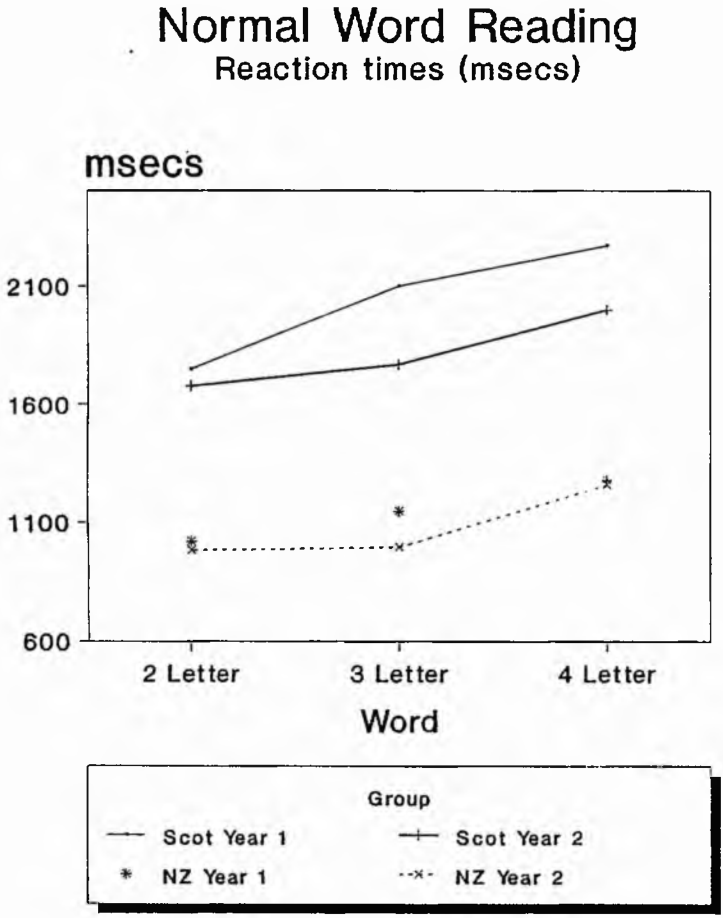
Year 1

	High Frequency		Low Frequency	
	regular	irregular	regular	irregular
Scotland	12.11	12.83	16.50	14.66
	(15.89)	(20.05)	(20.40)	(16.87)
New Zealand	14.16	17.64	3.53	5.88
	(18.39)	(15.62)	(10.57)	(11.75)

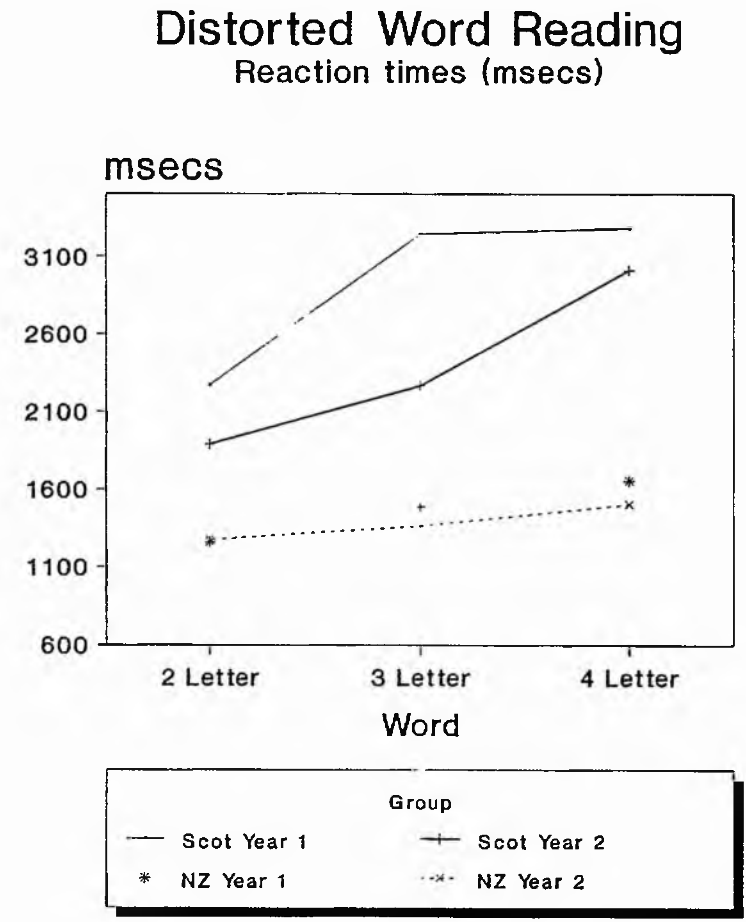
Year 2

	High Frequency		Low Frequency	
	regular	irregular	regular	irregular
Scotland	21.74	20.0	9.56	8.69
	(21.66)	(20.88)	(13.30)	(13.24)
New Zealand	27.5	24.16	0.83	4.16
	(20.27)	(21.24)	(4.08)	(8.29)

($F<1$), but there was an effect of Frequency ($F(1,78)=43.07$, $p<0.01$). There were also significant interactions of Group by Frequency ($F(1,78)=15.51$, $p<0.01$) (see Graph 9.1)and of Age by Frequency ($F(1,78)=16.88$, $p<0.01$) (see Graph 9.2). No other interactions were significant. A Newman-Keuls post hoc test on the interaction of Age by Frequency showed that the Year 2 children correctly spelled more ($p<0.01$) high frequency words than the Year 1 children but that there was no difference in the amount of low frequency words spelled


Normal Word Reading
Reaction times (msecs)
msecs
2100
1600
1100
600
2 Letter
3 Letter
4 Letter
Word
Group
Scot Year 1
Scot Year 2
NZ Year 1
NZ Year 2

Graph 7.3


Distorted Word Reading
Reaction times (msecs)
msecs
3100
2600
2100
1600
1100
600
2 Letter
3 Letter
4 Letter
Word
Group
Scot Year 1
Scot Year 2
NZ Year 1
NZ Year 2

Graph 7.4

correctly by the two age groups. Post hoc Newman Keuls testing on the interaction of Group by Frequency found that the Scottish children spelled correctly significantly more ($p<0.01$) low frequency words than the New Zealand children. There was no significant difference in the amount of high frequency words spelt correctly by the Scots and New Zealanders.

None of the groups showed a regularity effect in their spelling. This would appear to indicate that the child is more influenced by whether they have seen a word before rather than whether they can sound it out. The Scots spelt more low frequency words correctly than the New Zealanders but their percentage scores in reality only meant a consistent difference of one item. This could be due to a word that was introduced to the children in Scotland but not in New Zealand. The older age groups performed better than the younger groups in high frequency words but again this difference was to the extent of only one item different. Therefore, we can conclude from the low scores evident in all the groups that the test words were rather difficult for them to spell at this stage in their educational and spelling development.

High correlations between reading and spelling ability are very often found in children of this age group and this study was no exception. The correlation's between reading ability (as measured by the BAS test) and spelling ability are shown in Table 9.2.

Table 9.2 Correlation's between BAS scores and correct spelling of High and Low frequency words.

	Scottish BAS scores	New Zealand BAS scores
High Frequency	0.533**	0.495**
Low Frequency	0.212	0.183

** p<0.01

High frequency word spelling ability was highly correlated with reading while low frequency word spelling was not. The better readers are likely to know more words than the poorer readers so that common high frequency spelling patterns would be much more easily recalled by a good reader. The good reader uses their knowledge of words to help them also spell it and vice versa. The frequency difference might also be explained if we remember that the amount of children getting many of the low frequency items correct was quite low and there were quite a few zero scores. Correlational analysis of the relationship between high frequency word spelling ability and the type of errors produced by the children when reading brought to light some interesting differences between the Scots and New Zealanders.

The Scottish children's spelling skill correlates significantly with the production of phonetic errors (i.e. nonword or out of set errors) when reading words. The New Zealanders spelling skill did not correlate significantly

Table 9.3 Correlation's between high frequency word spelling and errors made on the BAS test.

	Scottish High frequency spelling	New Zealand High frequency spelling
Nonword errors	0.378*	0.213
Out of set errors	0.357*	0.203
Refusals	-0.312*	-0.060

* p<0.05

with phonetic errors made when reading despite correlating significantly with reading skill on the BAS.

It was also found that skill at spelling high frequency words was also correlated with skill at naming nonwords. This is shown in table 9.3.

Thus those who are good at a phonological reading task such as nonword naming are those who are generally good at spelling. Spelling skill is also generally thought to be

Table 9.4 Correlation between high frequency word spelling and nonword naming.

	Scottish nonword naming	New Zealand nonword naming
High frequency spelling	0.4004**	0.6262**

** p<0.01

correlated with phonemic awareness and the ability to identify sounds in words. In this study there were no significant correlation's between spelling skill and performance on the Yopp Singer phoneme segmentation test for any of the national groups. There were, however, correlations between performance on the high frequency spelling words and the Rosner test. These are shown in Table 9.5

Table 9.5 Correlation's between high frequency word spelling and performance at the Rosner task

	Scottish Rosner results	New Zealand Rosner results
High Frequency Word spelling	0.1665	0.4115**

** p<0.01

So in this case the New Zealand children who are good at spelling are seen to be also good at the Rosner task. This means that the better spellers in the New Zealand sample are those with more phonological awareness. This makes sense but contrasts with the earlier results that showed that the New Zealanders who are good at spelling do not produce phonological type errors. It is also surprising that the Scottish children did not show a relationship between phonological awareness and spelling ability considering that phonological errors did correlate with spelling ability. This data, however, is consistent with the data presented in the chapter on phonological awareness, which found a minimal relationship between reading skill and phonological awareness.

It was decided to look at the large body of spelling errors generated by the children to see if these revealed anything of interest that might relate to any of the results described so far.

Spelling Errors

An analysis was made of the spelling errors in order to determine whether there were any qualitative differences in the nature of the spellings made by the children in the two classes. In order to make this comparison Morris and Perney's (1984) spelling classification scheme was used. This scheme is compatible with Read (1986) and Beers and Henderson's (1977) observed stages in spelling development.

Spellings were classified as 'prephonetic', 'phonetic' 'Transitional' or 'correct'(See figure 9.1 for examples). If a random letter string was produced this would be classified as 'prephonetic' level 1. An error was 'prephonetic 2, if

Figure 9.1-spelling examples illustrating the scoring system

	Prephonetic levels		phonetic	transitional
word	1	2	3	4
wake	lea	wain	wak	waik
mail	rwl	mol	mal	mael

either the beginning consonant and/or final consonant was represented. Errors were classified as 'phonetic' if there was evidence that the child could 'sound his or her way through the word', representing the consonants and vowel segment, but being unable to represent the word according to the conventions of English spelling. Errors were classified as 'transitional' if they showed an emerging awareness of how to represent words according to English Orthography.

These scores were expressed as a proportion of the total errors for each child (see table 9.6 below for the means and standard deviations).

An analysis of variance was performed on these figures with two between subjects factors, Group (Scotland and New Zealand) and Age (Year 1 and Year 2) and with one within subjects factor, Error Type (Stage 1 to 4 Errors). There was no main effect of Group, ($F<1$) or of Age ($F<1$) but there was

Table 9.6 Mean % spelling errors

(Standard deviations in brackets)

Year 1

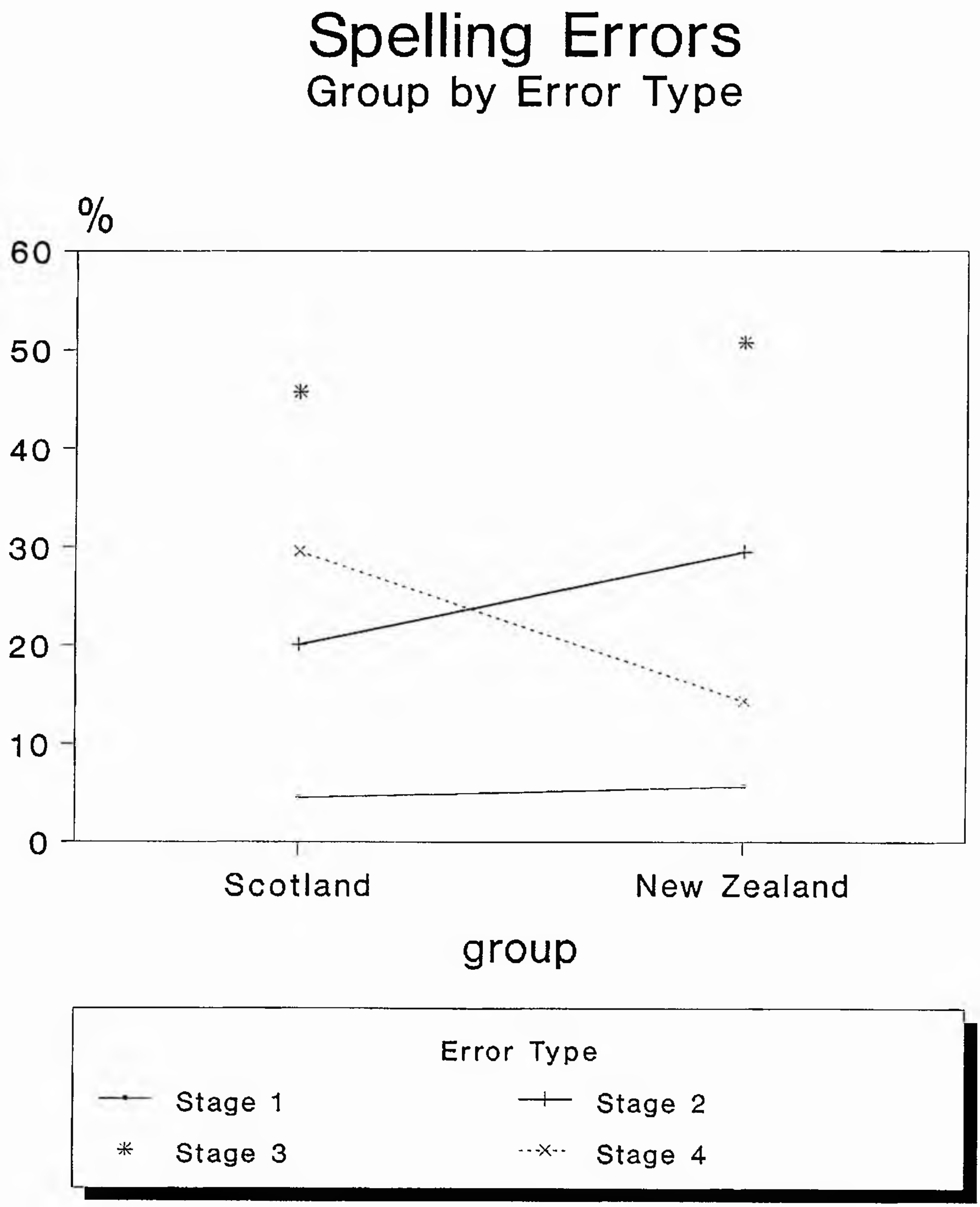
	Prephonetic levels		phonetic	transitional
	1	2	3	4
Scotland	6.15	29.84	36.16	27.82
	(8.17)	(20.85)	(19.43)	(24.10)
New Zealand	4.95	33.81	47.81	13.73
	(9.35)	(24.88)	(22.11)	(13.74)

Year 2

	Prephonetic levels		phonetic	transitional
	1	2	3	4
Scotland	2.98	10.32	55.37	31.28
	(8.43)	(12.17)	(21.78)	(24.63)
New Zealand	6.45	25.15	53.67	14.87
	(16.49)	(21.12)	(22.08)	(12.79)

an effect of Error Type ($F(3,234)=55.19$, $p<0.01$). There were also significant interactions of Group by Error Type ($F(3,234)=5.07$, $p<0.01$) and Age by Error Type ($F(3,234)=5.28$, $p<0.01$). No other interactions were significant.

Newman Keuls post hoc testing on the interaction of Group by Error Type (see Graph 9.3) revealed that the Scottish children produced significantly more ($p<0.01$) transitional Type 4 errors than the New Zealanders. The New Zealanders produced slightly more prephonetic Type 2 errors than the Scots but this difference was just outside the 5% significance criterion. There was no difference between the Groups in the amount of prephonetic Type 1 and phonetic Type 3 errors produced in the task. A Newman Keuls test on the interaction of Age by Error Type showed that the Year 2 groups produced significantly more ($p<0.01$) phonetic Type 3 errors than the Year 1 groups while the Year 1 groups produced significantly more ($p<0.01$) prephonetic Type 2 errors than the Year 2 groups. There was no difference


Spelling Errors
Group by Error Type
%
60
50
40
30
20
10
0
Scotland
New Zealand
group
Error Type
Stage 1
Stage 2
Stage 3
Stage 4

Graph 9.3

between the age groups in the amount of prephonetic Type 1 and transitional Type 4 errors produced.

It would seem therefore that the majority of the children in both countries are at the phonetic stage of spelling development, as assessed by the Morris and Perney scheme. This would explain why accuracy of spelling was so low for the task as most of the children are developmentally not ready to produce accurate spellings.

The only differences between samples were for the amount of prephonetic stage 2 and transitional stage 4 errors produced. The New Zealand sample produced more prephonetic stage 2 errors than the Scottish sample while the Scottish sample produced significantly more transitional stage 4 errors than the New Zealand sample. Therefore the Scottish sample would appear to be more advanced than the New Zealand sample in that they are producing more errors that show more knowledge of English orthography while the New Zealanders are producing more errors near the bottom end of the scale showing a non-phonetic approach. This result may explain why the Scots get more words correct in the spelling task - according to stage theory they are developmentally ahead of the New Zealanders.

The error type frequencies were correlated with the actual numbers of words spelt correctly and are shown in table 9.7 overleaf.

Table 9.7 Correlation's of Error types with number of high frequency and low frequency words spelt correctly.

Scottish Groups

	High Frequency	Low Frequency
prephonetic Stage 1 error	-0.16	0.13
Stage 2 error	-0.49**	-0.25
phonetic Stage 3 error	-0.28	-0.44**
transitional Stage 4 error	0.71**	0.55**

* p<0.05 ** p<0.01

New Zealand Groups

	High Frequency	Low Frequency
prephonetic Stage 1 error	-0.17	-0.13
Stage 2 error	-0.30	-0.23
phonetic Stage 3 error	0.19	0.07
transitional Stage 4 error	0.36*	0.40**

* p<0.05 ** p<0.01

Overall, better spelling is associated with transitional spelling errors. These results show that those who are good at spelling words correctly are more developmentally advanced than those who mis-spell badly. Spelling performance was therefore largely due to spelling skill and not chance individual knowledge of particular words.

The more advanced spelling error types also correlated significantly with word reading performance on the BAS test. This is shown in table 9.8 and confirms that the children

Table 9.8 Correlation's between spelling errors and BAS word reading

	Error Types			
	Prephonetic levels		phonetic	transitional
	1	2	3	4
Scottish				
BAS reading	-0.31	-0.65**	0.04	0.57**
New Zealand				
BAS reading	-0.12	-0.29	0.15	0.38*

* p<0.05 ** p<0.01

with the more mature spelling errors are also those who are good at reading.

There was a difference between the national groups in terms of the relationships between spelling errors and some of the types of reading error from the BAS test. This is shown in Table 9.9.

Table 9.9 Correlation's between spelling errors and reading errors from the BAS test.

Scottish sample

	Spelling Error Types			
	Prephonetic levels		phonetic	transitional
	1	2	3	4
Nonword error	-0.32	-0.54**	0.10	0.43**
Out of set error	-0.16	-0.50**	0.08	0.37*
Refusal error	0.02	0.33	-0.12	-0.11

New Zealand sample

	Spelling Error Types			
	Prephonetic levels		phonetic	transitional
	1	2	3	4
Nonword error	-0.19	-0.42**	0.55**	0.02
Out of set error	-0.24	-0.36*	0.49**	0.07
Refusal error	0.20	0.21	-0.41**	0.05

* $p<0.05$ ** $p<0.01$

Here we see that those New Zealand children who produce reading errors that correlate with reading skill are producing phonetic spelling errors. The Scottish children who are producing reading errors that correlate with reading skill are producing the more advanced transitional errors. Since reading skill correlates with spelling skill this may be further evidence that the New Zealanders are developmentally behind the Scottish children in terms of which error type they produce. These data also explain why the New Zealand childrens correct scores for the spelling test did not correlate with reading errors as much as the Scottish childrens.

In terms of a relationship of spelling development with phonological awareness, none of the error categories in any of the national groups had any significant correlation's with the Yopp singer test of phonological awareness. The New Zealanders did again show a relationship with the Rosner task though and this is illustrated in Table 9.10.

Table 9.10 Correlation's between spelling errors and the Rosner task

	Error Types			
	Prephonetic levels		phonetic	transitional
	1	2	3	4
Scottish				
Rosner results	-0.10	0.03	-0.28	0.27
New Zealand				
Rosner results	-0.22	-0.43**	0.37*	0.36*

* p<0.05 ** p<0.01

It can be seen that the better spellers in the New Zealand groups are those who are better at the Rosner task whereas this is not the case for the Scottish groups. This would indicate that the New Zealand spelling skills are more related to phonological awareness than the Scottish children. This would appear to run counter to intuition as the Scottish children receive instruction in letter sound relationships while the New Zealanders do not. The Scottish children do appear to be ahead in spelling development however and may rely more on the rule based instruction they receive in the classroom rather than having to apply more abstract phonological knowledge to spelling words as the New Zealanders may be doing. The New Zealand children rely more on the phonemic awareness skill they have derived for themselves, whereas with the Scottish children this is overlain by direct tuition in a phonological approach.

It would appear that most of the children in both groups are around the phonetic stage of spelling development and can only use simple sound spelling concepts. Since most words are therefore mis-spelt by the children, accuracy would be more affected by frequency than by regularity as the children cannot yet effectively apply orthographic rules to their spelling.

Non Word Spelling

It would appear from the data in the real word spelling task that the Scottish children do have an advantage at spelling which could arise from the phonic reading instruction that they receive. The Scots children produce more mature errors, which demonstrate greater knowledge of English orthography, than the New Zealand children. In order to correctly spell a nonword, explicit sound spelling knowledge must be exploited. Since the Scots children have shown an advantage over the New Zealanders at this in real word spelling it is hypothesised that the Scottish children will show superior performance at nonword spelling. This difference should be especially apparent in spelling nonwords with consonant digraphs and vowel clusters as these words require complex orthographic knowledge which the Scots learn about in their phonics instruction.

The percentage of words correctly spelled should be higher in this task than in the real word spelling task.

This is because a word spelled at stage 4 in this task, due to the regularity of the stimuli, will be correct.

Subjects

The two Year 2 groups who undertook the Real word spelling test were used in this task.

Materials

These consisted of 24 nonwords which varied in length from two letters to four letters. They were constructed by changing one letter of a word, taken from a set of twenty four real words, to make a nonword. These twenty four real words were all present within the first year reading programmes of both the Scottish and New Zealand samples (Thompson 1982, GINN 1988). The words were also high in frequency according to the Carroll et al (1971) Grade 3 norms. The mean frequency of the words was 412 (standard deviation 234). There were six two letter words, six three letter words and twelve four letter words.

The full set of nonwords is in appendix 8. The set of four letter words was divided into two sets. The first consisted of six nonwords with consonant blends, three words with blends at the beginning and three words with blends at the end. The second set consisted of six nonwords with complex vowel sounds, three words with vowel clusters in the middle and three words with long vowels.

Procedure

The stimuli were presented in random order. The children were told that they were going to hear and spell some made up words and that they should listen carefully. The experimenter read aloud each word three times. To guarantee the child had heard the word he or she was told to repeat it before being told to write it down as best as they could. The test was conducted at the child's own pace. Testing was conducted in quiet conditions individually. The test was in a single session and lasted about 10 minutes.

Results

The mean percentage of items that were correct for each sample are reproduced below in Table 9.11

Table 9.11 Mean percentage of nonwords correct by groups

Year 1

Scotland	59.4%	Standard Deviation 18.1
New Zealand	30.3%	Standard Deviation 10.9

Words were marked correct if the spelling that was produced conformed to any of the possible valid spellings using standard spelling sound rules. An analysis of variance was performed on the percentage correct data with one between subjects factor, Group (Scotland and New Zealand). A significant main effect was found for Group ($F(1,58)=35.89$ $p<0.01$). Therefore, despite being matched for word recognition ability, vocabulary knowledge, recall of digits, age, and time at school, the Scottish sample is better at spelling nonwords. Therefore the hypothesis that the Scottish children would be better at spelling nonwords was confirmed.

To evaluate this result fully we also need to look at the distribution of scores within the separate word categories that were included in the test. The Scottish sample may have a higher overall score simply because they are better at spelling only one of the categories of nonwords present in the test while the amount of correct items for the other categories may not vary between the two groups at all. The means for 2 letter, 3 letter and 4 letter nonwords are reproduced below (the 4 letter nonwords are split into nonwords with consonant blends and nonwords with complex vowel sounds).

Table 9.12 Mean percentage items correct by stimuli type. (Standard deviations in brackets)

	2 letter	3 letter	4 letter (blends)	4 letter (vowels)
Scotland	87.5	64.1	44.9	23.3
	(16.1)	(23.1)	(32.5)	(25.0)
New Zealand	47.8	40.9	25.7	6.2
	(23.2)	(22.5)	(24.5)	(9.5)

These data were subject to an analysis of variance with two between subjects factors, Group (Scotland and New Zealand) and one within subjects factor, Word Type (2 letter, 3 letter, 4 letter (blend) and 4 letter (vowel)). A main effect of Group was found, ($F(1,45)=42.3$, $p<0.01$) as was a main effect of Word Type, ($F(3,135)=47.2$, $p<0.01$). There were no significant interactions of any kind. The Scottish children were better than the New Zealand children at all the types nonword spelling. Of the four categories of nonwords the two letter nonwords were easier to spell than the three letter nonwords who in turn were easier to spell than the four letter nonwords with blends and these were easier to spell than the four letter nonword with vowels. Thus the superiority of the Scottish children was not just an artefact of being more accurate on only a proportion of the nonword types. The Scottish children thus showed more awareness of the orthographic rules of English spelling, with their superior performance at spelling words with consonant blends and complex vowel sound to spelling rules. The Scots' advantage in spelling would appear to have come from their formal phonics teaching in class, even if such teaching was intended originally for reading instruction.

This presumption would appear to be supported by the significant correlations of the amount correct in the nonword type categories with the overall amount correct (See Table 9.13 overleaf). Those in the Scottish sample who get most items correct are also those who score highly on the two 4 letter nonword types which require some orthographic knowledge (however it should be noted that the size of the New Zealand correlation of performance with 4 letter words with vowels will be influenced by the small number they scored correctly in this category).

Table 9.13 Correlation's of nonword types with total number of nonwords spelt correctly.

	Scotland	New Zealand
2 Letter word	-0.25	0.35
3 letter word	0.74**	0.64**
4 letter word (blends)	0.86**	0.66**
4 letter word (vowels)	0.77**	0.01

* $p<0.05$ ** $p<0.01$

There was a very interesting difference between the strength of the relationship between nonword spelling and performance at reading words and nonwords in the national groups. These correlation's are illustrated in Table 9.14 overleaf.

The New Zealand children's performance at the spelling task does not seem to be related to their ability to read the BAS real words but rather to their ability to read nonwords. The Scottish children whose spelling is good read both real words and nonwords well. This again is evidence that the New Zealanders use a different strategy when

Table 9.14 Correlation's of correct nonword spellings with reading words and nonwords

	Scotland		New Zealand	
	BAS words	Nonwords	BAS words	Nonwords
2 Letter word	-0.11	0.16	-0.08	0.25
3 letter word	0.34	0.36	0.36	0.34
4 letter word (blends)	0.82**	0.62**	0.03	0.72**
4 letter word (vowels)	0.55**	0.48**	-0.15	-0.15

* p<0.05 ** p<0.01

dealing with real words and nonwords in reading and spelling, whereas the Scottish children would appear to be able to handle both equally well.

New Zealand performance seems again, as in the real word spelling task, to be more related to phonological awareness than reading skill for nonword spelling. This is shown by the correlation's between the Rosner task results and nonword spelling in Table 9.15 overleaf.

The percentage correct rates across both national groups are much larger for nonword spelling than for the real word spelling in the previous section. This is probably because the nonwords are phonetically regular and conform to quite common spelling sound patterns. No regularity effect was found in the real word spelling study but in this task

Table 9.15 Correlation's between nonword spelling and the Rosner task

	Scotland Rosner Task	New Zealand Rosner Task
2 Letter word	-0.16	-0.35
3 letter word	0.02	-0.44*
4 letter word (blends)	-0.19	0.54**
4 letter word (vowels)	0.26	0.07

* p<0.05 ** p<0.01

the nonwords were derived from high frequency words so this may contribute to the higher scores. The other major factor that may contribute to the higher scores is the fact that some of the nonwords, especially the two and three letter nonwords, could be correctly spelt by someone who normally spells at stage 3 and almost definitely by someone who normally scores at stage 4, due to the phonetic regularity of the words. Therefore, since in the real word spelling task there was significantly more transitional spelling errors in the Scottish sample then there would likely be more correct spellings of nonwords for the Scottish sample than the New Zealanders. To investigate this the data were subjected to the Morris and Perney analysis detailed in the real word spelling task.

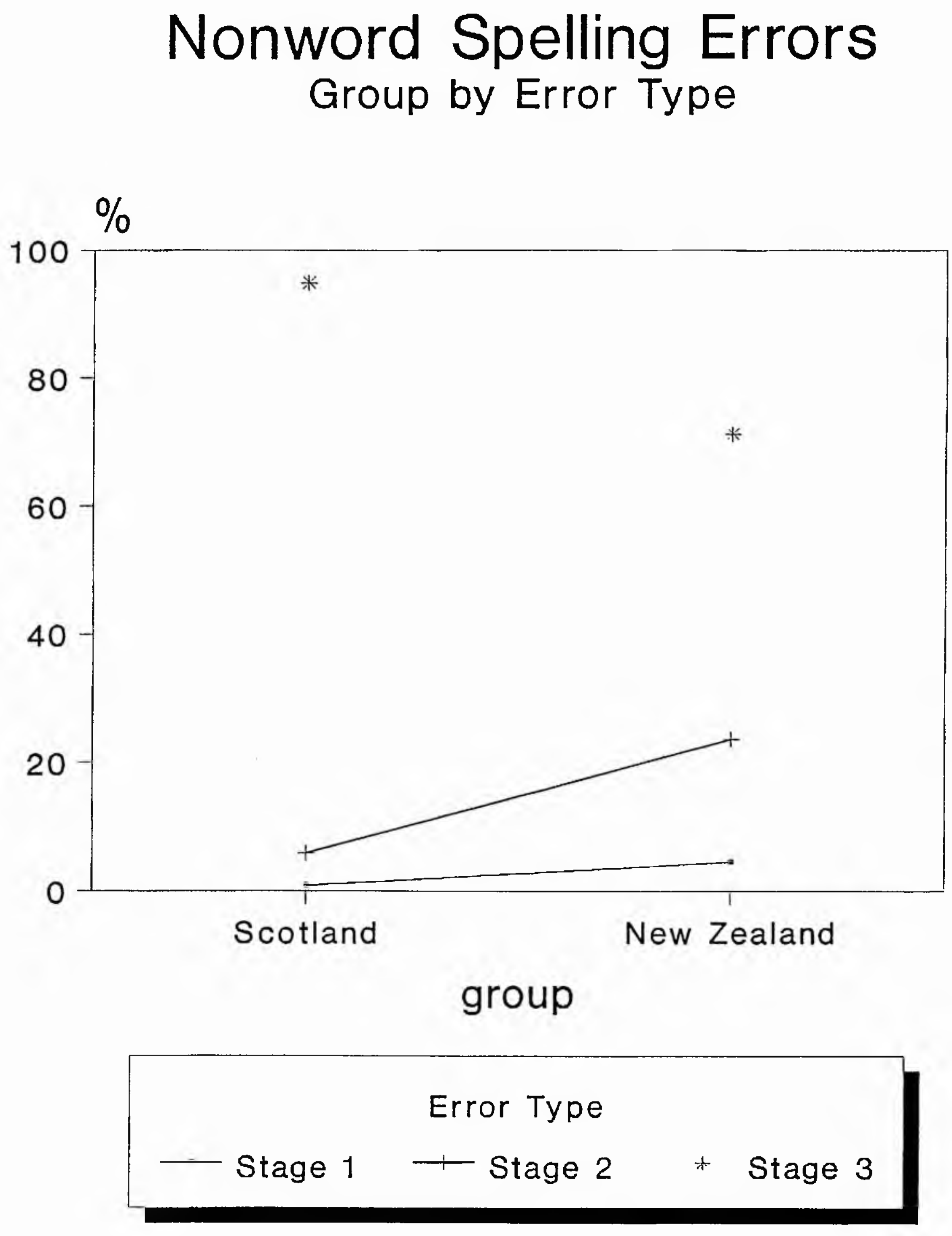
Spelling Errors

The errors as analysed, were as follows:

Table 9.16 Mean % spelling errors classified according to Morris and Perney's (1984) scheme

	Prephonetic	levels	phonetic
	1	2	3
Scotland	0.86	5.9	94.8
	(3.1)	(11.6)	(15.4)
New Zealand	4.5	23.7	71.3
	(16.7)	(16.1)	(23.3)

These data were analysed using analysis of variance with one between subjects factor, Group (Scotland and New Zealand) and one within subjects factor, Error Type (Stage 1 to 3 error). No significant main effect of Group was found. A significant main effect of Error Type ($F(2,90)=89.1$, $p<0.01$) was found, as was a significant interaction of Group by Error Type, ($F(2,90)=14.3$, $p<0.01$) (See Graph 9.4). This interaction was analysed using a Newman Keuls post hoc test. The Scottish sample was found to have produced significantly more ($p<0.01$) phonetic stage 3 errors than the New Zealanders while the New Zealanders produced significantly more prephonetic stage 2 errors than the Scots. There was no difference in the amount of prephonetic stage 1 errors produced by the two national groups. Therefore we can see a quite similar pattern to the real word spelling task, the



Nonword Spelling Errors
Group by Error Type
%
100
80
60
40
20
0
Scotland
New Zealand
group
Error Type
Stage 1
Stage 2
Stage 3

Graph 9.4

New Zealand sample again showing a sizeable amount of prephonetic stage 2 errors and the Scots a large amount of phonetic stage 3 errors. A slightly different pattern from the real word spelling task did appear when the error categories were correlated with number of items correctly spelt in the task:

Table 9.17 Correlation's of spelling errors with correct spellings

	Prephonetic levels		phonetic
	1	2	3
Scottish correct spellings	-0.02	-0.69**	0.12
New Zealand correct spellings	-0.57**	-0.49**	0.71**

* p<0.05 ** p<0.01

The above correlations for the Scottish sample with correct nonword spelling were surprisingly low. This could be because of the high accuracy of all the Scots on this task.

It would appear that the small difference apparent in stage development in the real word spelling task was amplified in the nonword spelling task, so much so that the Scottish children had superior accuracy in all the types of nonwords presented. The advantage in transitional stage 4 performance illustrated by the real word spelling test probably made a significant impact on this task because a large proportion of the nonwords needed some stage 4 orthographic knowledge before they could be spelt accurately.

Discussion

The Scottish children, as was predicted, did show a greater amount of regularisation errors in spelling. This was particularly the case on the nonword spelling task. However, when it came to accurately spelling real words, the effects of frequency were greater than those of regularity. This is a good illustration of the fact that spelling at this age (and any age) is not just about simply recoding spoken words but that the amount of times that a person has written and read a word are important as well. The children do not know all the orthographic rules that are inherent in spelling and so when they use their knowledge of phonological rules to recode the word then they generally fail. High frequency words are perhaps recognised in a more automatic whole word way than the less frequent words. This would fit in with the Ehri (1989) view of spelling development that was mentioned earlier in the text. This would also explain why regularity had no effect on correct performance despite large amounts of regularisation errors being shown by the children.

The better spellers (of both words and nonwords) in both national groups were also the better readers in general. The Scots spelling performance also correlated positively with the major types of errors they produced in reading. The New Zealand child who spelt well also showed skill at reading words and nonwords but their performance did not correlate with the majority type of reading errors they produced. Rather, their spelling skill correlated with a measure of phonological awareness. This seems quite logical considering the large phonological component inherent in spelling. One can conclude from this that the Scots spelling and reading are closely interlinked and are influenced by the phonics instruction they receive in the classroom. The New Zealand also shows a strong relationship between reading and spelling but this relationship revolves around the child's inherent level of phonological awareness rather than instruction that they receive in the classroom.

The Scots show more mature errors according to the error categorisation scheme that was used. This is despite being matched on word recognition and the other factors with the New Zealanders and only showing a very small difference in correct spelling. Yet again strategy differences which can be put down to the instruction the child receives have been seen. The phonics teaching of the Scots is having a benficial effect on spelling, particularly nonword spelling, where the words were very regular. Phonetic spelling skills may also be helping reading development, as Ehri (1989) predicted.

In summary, the Scots are more mature spellers than the New Zealanders despite being well matched; it is especially notable that this maturity occurs when the groups have been equated on word recognition ability which is highly correlated with spelling. The Scots spelling correlates more with measures of reading than with tests of phonological awareness, whereas the New Zealanders spelling correlates more with phonological awareness. The Scots performance at spelling would therefore appear to be mediated by more than the application of simple phonological awareness; more complex orthographic skills related to reading would seem to be involved. Phonics instruction teaches more than phonological awareness, it also teaches how words are spelt in English, i.e. it teaches orthography. The Scots children are exploiting their taught orthographic knowledge in the spelling tasks and have an advantage over the New Zealanders because of it. They are able to use virtually the same strategy for both reading and spelling (albeit in reverse) while the New Zealanders approach day-to-day reading in a less phonologically based way but rely on phonological awareness and knowledge to spell.

Chapter 10-Comprehension of Text

"The question is," said Alice

"whether you can make words mean different things."

The New Zealand method of teaching reading puts a large emphasis on the reading of texts. Here the child can develop the skills of prediction that it is claimed are needed to become a skilled reader (NZ Dept. of Education 1986). Therefore, it would seem unfair to judge the New Zealand children solely on the basis of single word reading. This section details the results of the Scottish and New Zealand children on a test of textual reading, the Neale Analysis of Reading Ability-Revised (1988). The test provides three measures of reading, accuracy (how accurately each word is read), reading rate (how many words per minute are read), and comprehension (how much the child understood the story line).

It was hypothesised that the New Zealand children, with their greater emphasis on contextual prediction and reading for meaning, would do better on the comprehension measure than the Scottish children. Evidence for this hypothesis was found in chapter 5 where the New Zealanders were found to be better at accurately judging whether sentences made sense or not. It was also predicted that the Scottish children would be slower at reading the texts than the New Zealand children as they would be handicapped by having to slowly sound out each unknown word, but that there should be no difference in accuracy as the groups are matched on word recognition already.

It was predicted that error analysis would show that context cues would cut down on the amount of refusals in both groups by providing more clues to the identity of words. This should be especially so in the New Zealanders, who are taught to rely on context more for reading unfamiliar words. Contextual clues should also reduce the amount of nonword errors produced by both groups, as such words will not fit in with the meaning of a story. The amount of errors "out of reading set" may also decrease as the children are reading age standardised stories with high frequency words. This follows the design of reading scheme books. If context does have as large an effect as some would predict (Smith 1971, Clay 1977, NZ Dept. of Education 1986) then the amount of errors sharing letters with targets should decrease as more semantic errors rather than graphophonic errors increase. This however may not be a very strong effect, as others have shown that graphophonic errors and semantic errors are not necessarily mutually exclusive (See chapter 4 for a fuller discussion of error analysis).

Subjects

Due to time constraints only a limited number of subjects from the normal four matched groups were tested on the Neale analysis. These subjects were combined together to form two composite national groups. Each national group covered both the year 1 and year 2 age range.

i) Scottish sample

This sample consisted of sixteen children from the matched sample who had performed the Neale Analysis of Reading Ability-Revised (1988). There were six females and ten males in the sample. The mean chronological age was 80.1 months (six years and eight months) with a mean time at school of 16 months. The children had a mean standard score of 95.2 on the British Picture Vocabulary Scales test and an ability score of 115.5 on the British Abilities Scales recall of digits test. The raw score of the British Abilities Scales word recognition test taken closest in time to the Neale test was 37.3.

ii) New Zealand Sample

This sample consisted of twenty six children from the matched sample who had performed the Neale Analysis of Reading Ability-Revised (1988) and who were equivalent in age and basic skills to the Scottish sample detailed above. There were eighteen females and eight males in the sample. The mean chronological age was 79 months (six years and six months) with a mean time at school of 16.1 months. The children had a mean standard score of 95.9 on the British Picture Vocabulary Scales test and an ability score of 115.2 on the British Abilities Scales recall of digits test. The raw score of the British Abilities Scales word recognition test taken closest to the Neale test was 34.8.

Group Match

To evaluate the matching of the two groups an analysis of variance was performed on each matching factor. There was no main effect of Group (Scotland and New Zealand) for age, ($F<1$) for time at school, ($F<1$) for BPVS scores, ($F<1$) for Recall of digits, ($F<1$) or for BAS Word Recognition, ($F<1$). Therefore the two groups were matched in terms of chronological age, time at school, vocabulary knowledge, recall of digits and word reading.

Materials

The Neale Analysis of Reading Ability-Revised (1988) was used to test the reading of related text. Form 1 of the test was used for all the subjects.

The test comprises a series of six short graded narratives designed to test the rate, accuracy and comprehension of children's oral reading between the ages of 6 and 12. The narratives are presented in a book and each narrative has a central theme, some action and a resolution. There is a picture accompanying each narrative. There are comprehension questions for each passage, four questions for the first passage and eight questions each for the remainder of the passages.

Procedure

The procedure followed was that as detailed exactly in the manual of the Neale Analysis test. This involved the child first reading Practice Passage One and answering comprehension questions about it. Testing then began from the first passage of the scale for all the children. Each passage and the accompanying comprehension questions were attempted until the reader made 16 or more errors in one passage. The ceiling for comprehension, accuracy and rate had been reached at this point and no more passages were introduced.

Accuracy errors were recorded on the Individual Record Form at the time of reading. Timing of reading began as soon as the first word of the passage was read and stopped as the last word of the passage was read. Comprehension questions were asked immediately the child had finished reading the passage unless the child had exceeded 16 errors for that passage.

Results

Raw scores were calculated using the instructions in the test manual and then converted into standardised reading ages. A summary table of results are reproduced overleaf in Table 10.1. A full discussion of each of the three sections of the test follows.

Accuracy Measure

An analysis of variance was performed on the accuracy data with one between subjects factor, Group (Scotland and New Zealand). No significant main effect of Group was found, ($F(1,40)=1.14$, $p>0.05$).

Table 10.1 Summary of mean results for the Neale Analysis (all figures standardised reading ages in months and standard deviations in brackets)

	Accuracy	Rate	Comprehension
Scotland	75.06	70.40	78.90
	(6.5)	(9.9)	(6.6)
New Zealand	72.90	83.60	73.70
	(6.1)	(15.4)	(7.3)

Therefore, there was no difference in word recognition ability between the two samples in a test which measured reading in context. The hypothesis that there would be no difference between the groups was upheld as they were matched on the BAS word recognition test already.

The results of the accuracy measure were correlated with the other measures in the test:

Table 10.2 Correlation of Neale Accuracy score with other scores on the Neale test

	Scotland	New Zealand	All
Comprehension	0.59**	0.63**	0.62**
Rate	0.41	0.71**	0.47**

** $p<0.01$

We can see that those who did well at accuracy generally also did well at the two other measures that were assessed.

The accuracy scores were also correlated with performance on the BAS word reading test and the results from this are reproduced below:

Table 10.3 Correlation of Neale accuracy score with BAS word reading score

Scotland	0.7248**
New Zealand	0.8234**
All	0.7890**

** $p<0.01$

Those who did well at the BAS word reading test are those who also did well at the accuracy measure of the Neale test. We can see that even though the medium of context was available to aid the children, it was overwhelmingly those who were good at reading without needing any context that were best at accuracy in a contextual setting.

Marie Neale is correct when she says that her test "..is not a simple test of verbal utterances according to a list of random unrelated words" (Neale Analysis of Reading Ability manual 1998). However, when it comes to testing accuracy alone the random list is still an accurate measure of reading performance. The accuracy scores were also correlated with measures of phonological skill to see if they would correlate in a similar way to the BAS test.

Table 10.4 Correlations of Neale Accuracy scores with measures of phonological skill

	Scotland	New Zealand	All
Yopp task	0.29	-0.30	-0.06
Rosner Task	0.10	0.35	0.23
Nonword naming	0.37	0.53*	0.49**
Pseudohomophone Naming	0.40	0.32	0.38**

We can see that there is a small relationship between tasks that involve explicit awareness of sound letter correspondences and word recognition in text based settings, but no relationship with measures of phonemic awareness.

Error Analysis

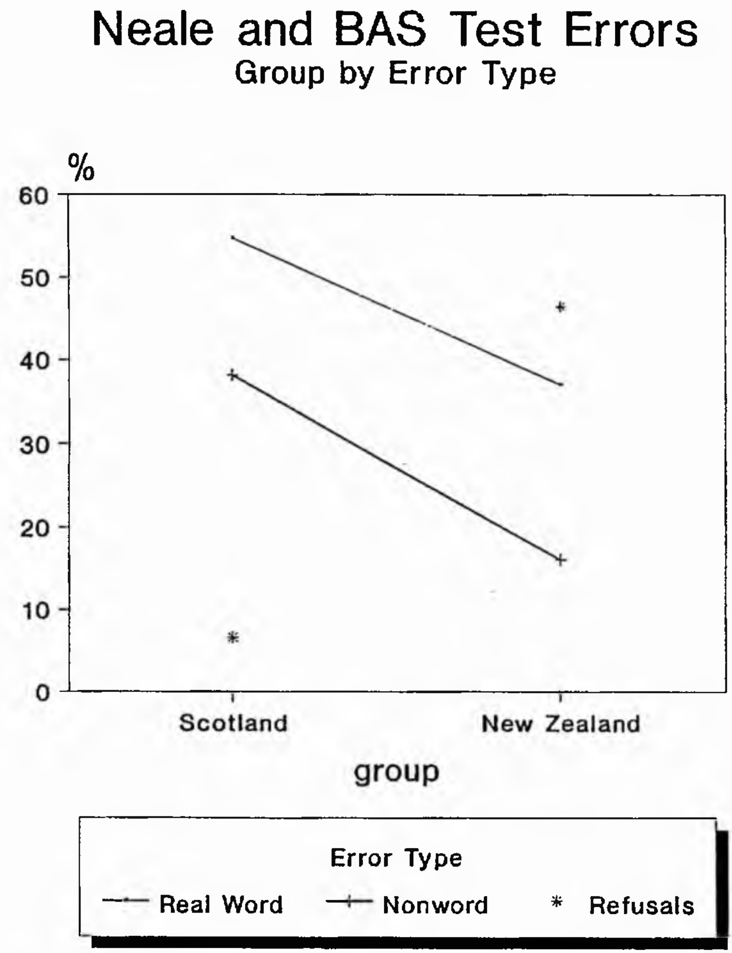
Since the BAS test and the accuracy measure correlated so highly it was decided to see if the errors made while reading in context were of a similar type to those in the simple BAS word recognition test.

The same error categories were used as in the BAS test section (see chapter 4 for a complete description of the categories). Firstly the errors made by all the subjects during the Neale test were split into the three categories of real word error, nonword error and refusals error and compared with the means for the same error categories for the BAS word recognition test. The mean percentages by group are given overleaf.

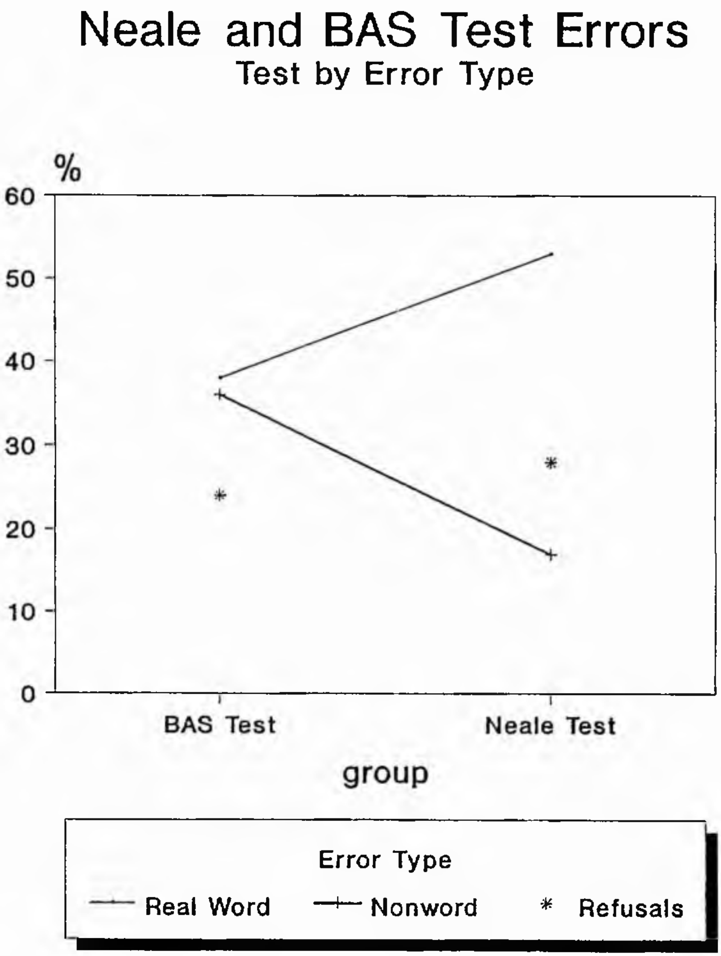
Table 10.5 Percentage of error types by Group for the BAS test and the Neale Test
(standard deviation in brackets)

	Real word	Nonword	Refusal
Scotland BAS	47.6	50.1	1.8
	(18.0)	(19.6)	(4.2)
Scotland Neale	61.9	26.3	11.5
	(21.5)	(22.8)	(17.1)
New Zealand BAS	29.3	23.2	47.3
	(14.1)	(21.3)	(32.9)
New Zealand Neale	44.8	9.1	45.6
	(24.3)	(14.5)	(27.9)

These data were subject to analysis of variance with one between subject factor, Group (Scotland and New Zealand) and two within subjects factor, Test type(BAS test and Neale test) and Error Type (Real words, Nonwords and Refusals). The main effect of Group was not significant, ($F<1$), nor was the main effect of Test type, ($F<1$). The effect of Error type was significant though, ($F(2,80)=10.5$, $p<0.01$) as was the interaction of Group by Error Type, ($F(2,80)=25.8$, $p<0.01$) (see Graph 10.1). Newman Keuls post hoc tests on the interaction showed that over both tests the Scottish


Neale and BAS Test Errors
Group by Error Type
%
60
50
40
30
20
10
0
Scotland
New Zealand
group
Error Type
Real Word
Nonword
*
Refusals

Graph 10.1


Neale and BAS Test Errors
Test by Error Type
%
60
50
40
30
20
10
0
BAS Test
Neale Test
group
Error Type
Real Word
Nonword
Refusals

Graph 10.2

children produced significantly more ($p<0.01$) nonwords and real words ($p<0.01$) than the New Zealanders while the New Zealanders produced significantly more ($p<0.01$) refusals than the Scots. The interaction of Test type by Error Type was also significant, ($F(2,80)=12.2$, $p<0.01$). A Newman Keuls post hoc on this interaction (See graph 10.2) showed that significantly more ($p<0.01$) real word errors were made in the Neale test than in the BAS test and that significantly fewer ($p<0.01$) nonword errors were made in the Neale test than in the BAS test. The amount of refusals did not significantly vary between the tests. The interaction of Group by Test by Error Type was not significant, ($F(2,80)=1.16$, $p>0.05$).

We can see that the pattern of errors produced by both groups across both tests are quite similar. The Scottish children still produce more errors in the form of real and nonwords than the New Zealanders, who produce many more refusals. The amount of real word errors increased in the Neale test as was predicted, while the amount of nonword errors decreased. This would appear to show that context does have some effect when the child is struggling to decode a word. The amount of refusals over the two tests remained the same. This would appear to say that if the child is not willing to decode, context will not alter that decision. This idea was further supported by the positive correlation (0.61, $p<0.001$) between refusal production for the BAS test and refusal production for the Neale test. However if the child is willing to decode, then context may be used to help identify the word. A teaching strategy that encourages children to actively decode will then allow the child to make use of both context and sound spelling rules in reading text.

The errors were then subjected to an additional analysis that gave a rough estimate of the effect of context, both grammatically and semantically, on error production and on the reading of the texts.

All the errors that fitted with either the immediate grammar or context of the sentence and story line in each text (a quite wide definition but see Thompson 1986 for a fuller discussion of the pitfalls of this approach), were counted for each reader. They were then measured as a percentage of the total number of errors made. The results of this for the two national groups are reproduced in table 10.6 below:

Table 10.6 Mean percentage of total errors that make grammatical or semantic sense in the Neale texts
(Standard deviations in brackets)

Scotland	49.325	(22.539)
New Zealand	36.125	(27.712)

A T-Test on these figures revealed no significant difference between the percentages ($t=1.69$, $p>0.05$). This result shows that both samples are using context and grammar to the same extent, and that despite the New Zealand emphasis on this approach they are if anything a little less likely to use it. In fact less than half the New Zealand errors were visibly related to grammar or context.

Such an error analysis as this can only really measure context and grammar as it has surfaced in real word errors, other factors may interact with grammar or context in the production of nonword errors or refusals that we are not aware of. This result also does not mean that spelling sound factors were not involved in the production of grammatically or semantically correct errors, far from it in fact, as further analysis will show.

The errors were then put into the three categories of "Error in reading set", "Error not in reading set" and Refusals. The mean percentages by group are given below:

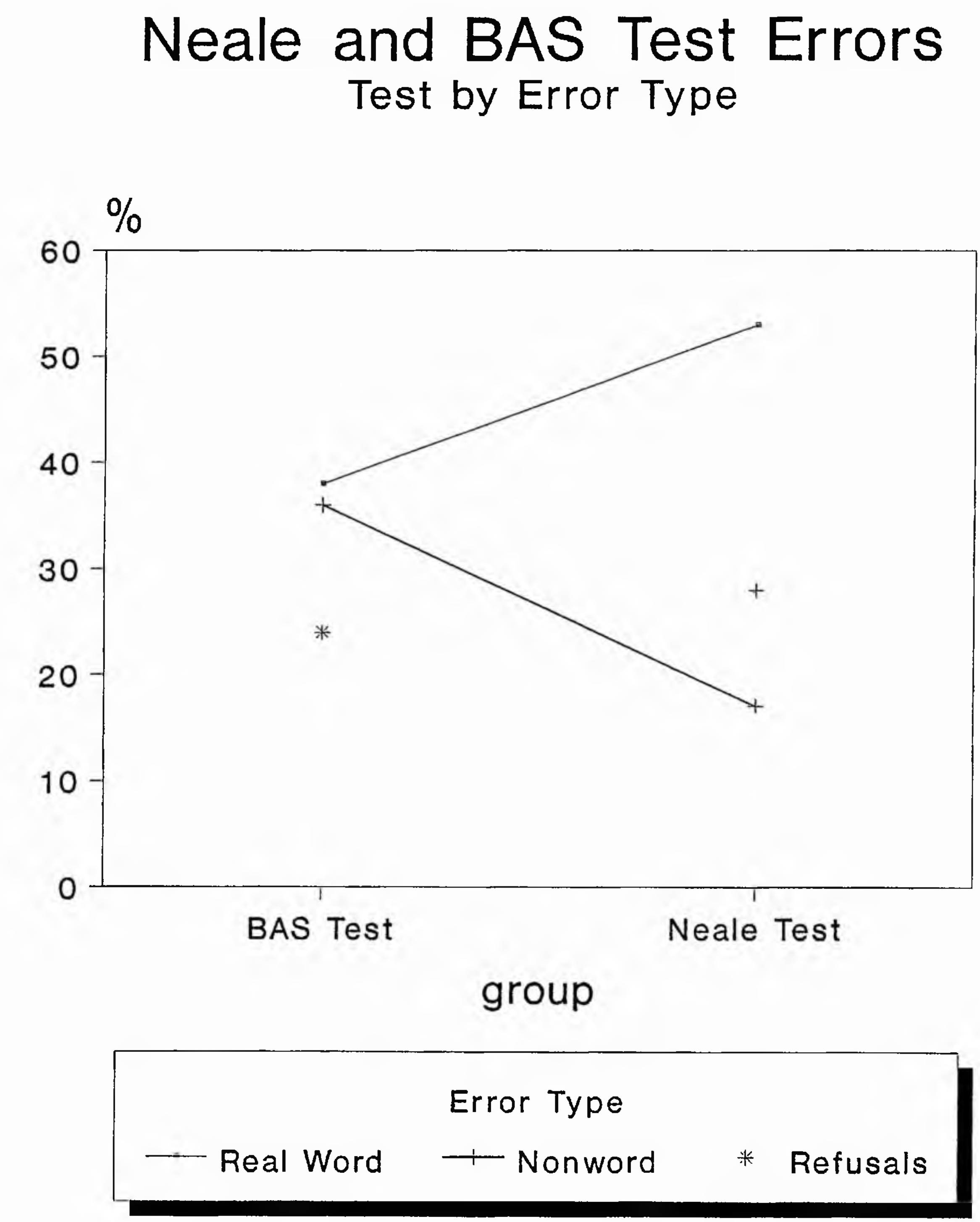
Table 10.7 Percentage of error types by Group for the BAS test and the Neale Test
(standard deviation in brackets)

	In Reading set	Not in Reading set	Refusals
Scotland BAS	10.4	87.5	1.8
	(10.9)	(13.4)	(4.2)
Scotland Neale	31.7	55.9	11.5
	(17.9)	(24.9)	(17.1)
New Zealand BAS	9.1	43.4	47.3
	(30.6)	(30.6)	(32.3)
New Zealand Neale	18.6	35.7	45.6
	(20.3)	(22.2)	(27.9)

These data were subjected to an analysis of variance with one between subject factor, Group (Scotland and New Zealand) and two within subjects factor, Test type (BAS test and Neale test) and Error Type (Error in set, Error not in set and Refusals). The main effect of Group was not significant, ($F<1$) nor was the main effect of Test type, ($F<1$). The main effect of Error Type was significant, ($F(2,80)=32.7$, $p<0.01$) (see Graph 10.3). The interaction of Group by Test type by Error type was also significant, ($F(2.80)=4.25$, $p<0.05$). A Newman Keuls post hoc test on the interaction revealed a number of interesting points.

The Scottish sample produced significantly fewer "errors not in reading set" in the Neale than in the BAS test; instead they produced more "errors in reading set" for the Neale than the BAS test. The amount of refusals produced did not vary significantly between the tests. The New Zealand sample showed no significant changes in the amount of any of the error types between the Neale and the BAS test. As far as the comparison between the groups was concerned, the Scottish sample still produced significantly more ($p<0.01$) "Errors not in reading set" across both tests despite the drop in quantity with the Neale test. There was no difference between groups for the amount of "Errors in reading set" for the BAS test or in the Neale test. The New Zealanders produced significantly more refusals ($p<0.01$) in both tests than the Scottish sample.

It was hypothesised that the amount of "Errors not in the reading set" would fall because the Neale test passages


Neale and BAS Test Errors
Test by Error Type
%
60
50
40
30
20
10
0
BAS Test
Neale Test
group
Error Type
Real Word
Nonword
Refusals

Graph 10.2

would reflect more closely the children's experience of reading books with high frequency words in context, unlike the BAS test, which very rapidly moves onto complex words. This hypothesis was only realised for the Scottish children and not the New Zealanders.

The errors were then split into the eight categories of error type that measured how similar the letters in the error were to the target word (for a reminder of these categories see chapter 4). The mean percentages by group are given below:

Table 10.7 Percentage of error types by Group for the BAS test and the Neale Test
(standard deviation in brackets)

	Error Types							
	1	2	3	4	5	6	7	8
Scotland								
BAS	1.0	4.1	14.1	17.1	6.6	4.5	48.4	1.8
	(1.6)	(4.2)	(8.4)	(6.2)	(17.5)	(7.9)	(17.6)	(2.4)
Neale	8.8	10.3	6.4	19.2	0.8	6.8	32.6	3.4
	(11.3)	(12.3)	(8.5)	(13.6)	(2.1)	(10.2)	(18.0)	(7.3)
New Zealand								
BAS	1.1	1.2	10.1	10.4	0.7	2.0	25.6	0.8
	(2.3)	(2.2)	(9.3)	(9.6)	(1.5)	(2.9)	(15.6)	(2.0)
Neale	5.5	2.8	10.6	10.8	0.0	1.8	20.9	1.1
	(11.3)	(5.3)	(12.8)	(14.4)	(0.0)	(5.8)	(18.3)	(3.9)

These data were subject to analysis of variance with one between subject factor, Group (Scotland and New Zealand) and two within subjects factor, Test type (BAS test and Neale test) and Error Type (Types 1 to 8). There was a main effect of Group, ($F(1,40)=31.6$, $p<0.01$) but no main effect of Test type, ($F<1$). The interaction of Group by Test type was not significant, ($F(1,40)=1.4$, $p>0.05$). There was a main effect of Error Type, ($F(7,280)=79.6$, $p<0.01$) and the interaction of Group by Error Type was significant, ($F(7,280)=5.79$, $p<0.01$). A Newman Keuls post hoc test on this interaction showed that the Scottish children produced significantly more Type 7 ($p<0.01$), Type 4 and Type 2 errors across both tests than the New Zealand children. There were no other significant differences between Error Types for the groups. There was also a significant interaction of Test type by Error type, ($F(7,280)=5.65$, $p<0.01$). A Newman Keuls post hoc test on this interaction revealed that Type 1 Errors were produced significantly more frequently in the Neale test than in the BAS test, while the frequency of Type 7 errors was significantly lower in the Neale test than in the BAS test. Type 7 and Type 4 errors were still the most frequent errors in both tests, however. The interaction of Group by Test type by Error type was not significant but was rather close, ($F(7,280)=1.86$, $p=0.07$).

The general pattern of results for the Neale test would appear to be quite similar to the pattern of results for the BAS test for these subjects and the BAS tests in the larger sample. Type 4 and Type 7 are still the most prevalent and the Scottish children produce more of them than the New Zealanders. Type 1 and 2 errors rose significantly for the Neale test, however this may be because context in these cases is overriding knowledge of sound spelling rules. Type 1 and 2 errors though are still only produced in small amounts reaching at most just over six percent of the total errors for the Neale test.

Table 10.8 Correlations of Neale Accuracy scores by Error types

	Error Types							
	1	2	3	4	5	6	7	8
Scotland	-0.34	0.04	-0.49*	0.31	-0.38	-0.34	0.22	0.43*
New Zealand	-0.2	-0.41*	-0.19	-0.01		-0.03	0.59**	0.07
All	-0.24	-0.02	-0.34*	0.2	-0.21	-0.16	0.45**	0.36*

* p<0.05 ** p<0.01

When the accuracy scores for the Neale are correlated with the error types we see that the Scottish sample Type 4 and 7 errors do not correlate significantly with high accuracy scores. It could be that because everyone in the Scottish sample produces many of these errors, as evidenced by their high production level in the test, that the correlation is not found because of lack of variance in the scores. The New Zealand sample's accuracy scores correlated quite highly with the production of Type 7 errors. Type 8 errors, which were produced in very small quantities, correlated significantly with accuracy in the Scottish sample and in the overall sample. This would be expected as a type 8 error means that they have almost got the target word but that it has become embedded in a larger word.

These correlations would again seem to indicate a similar pattern to the BAS test results from the main analysis of errors on the BAS test. The error pattern information and the high correlation of accuracy scores for the Neale with accuracy scores for the BAS would seem to provide evidence that textual and single word reading are not all that different in terms of how words are recognised.

Rate of Reading

This was the second measure assessed by the Neale test. Reading was timed and the rate was worked out in words per minute and then converted to a standard reading age score. The mean standard reading age scores for rate are printed below:

Table 10.9 Reading Ages for the Rate measure

Scotland	70.4 months	Standard deviation 9.9
New Zealand	83.6 months	Standard deviation 15.4

Analysis of variance was performed on these results with one between subjects factor, Group (Scotland and New Zealand). A main effect was found of Group, ($F(1,40)=9.14$, $p<0.01$) showing that the New Zealanders were faster readers than the Scottish children.

This would seem to confirm the hypothesis that the Scottish children would be slower at reading, because they tend to sound out unknown words more than the New Zealanders. The New Zealanders if they do not know a word tend instead to hesitate and refuse to attempt the word. In the Neale test the procedure for testing states that if a child hesitates the experimenter should offer the correct word after five seconds while if the child is decoding phonetically the correct word should be offered after six seconds. This is only a one second difference in procedure but considering that refusal errors take up 45.6% of the total New Zealand errors compared to 11.5% of Scottish errors it may make account for the difference in rate.

When we correlate the rate scores with the other measures in the Neale test we see that the most accurate readers are also the fastest readers:

Table 10.10 Correlation of Neale Rate scores with other scores on the Neale test

	Scotland	New Zealand	All
Accuracy	0.40	0.71**	0.47**
Comprehension	-0.08	0.43**	0.10

** p<0.01

In the New Zealand sample the fastest readers are also those who best comprehend the storyline. This is understandable as the less breaks in reading the story the less likely comprehension will suffer. In the Scottish sample, however, the child who is reading quickly may not be sounding out and may have a low accuracy score (accuracy does not correlate significantly with rate either for the Scottish sample) as they are not reading as they are taught to. This would then lead to low comprehension as their accuracy and hence understanding of the storyline may be impeded.

Comprehension

This was the third measure of the Neale test and was assessed by asking the child a set of questions immediately after each passage was read. The correct scores for this were then converted to standard reading age scores and are shown in table 10.11.

Table 10.11 Reading Ages for the comprehension measure

Scotland	78.9 months	Standard deviation 6.6
New Zealand	73.7 months	Standard deviation 7.3

Analysis of variance was performed on these results with one between subjects factor, Group (Scotland and New Zealand). A main effect was found of Group, ($F(1,40)=5.23$ $p<0.05$) showing that the Scottish children had a higher reading age for comprehension than the New Zealand children.

This was the opposite of what had been predicted. The training the children receive in Scotland emphasises individual words and subword segments, while the training in New Zealand emphasises meaning and context. The New

Zealanders should have had an advantage in this particular task especially given that the New Zealand sample in year 1 were better at the Reading for Meaning task.

Table 10.12 Correlation of Neale Comprehension scores with other scores on the Neale test

	Scotland	New Zealand	All
Accuracy	0.58**	0.63**	0.62**
Rate	-0.08	0.43*	0.10

** p<0.01

In the New Zealand sample the correlations between Comprehension and accuracy and rate on the Neale test are significant. This makes sense if we think that it is the fastest, most accurate readers who comprehend the story the best. In the Scottish sample, though, it is the certainly the most accurate readers, but not necessarily the fastest readers, who comprehend most. Do the Scottish children, who may be accustomed to stops and starts in their reading, develop a facility to pay more attention to a story line because they know that they will be slowed down by unknown words?

Discussion

It has been seen that reading text depends on competent word recognition. The strategies that the children use in single word recognition are also those employed in textual reading. The New Zealanders did not have a strategy for dealing with those words that they did not know in the text and they therefore produced more refusal errors as they did in single word reading. When they produced refusals they had to wait for the experimenter to tell them what the correct word actually was. This is when the child is likely to lose the gist of the story as their concentration is broken and their mind can wander. When the phonics taught child comes across an unfamiliar word they try to work out what it is using all the cues they can, including context. This holds their concentration and encourages them to think about the story line.

The New Zealanders are faster at reading familiar words (as we also saw in chapter 7) but their refusal to try to work out unfamiliar ones hampers them with less frequent words. The Scots children are slower in their reading but ultimately remember more about the story due to how they have been taught to read unknown words.

These results are the final confirmation that two groups of children taught by different instructional techniques, although matched on word recognition, are pursuing fundamentally different reading strategies. A simple stage account of reading acquisition cannot account for the better performance of the Scottish children on the comprehension measure. The way the children have been taught in class has determined to a large extent how the children read words, and therefore text. There is more than one route to skilled word recognition, and some approaches may be better than others.

Chapter 11-General Conclusions

"Would you tell me, please, which way I ought to go from here?"

"That depends a good deal on where you want to get to." Said the cat.

This thesis has shown that groups of young readers matched on word recognition ability, age, vocabulary knowledge, digit span and time at school, but who differ in the type of reading instruction they receive, show different word recognition strategies. These strategies are clearly a reflection of the reading instruction that the children have received. This shows that those who advocate universal stage theories of reading development in children (e.g. Frith 1985) will need to take into account in their models the type of reading instruction the children receive. The details of the differences found in this study are summarised below:

Word reading errors

1) The phonics taught children produced errors that had more correct letters in the appropriate position in relation to the target word than the language experience taught children, in particular the beginning and end letters of words. The language experience children produced more refusals, while the phonics children produced more errors that were nonwords or real words. The phonics children produced more errors that contained words from outside the set of words used in their reading scheme books. This pattern of error production in the two

groups of children's reading was consistently reproduced across a number of separate tasks.

Nonword reading

2) The phonics taught children were better at reading nonwords. The language experience children could use a phonological approach when pressed to do so but were not as good as the phonics children.

Irregular words

3) The language experience children were better at reading low frequency irregular words than the phonics children. They were also faster and more accurate at reading familiar words than the phonics taught children.

Word length and reading speed

4) The phonics children showed a word length effect, i.e. they read long words more slowly than short ones, while the language experience children did not. The phonics children sounded out words and so were slower at single word reading and reading in context.

Phonological awareness

5) The phonics taught children were better at a simple phonological awareness test (the Yopp singer test) but there was no difference between the groups on a more complex phonological awareness task (the Rosner task). It was found therefore that it was not necessary for children to possess good phonological awareness skills to

have appropriate word recognition skills for their age. Phonological awareness in the language experience children did seem to be related to the level of nonword naming skills they possessed rather than pure word recognition skill. The phonics taught children's nonword naming skills were not correlated with phonological awareness but were more closely associated with word recognition skill.

Spelling

6) The phonics taught children correctly spelled more low frequency word and nonwords than the language experience taught children. The phonics taught children made more errors that were closer to the target word than the language experience taught children. This advantage was due to the phonological and orthographic information taught to the phonics taught children in the classroom. The language experience children had to rely more on their derived phonological awareness skills to help them spell words.

Comprehension

7) The phonics taught children were better at the comprehension of stories than the language experience children, despite being slower readers. The phonics children used contextual cues more than the language experience children because they were able to follow the story line better due to their superior decoding skills. The language experience children refused to decode a lot

of words and so their understanding of the story line was disrupted as a result.

Consistency

8) The phonics taught children used reading strategies derived from the method of teaching throughout all the tasks in the study. The language experience children were forced to use a different reading strategy from their normal reading approach when they had to use phonology to carry out a task.

Independence

9) The strategy used by the phonics taught children correlated throughout the study with success at reading, while the language experience children's strategies generally did not. This is a product of phonics instruction which research has shown is more successful at producing independent readers than the language experience approach (Adams 1990).

Age Trends

It was generally found that the older children in each of the national groups did not exhibit radically different patterns of performance from their younger counterparts. Rather, they had a more pronounced trend in a particular direction, for example, they would produce more of a type of error the older they were, not produce a different type of error. It was also noted that the older national age groups differed less from each other than the younger age groups. The effects of instruction seemed to have lessened with time and there appeared to be a convergence of error types produced by the older groups. Thus the older groups produced more nonword and real word errors, less refusals and encoded more end letters than their younger counterparts.

The results from the older age groups would seem to indicate that the different effects of instruction begin to diminish as the child grows older and more skilled at reading. However, Johnston and Thompson (1989) found differences in reading ability and reading strategies at age eight in a similar group of children and it has been reported that there is a discrepancy in word recognition ability as late as ten years of age (Johnston and Thompson, personal communication). The problem with measuring potential instructional differences at older ages is complicated because the reading process has become so automatic. The tests that have been used in this thesis may therefore not pick up the differences between more skilled readers.

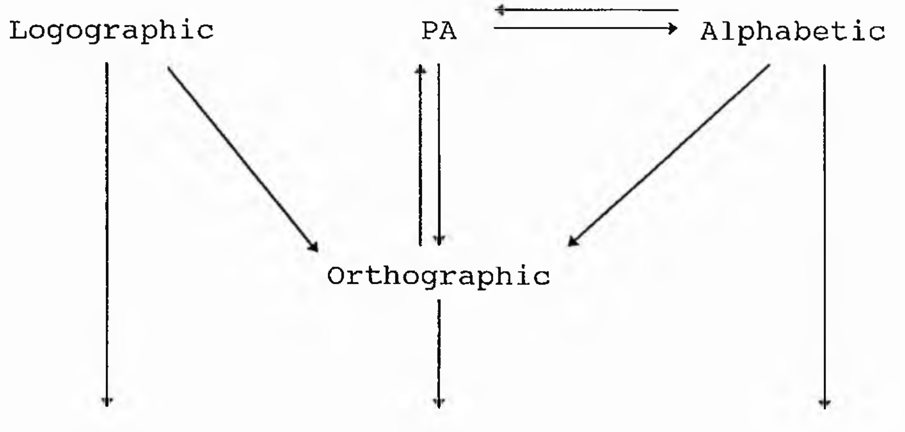
Consequences for Stage theories of development

One of the principles of stage theories like that of Frith (1985) is that stage development is characterised by a particular strategy use. This study has illustrated that two groups of readers who are at the same point in terms of reading can exhibit different strategy use. These strategies are reflective of the type of reading instruction that the children have received.

These results are in line with other studies that have questioned the invariance of stage models (e.g. Stuart and Coltheart 1988) and those studies that appear also to have found that strategy use is not confined to one simple sequence. Thus Goswami (1986) demonstrated that very young readers can use analogies to help them read even though this was thought to be a late developing orthographic skill according to a number of models (Marsh et al 1981, Frith 1985). Johnston, Anderson, Perret and Holligan (1992) found that poor readers appeared to have available a number of reading strategies when only alphabetic reading would have been predicted by Frith (1985) and Morton (1989). Pring and Snowling (1986) hypothesise that "young children pool information from a number of different sources and integrate this information to bring about a response" (Pring and Snowling 1986, p.414). A theory of development which identifies each stage by only one strategy is too simplistic. Children will use whatever is available to them in order to read words. Strategies they have been taught will be used as they are the most familiar and practised way for the child to read.

Seymour and Evans (1992) found evidence that a different instructional regime to the one reported by Seymour and Elder (1986) produced a different type of reader compared to the previous study despite having samples of children of the same age. The children in the Seymour and Evans study were followed through the first three years of school and were taught to read using a "mixed" method which involved a combination of whole word learning and letter sound relationship learning. It was found that the children could read both words and nonwords, which was unlike the children in the Seymour and Elder (1986) study. The children in the Seymour and Evans (1992) study also produced different kinds of errors to real words and nonwords which Seymour and Evans took as evidence that the children were pursuing different strategies when they came across each type of word. They claimed that the children were using a logographic approach when reading real words, i.e. instant recognition, and an alphabetic approach when reading nonwords, i.e. sounding out. This is a contradiction of the stage theory of Frith (1985). Seymour and Evans have therefore proposed the "Dual Foundation" model of reading development.

Figure 11.1 The Dual Foundation model
(Seymour and Evans 1992)



This model accepts the premise that logographic and alphabetic development are still the foundations of orthographic reading but proposes that logographic and alphabetic skills can develop in parallel. Alphabetic skills are seen as interacting with phonological awareness in the development of orthographic reading skill.

Seymour and Evans point to the class performance in nonword reading and the rising incidence of sounding out as evidence that the children are using the alphabetic route while using the logographic route in parallel to read familiar words like names. They also propose that a hyperlexic in the class, M.P., showed evidence of developing a logographic approach which then led directly into orthographic reading and by-passed any alphabetic experience altogether. The Dual Foundation model allows for development like this and it is claimed that "orthographic development could proceed given a logographic base and an appropriate structural model from PA (phonological awareness)" (Seymour and Evans 1992, p.119). The evidence presented for this viewpoint is that M.P. showed little evidence of overt sounding out, even when reading nonwords, and that reaction time data showed that he may have established an orthographic framework for reading at the end of year 1. Seymour and Evans do not detail how someone with a logographic strategy can build up rapid orthographic knowledge, given that an logographic reader is typified by being able to read words only after they have been taught them and that those responses to words are drawn from a restricted reading vocabulary (Seymour and Elder 1986). How does this explain the high skill level of M.P. at reading nonwords throughout year 1? If M.P. is not reading nonwords by a strategy characteristic of alphabetic reading in year 1, then he may be reading using basic orthographic rules. Evidence that M.P. knows explicit orthographic rules was provided in year 1 on the first spelling test given to the children when he told other children to "remember the lazy "e"." (Seymour and Evans 1992, p.92). He may not have been sounding out nonwords as the others did because his orthographic knowledge during year 1 allowed him to instantly compute a pronunciation to a nonword (and a real word). By claiming that a child can reach maturity by utilising only one of the two procedures which provide the "foundation" for reading, how can they continue to be called foundations?

The New Zealanders in the study reported in this thesis according to the Seymour and Evans (1992) model could be said to be developing a logographic base (combined with phonological awareness). They do not overtly sound out very often, they do not produce a lot of errors consistent with an alphabetic strategy, they are not very good at reading nonwords, they have a bias towards recognising familiar words and they do not display a word length effect. Yet like M.P., they do display knowledge that is not consistent with a purely logographic approach. They do produce some nonword errors in their reading, they can use limited phonological skills in homophone decision tasks and they can read some nonwords. Therefore they are not pure logographic readers. The Scottish children in our sample, on the other hand, are not pure alphabetic readers as they have developed skills to read irregular words. They, like the Seymour and Evans children, have built up a small sight vocabulary. Even the Seymour and Elder (1986) children, as Ehri (1994) pointed out, are not pure logographic readers. Therefore there is no evidence for the existence of pure logographic or pure alphabetic readers, only combinations of both. This effectively means that the processes of alphabetic and logographic reading can be put down to two constituent factors: instruction and individual differences. The logographic and alphabetic labels can effectively be replaced by the labels "phonics" and "language experience" respectively. The largest individual differences are likely to be manifest in the ability to develop and use phonological awareness.

Seymour and Evans claim that the children in their study have different procedures for reading words and nonwords. The evidence for this claim comes from a study of the reading errors that the children make to both kinds of words. This would appear to show the existence of both logographic and alphabetic reading. In the study we have reported here, however, the Scottish children show no difference in the types of reading errors they produce across different stimuli, rather they show consistent strategy use across both words and nonwords. The same is generally true of the New Zealanders, although they do show some evidence of treating nonwords differently in tasks where the use of a phonological approach is obligatory. This then would again suggest that it is the effect of instruction that determines how items are read. If the use of logographic and alphabetic approaches can be so manipulated by instructional technique then the concept of them as determined by Seymour and Evans would not appear to be very useful. It would be more useful to discuss the findings in this thesis in terms of instructional approach than terms like logographic and alphabetic.

It was pointed out in Chapter 2 that the concept of orthographic reading has never been fully worked out. There is debate over the form of orthographic reading and how the concept of orthographic reading fits in with skilled models of reading. Since these questions have not been adequately answered, it is difficult to conceptualise orthographic reading as the end point of development. It would appear more fruitful to discuss the findings in this thesis in terms of an agreed point of reading development- skilled word recognition and skilled spelling rather than through undefined terms like orthographic reading.

It was also noted in Chapter 1 that skilled models of word recognition and spelling are split between classic dual route models like that of Coltheart (1978) and PDP models like that of Seidenberg and McClelland (1989). How do the data presented in this thesis link in with these models? The Seidenberg and McClelland model proposes that familiar words and unfamiliar words are read by a common process. However the idea that the Scottish children are using a strategy based more on phonology than the New Zealand children, which is mediated by instructional technique, does not point to the development of one common process underlying their reading at this point in their reading development. This does not mean that the PDP model is not a valid model of skilled reading but that it does not appear to encapsulate differences in the approach taken to developing skilled reading. Thus, Cassidy (1990) has argued that the Seidenberg and McClelland model did not take into consideration the learning environment of the child, and Coltheart and Leahy (1992) point out that the child's exposure to print in class is very different from the print that the model was trained on.

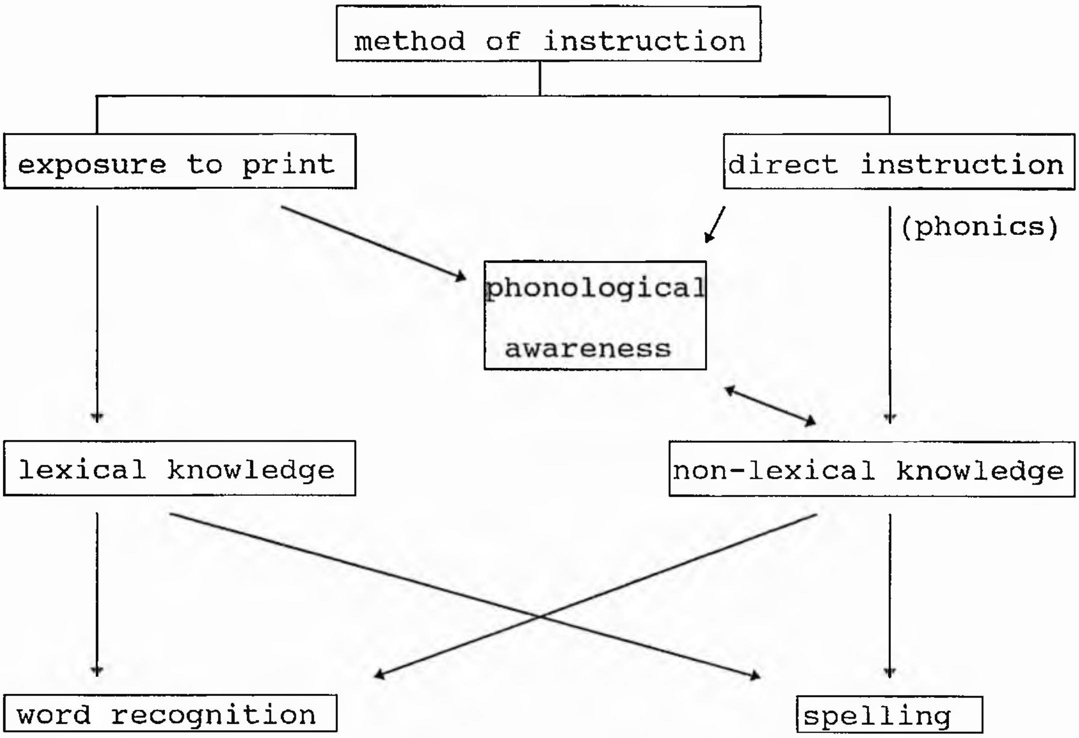
The two groups in this thesis have different procedures for reading words which would appear to be based on lexical and sub-lexical approaches. This would indicate that something like a dual route framework is being assembled by the children at this point in their development. The recent computational model of dual route processing by Coltheart, Curtis, Atkins and Haller (1993) has two distinct procedures for reading words but has more flexibility than the older dual route models and so is more suited to accommodating reading strategies stemming from different instructional regimes.

Before we consider how such a framework can accommodate the results of this thesis we need to look at the instructional approaches that were studied to see if this can help explain how the children in each group are reading. The New Zealand method, i.e. the language experience approach, and the Scottish phonics approach are both detailed in Appendix 1, but what can we say are the largest differences between the two? The Scottish children receive direct instruction about the rules and conventions of English orthography; they are shown how to decode and encode words using these rules; they are given the opportunity to practice on single words and words in text. The New Zealanders receive very little direct tutoring in any of the rules of English orthography. The main emphasis in New Zealand is on actual reading of texts. Before a text is considered to have been mastered they must be able to read successfully 90-95% of the words (Thompson 1993, NZ Dept. of Education 1986). Texts can be read to this level because the child has been exposed to the text in shared, guided and independent reading. There is much repetition of text (and so words) in the New Zealand system. Time is not taken up learning rules but in practising text reading. These differences between the techniques lead to the conclusion that instruction in reading can be split into two important factors: direct instruction of decoding/encoding rules and exposure to print (from which the child may elucidate the rules for itself).

In the dual route model two processes are important, the lexical and the sub-lexical. It is assumed that sub-lexical processes involve the application of spelling-sound GPC rules to unknown words in order to work them out, while lexical processes revolve around the building up of a sight vocabulary of words which is easily accessed. Therefore, the direct instruction of decoding/encoding rules can be assumed to contribute more to the growth of sub-lexical procedure (Coltheart, Curtis, Atkins and Haller 1993) than lexical procedures (at least to begin with, see Ehri 1994 for the contribution of sub-lexical procedures to the formation of a lexicon). Exposure to print is therefore assumed to contribute more to the build up of a sight vocabulary (Juel, Griffith and Gough 1986). Lexical and sub-lexical processes, however, both contribute to word recognition and spelling. The role of instruction in reading development, taking into account the results presented in this thesis and the assumptions just presented, can be illustrated figuratively in Figure 11.2.

Working from the top of the diagram reading instruction can be weighted to either of the two factors that it is split into. In the New Zealand samples the method of instruction is weighted towards "exposure to print" with many words being read and practised again and again. This builds up a large amount of lexical knowledge about the words they read at school. This explains why they are faster at reading familiar words and are better at aspects of irregular word reading but are bad at nonword reading. They have never encountered nonwords in their texts before and the amount of direct instruction on decoding they have received is minimal (restricted to

Figure 11.2 The effects of method of instruction on word recognition and spelling



first letters only). Therefore they do not perform well at tasks requiring non lexical knowledge. Exposure to print does allow the reader to develop a phonological awareness though (see chapter 8) and this can help contribute to sub-lexical knowledge. This was shown by the significant correlations that the New Zealanders displayed in tasks requiring sub-lexical skills with measures of phonological awareness. Therefore the New Zealand method of instruction makes the readers in our sample depend on lexical procedures most of the time but does allow limited sub-lexical procedures to develop through phonological awareness.

The Scottish children are receiving explicit instruction in phonics, therefore the method of instruction is weighted towards the sub-lexical part of Figure 11.2. This means that the phonics approach will have its greatest effect on sub-lexical knowledge. The evidence for this view is illustrated by the nonword errors the Scots make when reading, their high level of nonword reading and their superior performance at spelling. The Scots also show a word length effect, which indicates left to right processing using a serial decoding process. The Scots are also receiving exposure to print, however, and do appear to build up a limited sight vocabulary as shown by their ability to read irregular words. There is also evidence that non-lexical procedures do contribute to lexical knowledge (Perfetti 1992, Ehri 1992, 1994, see also Chapter 2). This would also explain why the phonics method is a faster way of learning to read than the language experience approach (Thompson and Johnston 1993, Adams 1990) as it effectively builds up lexical knowledge by exposure both to print and sub-lexical procedures. Sub-lexical knowledge allows unknown words to be read with little or no prior experience. The New Zealand method builds up a large amount of lexical knowledge and begins to develop sub-lexical procedures but it is a slow method of learning. For a long time exposure to print is the only way that the New Zealanders can build up lexical knowledge, until phonological awareness levels develop such that sub-lexical procedures become available. Figure

11.2 can account for all the differences found in this study between single word and nonword naming in phonics and language experience taught children.

Lexical knowledge and how words are represented in the lexicon would seem to be a crucial area to study in the development of reading. What can the data from this study reveal about lexical knowledge? for both the Scottish and New Zealand children, high frequency words would seem to be the first type of words that are encoded lexically. There was no difference in reading high frequency irregular words or in spelling high frequency regular or irregular words between the national groups. This would confirm that exposure to print is a contributory factor in the growth of lexical knowledge. Evidence that lexical knowledge is based on whole word representations was shown by the New Zealanders, who did not show a word length RT effect when reading familiar words. They were also much faster at reading these familiar words than the Scots, who were using sub-lexical knowledge in a lot of cases and who also showed a word length effect.

The results of the error analysis in this thesis show that the representation of words as part of lexical knowledge may be developing along similar lines in both national groups. The most prevalent errors in both groups were errors which preserved the first and last letters correctly. This category of error was originally thought to be wholly phonological in nature (after Stuart and Coltheart 1988) but it was found that production of this error type also correlated with irregular word reading. Therefore, it was considered that such errors may be more orthographic in nature and that they contain a visual component.

Perfetti (1992) theorises that a reading lexicon consists of two parts, a developing functional lexicon with incomplete representations of words and an autonomous lexicon with fully specified representations of words. He claims that the lexicon develops due to the interaction of sub-lexical knowledge and practice at lexical access. The representations he specifies are built up from the outside in (See Figure 4.1 p.80). The outside letters fix the word boundaries and length visually and give a phonological basis for the word as well. The harder to recognise and harder to pronounce vowels, which are generally inside a word, become represented later (see Chapter 1 and 4 for a more specific look at representations in the lexicons of dual route models).

The consistent finding that children encode the end letters correctly in their errors throughout this study and in others (Perfetti 1992, Stuart and Coltheart 1988, Fowler, Leiberman and Shankweiler 1977, Weber 1968, 1970) confirms that they are a special case of error. There is no reliable way in this study to distinguish whether the outside letters are used as phonological cues or visual cues; we shall assume that it is a combination of both in this study. The representations of words built from the outside in certainly needs to be a focus of future research.

Representation of lexical knowledge must include some visual memory processes otherwise the New Zealanders, who have limited phonological skills, could not acquire the speed and accuracy at reading familiar words that they show. These visual memory skills are aiding the New Zealanders by helping them produce an equivalent level of word recognition to the Scots. Further evidence that visual memory skills are important for reading development comes from studies of dyslexics like R.E. (Campbell and Butterworth 1985) who was able to read competently and had apparently good visual memory skills (as measured by non-reading tests) but very poor phonological skills. Cossu and Marshall (1990) Cossu, Rossini and Marshall (1993) claim to have found readers who have learned to read a large amount of words with virtually no phonological knowledge. The word distortion study detailed in chapter 7 shows us that visual memory for words is not based on word shape cues but more likely, as we have discussed on some aspect of salient letter processing. Tachistoscopic studies and pattern masking experiments, as used in adult reading experiments, may help pin down the influence of end letters and what visual memory for words is based on. It would be interesting to find out how much practice is needed to allow a word to become represented in the lexicon. Longitudinal studies of the acquisition of word representation acquisition would help throw light on the development of lexical knowledge.

Dual route models of reading characterise the development of encoding/decoding skills in terms of the learning of GPC rules. This study has shown that the Scottish children make errors and produce data consistent with this viewpoint (Stuart and Coltheart 1988) but submits no direct evidence about the level of analysis at which these rules are applied. It was found in the distortion task that the Scots reading of words was disrupted. It was hypothesised that this was evidence against the Scots reading in a letter by letter serial manner and that it was more likely that the Scots base decoding on segments of words like consonant clusters and vowel digraphs. A number of other studies reinforce this idea (Coltheart and Leahy 1992, Stuart and Coltheart 1998, Ehri and Robbins 1992, Ehri 1994, see Chapter 1,2 and 4 for more information on phonological reading). Some authors think that phonological skills are based initially on larger word segments like onset and rime (Goswami and Bryant 1990, Goswami 1994). However, Seymour and Evans (1991) and Ehri and Robbins (1992) have contested this and claim that skill at using smaller segments like phonemes develops before onset-rime awareness. The Scots in this study could have been recognising words by recognition of vowel and consonant digraphs which the zig zag disruption would disrupt. The type of instruction the children receive in this matter is obviously of great importance and needs to be further investigated.

The evidence of a word length effect in the Scottish children would indicate that they employ sequential left to right decoding. How does this differ from the New Zealanders who show no such effect with familiar words? This could be investigated further by comparing eye movement data between the two groups across a number of different stimuli. Do high frequency words which are stored in the lexicon need only a brief glance in order to be recognised as the RT data would suggest? How long does the serial decoding in the Scottish readers last? On a more general level, how long does the differention between the two groups of readers last? Does the lexical and sub-lexical knowledge develop to such an extent that effects of instruction are subsumed by levels of individual skill? All these questions could be answered by a longitudinal study of readers studying under different instructional approaches.

It has been shown in this study that instruction can help produce readers who have the same overall skill level in general word recognition but who use different strategies to read words. These strategies are a reflection of how the child has been taught. These results therefore also have practical implications as well as theoretical ones. Reading age control designs in investigations of dyslexics, for example, may need to be more carefully controlled to ensure that the method of teaching is comparable across groups. A child who shows a phonological deficit and who has been taught by a language experience approach if matched against children taught by a phonic method would probably show an exaggerated difference. Readers can read at an adequate level of competence using either instructional method at an early age but this may change over time so that the phonics children will develop greater independence in their reading earlier than the language experience children (Adams 1990). The start of this may already be seen in the advantage in comprehending text found in the Neale test. The type of instruction a child receives in order to learn to read will ultimately have an effect on reading development. The question of why this is so now needs to be addressed.

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Appendix 1

Reading instruction in Scotland and New Zealand

Scotland and the phonics method

Phonics can be termed a bottom-up approach to reading, working from letters, syllables and words, the building blocks of reading material, up to meaning. It involves giving the child coaching about the relationships between letters and sounds in words whilst also giving explicit instruction about the written form of those letters and sounds at the same time. For example children are shown that "cat" and "cub" not only start with the same sound but also the same alphabetic letter. Soon more complex phonic rules are learnt covering consonant blends (for example, track and trap) and vowel digraphs (for example, deer and meet). The child is encouraged to decode new words using the letter sound associations they have been taught. This intensive training in the Scottish schools was accompanied by the use of a standard reading scheme so that the communicative purpose of reading was not lost. The ultimate aim of the phonic system is to enable the child to build its knowledge of orthographic rules such that its use of them becomes automatic and effortless, so the child can quickly become an independent reader free to concentrate on the message of the text.

The general reading scheme used is the GINN 360 programme. It is used throughout all the years at Primary school. The Primary 1 and 2 use levels 1 to 6 of the scheme. There are generally five to six basic books at each level which introduce a variety of words to the children. The words become more complex as the levels go on. They include nouns, verbs, adjectives and functors, with a length range, in levels 1 to 6, from one to nine letters. Each level is also supplemented by smaller more colourful "Magic Circle" books which reinforce the vocabulary introduced in the Basic Books.

Worksheets and exercises, both verbal and written also reinforce the vocabulary met in the texts. These worksheets also emphasise other concepts like letter sound relations, rhyming words and the break up of words into individual letters. As the child progresses other more complex skills are introduced, like using letter sounds to decode new words, what sounds consonant clusters make and the use of "magic e". The written worksheets give the child practice in simple writing, starting with individual letters, then moving onto words and sentences. This helps also to introduce the child to basic spelling concepts.

All of this is supplemented by many colourful charts and posters about letters and words in general which the teacher can apply in a learning context.

GINN 360 is not just a reading scheme but more of a language scheme which is constantly emphasising the relationship between what the children read and what they write. The children all appear to enjoy their books when questioned about them and eagerly recount their favourite stories.

The scheme claims not to be overtly "phonic" but it does emphasise word structure and grapheme-phoneme relationships from level 1 and continues to do so more and more as levels progress.

The reading aspects of GINN are backed up with a more overtly phonic scheme LINK-UP. This scheme also has its own workbooks which emphasise grapheme phoneme relationships strongly.

The class teachers teach phonic rules to the children. They explicitly teach that words are made of letters. "Word families" are taught which point out phonic rules. To begin with these families consist of simple groups of words with the same initial letter sounds. There is a rapid progression from this to families with the same consonant blends, e.g. "sh" or "th", to vowel digraphs like "ae" or "oo", through to complex phonic rules like "magic e" and "silent k" by the end of Primary 2.

The "rules" learnt are further reinforced by chanting and memorization, e.g. "two o's make oo". Lists of words are presented on the blackboard to emphasise these rules. The children are encouraged to think of more words within the same family.

. Reading instruction commences almost immediately the child begins school, using GINN. At the same time, the sounds of letters are taught using individual letter cards. The children are urged to put together the words they have learnt with their letter cards. Word decoding is taught using the letter sounds and blends learnt from direct teaching from about three months after starting school.

So phonic instruction occupies a most integral part of the programme for reading in the Scottish schools studied; in fact it would be difficult to find a more phonic approach to reading.

New Zealand and language experience

The New Zealand "language experience approach" is compatible with the reading theories of Frank Smith (1971) and Kenneth Goodman (1979), where reading is assumed to be a "top down" cognitive process moving from meaning down to words. So "reading for meaning" from the outset is seen as paramount to the learner. Instruction is based on the philosophy that children will use their knowledge of language to help them understand what they read. Reading is deemed to be a part of language, and language is about communication; children should therefore not learn to communicate by fragmenting words or looking at words in isolation, where their meaning is lost. By concentrating on single words, the argument goes, the child cannot see the wood for the trees. As the child did not learn to talk by taking words in isolation or out of context, why should reading be taught like that? Children will learn to read by reading, just as they learned to talk by talking.

There is an emphasis, therefore, on the story line of a book, the text only being sampled where necessary to establish meaning. Young readers therefore receive training in using meaning to help them read. The child is encouraged to study the context of a story and to think logically ahead, drawing on their own experiences of language to predict the text. It is only when meaning is lost that a reader has to attend more closely to the print, perhaps rereading words or reading on and looking at other sources of information. Phonic cues are only used as a last resort, but they are used to a limited extent. In New Zealand this involves the child using the initial letters of words to help work out what the word is.

The core reading series in New Zealand is the "Ready to Read" series produced by the national Department of Education. In the first two years of school the child who shows average progress will meet 40 single text books and 7 books with collections of stories. These books are grouped in colour coded difficulty levels which allows the teacher to pick an appropriate text for the young reader. The "Ready to Read" series is used in conjunction with other commercially produced books which emulate the "Ready to Read" style.

The reading books are used in three different ways in classrooms in New Zealand> They can be used in shared book experience, guided reading or independent reading. Shared book experience involves the teacher reading a book out loud to the class or a large group of children.

The book is quite often an enlarged version which the children find easier to see. The teacher comments on the story and asks the children to make predictions about the text as it is read to them. Guided reading is with a small group or an individual child. The child attempts to read the text to the teacher and the teacher assists the child where necessary. Prediction and meaning from the storyline are still emphasised. Independent reading involves the child reading by themselves. The books they can choose for this activity are usually drawn from the pool of books they have met before in shared and guided reading. They are familiar and easy to read. Independent reading is designed to allow the child to enjoy reading favourite texts away from the pressures of performing for the teacher as well as practicing what has already been taught.

Read-along cassettes are popular with the children and are produced for selected single texts and collections. The cassettes report the text in a slow even paced manner to allow the child to link the spoken and written word.

It should be emphasised that all of the above reading activities also take place in the Scottish classes but on a much smaller and less formal scale.

The language experience approach in New Zealand is organised in a very efficient and comprehensive way at a national level. Detailed standardised records are kept for every child and an intensive Reading Recovery programme is at hand if the child seems to be failing at reading. Reading has unchallenged prominence in the New Zealand junior school, and we found that more time was spent on reading instruction there than in the Scottish schools that were studied.

Appendix 2

British Abilities Scales Word Recognition Test

B		C		D
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

Appendix 3

Stimuli for the Lexical decision, Homophone decision and Nonword naming tasks

Pseudohomophones	Ordinary Nonwords	Filler words	
loe	coe	hat	hope
luv	druv	bank	box
gon	bon	want	bark
bild	brise	snow	pant
hoam	soam	three	then
blud	blum	band	bar
wosh	mosh	hunt	hung
moove	doove	seem	pat
oan	goan	side	wave
gole	brode	rag	pot

Appendix 4

Stimuli for the Sentence Decision Task

Set A	Set B
Homophonous sentences	
he went to by a book	she ran down the rode
I no your name	give me sum sweets
he ran threw the streets	hear are the pens
we swim in the see	the glass will brake
tell me wear he went	the girl picked the flour
Nonsense Sentences	
she ran down the rose	he went to boy a book
give me sun sweets	I not your name
heap are the pens	he ran three the street
the glass will bread	we swim in the seat
the girl picked the floor	tell me what he went
Filler Sentences	
the dog barked at me	the room is hot
put the cup down	you lost my pen
it is playtime	the bell has rung
I have red hair	the dog ran away
Tom lost his bag	the door is open
here is my apple	give me a drink
the sun is shining	here is my book
look at my dress	we play at home
she drank some water	I ride my bike
come to my house	show me your toys

Appendix 5

Stimuli for the irregular word reading task

High frequency	Low frequency
you	wood
one	foot
are	pint
the	shall
come	broad
said	both
what	lose
good	wool
water	sword
	money
	great

Appendix 6

Stimuli for reaction time and distortion tasks

2 letters	3 letters
go	you
he	one
me	too
no	are
we	the
am	but
at	can
in	got
on	for
up	not

4 letters (silent e)	4 letters (vowel digraph)	4 letters (front blend)	4 letters (final blend)
came	look	they	down
like	said	play	with
home	good	this	went
make	read	what	help
here	rain	stop	bird

Appendix 7.1

The Yopp Singer Phoneme Segmentation Task Stimuli

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

Appendix 7.2

Rosners Test of Auditory Analysis skills

Word	**sound to miss out**
cowboy (PRACTICE)	boy
steamboat (PRACTICE)	steam
sunshine	shine
picnic	pic
cucumber	cu(q)
coat	/k/
meat	/m/
take	/t/
game	/m/
wrote	/t/
please	/z/
clap	/k/
play	/p/
stale	/t/
smack	/m/

Appendix 8

Stimuli for the Spelling tasks

Real word stimuli

	Irregular words	Regular words
low Frequency words	sword	luck
	pint	spear
	broad	mile
	lose	beer
	wool	stuck
high frequency words	come	door
	foot	stick
	shall	best
	both	green
	great	fine

Nonword stimuli

2 letters	3 letters	4 letters (blends)	4 letters (vowels)
ga	ome	dith	rike
ap	bup	plam	loof
re	tob	hent	hobe
ig	caz	thit	sood
na	arg	lant	pake
ob	lor	stom	tain