CAPTURING READING STRATEGIES IN YOUNG CHILDREN

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Copyright Statement

Abstract

Traditional models of children's reading, based on fixed invariant stages, have proved less than adequate in explaining the flexibility in which children approach the task of learning to read. One way to examine emergent reading is to focus on the child's strategy use as a discrete measure of early reading development. However, the exploration of such strategy use within the domain of reading is a relatively new area of research. This current research adds to that burgeoning debate and presents evidence of young children's strategy use and the implications for current theories of reading development.

Study One examined the validity of verbal self-reports as a way of capturing early word reading strategies by assessing the veridicality and reactivity of verbal self-reports. Study Two explored children's sensitivity to rime unit frequencies and how this can shift their reliance on certain word reading strategies. Study Three provided an in-depth examination of reading errors in young children to capture a more detailed account of the processes involved in early word-reading. Study Four used a repeated measures study that examined adaptability in children's reading strategy performance over one academic term. Through an analysis of strategy use and error analysis, Study Four provided a greater understanding of children's reliance on using lexical and non-lexical strategies.

Overall, the results showed that verbal self-reports remain valid and that children were able to accurately verbalise their processing. Children's strategy use was found to be variable and flexible over time and strategy choice was dependent on children's sensitivity to underlying orthographic features (including rime unit frequency and grapheme-to-phoneme regularity). The conclusion from this research is that children's reading is more flexible than the original stage models portray and is in line with phase models of reading development which allow children to progress or regress in their choice of strategy as needed.

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Introduction to Thesis

1.1 Why research reading?

Research into emergent reading development has been widely studied over the last century from many different perspectives. It is necessary to appreciate the processes involved in learning to read if we are to assist children who are struggling to master this complex skill. Inadequate literacy skills place children at an educational disadvantage, a disadvantage that continues into adult life. There is, for example, a lower level of literacy in our prison populations compared to the general population and reading difficulties combined with poor school attendance or attention/behavioural difficulties have been linked to increased risk of offender behaviour (Ouston, 1984). There has been a suggestion that literacy intervention could prevent reoffending (Klein, 1998).

The ability to read allows the child to achieve educational success and hence reading is one of the first skills taught in schools. However, learning to read is not an easy task, especially in a language containing a deep orthographic structure, such as English. This is evidenced by the statistic that 20% of eleven year olds are still not reading at the level they should be and are therefore experiencing isolation in terms of accessing information (Education and Skill Committee, 2005). Gough and Hillinger (1980) described learning to read as an 'unnatural act' due to the complexity of the rules and the cognition required. In order to help children to learn to read it is important to understand the processing that is involved in learning to read and how these procedures are applied to reading different words.

While an extensive body of research into the issues surrounding children who are not reading at their age appropriate level exists, this will not be discussed in detail as this thesis is concerned with examining early word identification among typically developing readers. There is a great importance of conducting research into typically developing children's reading as the findings can assist in building up a picture of the processes of the trajectory of typical reading development, which can therefore be used to assist those who are struggling with literacy.

1.1.1 Previous research in reading

Huey (1908) was one of the first researchers who identified the importance of research into reading and also the impact that the teaching of reading can have. This ground-breaking work raised many issues that still remain pertinent today; some of these will be discussed below. Eye movement research has been greatly explored to see where the eyes are focussing during reading and how the patterns of saccades (fast scanning motions) and fixations allow us to gain information from the text. Eye movement research has been used to inform models of word recognition to gain further understanding about how reading is carried out (c.f. Rayner, 1998).

One of the main questions concerning how children learn to read is how they attempt to read novel words. Initial work resulted in the development of word recognition models (Treisman, 1960; Morton, 1969). These were attempts to map out the cognitive processing that happens when a child (or an adult) reads a word. Later models included the dual route model with separate lexical (retrieval from memory) and non-lexical (phonological) route, for word recognition (Coltheart, 1978) and the opposing connectionist model which predicated on processing words in parallel a single route

(Seidenberg & McClelland, 1989). These models have been through many revisions as extensive field data on children's reading has become available.

A second focus of this extensive research base focuses on how reading skills develop. Stage models were traditionally used to follow children's reading development. These models were based on fixed invariant stages and included prerequisite stages of development that the children had to pass through before they could reach the next level (c.f. Marsh et al., 1981; Frith, 1985). More recent models of reading development are based on phases (less fixed than a stage) which are fluid and children are able to progress or regress through the phases as necessary. Ehri's mediated phase model (1995; 1999; 2002) is predicated on developmental phases and the children are able to move between the phases if necessary. The model also emphasises the importance of 'sight-word reading' and explains how this can be achieved during any phase for certain words. Sight-word reading is how we typically read familiar words as an adult, from memory. The importance of the phase models of development is that they provide information about the types of strategies being used to read the words during emergent reading.

Other areas of reading research that have been explored include the underlying skills that can help to predict reading ability. For example, the ability to manipulate phonemes can predict reading success (c.f. Goswami &Bryant, 1990; Goswami, 1993; Muter, Hulme, Snowling &Taylor, 1998). In addition there have been numerous studies looking at children with deficits in phonological skills (which can be displayed as phonological dyslexia) and how this can impact on their reading ability. However, there is a significant number of children who have high levels of word recognition, but cannot understand what they are reading (Nation, 2007) a disjunction that has lead to a number of studies on reading comprehension studies which show vocabulary and text comprehension are also important skills for emergent reading (Cain, 2009; Cain & Oakhill, 2006).

Analyses of reading errors have been used to highlight early reader strategy use. Studies have highlighted that phonological errors (errors sharing phonological characteristics with the target word) have been found to be predictive of later reading success (c.f. Stuart & Coltheart, 1988; Savage & Stuart 2001; 2006). Reading accuracy could also be related to the way in which teachers or parents 'correct' the child after making an error. The analysis into reading errors however has not been examined by looking at the strategies that are applied to the word when the errors are made. This could give an insight into why errors are made and assist in teaching efficient strategies to create high accuracy in reading.

This brief overview of research in reading does not in any way describe the vast amount of research that has been carried out, nor does it refer to all of the issues that have been investigated in the current thesis. The main purpose however of all of the research carried out looking at children's reading is to assist children who are struggling with reading and to inform the debate on how best to teach reading in English.

1.1.2 Implications of research into reading

One of the major goals of research into reading is to help inform educational policy and assist with decisions about how best to teach reading in schools. The National Literacy Strategy (NLS) was introduced in 1998 suggested 'best practice' ways of teaching reading (Department for Education and Employment, 1998). The NLS was based on psychological models of reading which highlighted the key elements needed to learn to read. Gough and Tunmer (1986) presented the simple view of reading arguing that the key skills required were decoding and comprehension. They argued that with a combination of these two skills a child could become a good reader. The NLS has used this framework to identify the two key skills that need to be taught in school. The first element they have termed ‘word recognition’ and covers decoding the word or identifying the word straight from a sight vocabulary (see Ehri 1995; 1999; 2002). The other element is ‘language comprehension’. This looks at the ability to understand the text that is being read (Rose, 2006).

One of the major debates in the teaching of reading stems from this ‘word recognition’ element, more specifically how the child learns to decode. The evidence examining the use of phonics in teaching reading has suggested that it is very important and can have a great impact on reading acquisition in children (Ehri et al. 2001; Rose, 2006; Stuebing et al., 2008; Torgerson et al., 2006). Whilst there are many ways of teaching phonics in schools, the two main teaching methods are analytic phonics (using large phonological units) or synthetic phonics (using the small phonological units to sound-out each letter and blend). Within the UK currently the advice from the NLS is to use the synthetic phonics route, meaning that children are being specifically taught to manipulate individual phonemes, rather than working at the analogy level (Department for Education and Employment, 1998). This could have the impact of promoting certain strategies over the use of others. The National Reading Panel (NRP) in the U.S. examined the difference between schools using the two types of phonics approaches and concluded that there was no significant difference between the analytic and synthetic phonics training. Based on these conclusions there is no evidence based argument to promote one over the other (Ehri et al., 2001). It is apparent that phonics is not the full answer to the teaching of reading. Although they are part of a necessary skill-set other aspects such as comprehension and fluency are equally significant. The Rose review of reading highlights that whilst phonics teaching provides an adequate decoding mechanism for reading words, without learning other strategies the child would not successfully be able to read all words in English (Rose, 2006). Exception words require different skills and it is important that these are taught alongside. The way that reading is taught within school can have an impact on how children attempt to read a novel word and therefore form an important point.

1.2 Contribution of this thesis to the area of reading research

The contribution of this thesis is to add to the current knowledge about how children learn to read through a direct examination of the strategies that the children are using to read words on a single word reading task. There are both methodological goals (validating the use of verbal self-reported strategy use and applying a cross-sectional, longitudinal design) as well as theoretical goals (examining strategy use over time and across different word types).

The first purpose of the thesis concerns the validation of verbal self-report methods in the context of early word-reading. Verbal self-reports of strategy use have been used as a method of capturing how children are carrying out literacy based tasks (c.f. Rittle-Johnson & Siegler, 1999; Kwong & Varnhagen, 2005), however the accuracy of the reports has been questioned. The initial study of this thesis examined whether the children were able to give an accurate report of the strategy that they are using to read the word. The study included a triangulation of different methods to study the development of reading strategies incorporating latencies, reading accuracy and direct behavioural observations. Similarly in Study One, the validation of using self-report methods was provided through an explicit comparison across different self-report methods (retrospective vs. concurrent reporting methods) was examined to assess whether providing a verbal report would change the children's performance on task. An additional feature of this study was the rapid naming task which aimed to validate the use of retrieval from memory (as there is little associated behaviour when a word is simply read by sight).

The second objective of the research was to examine word-specific shifts in children's strategy performance in the context of word reading. Study Two provided an in-depth investigation of the different patterns of strategy use across word items that varied in terms of grapheme to phoneme correspondence rules (GPC) and rime unit frequencies (namely consistent, exception and unique words). The strategy use for spelling each of these three word types has been examined in previous studies and found that the children displayed a sensitivity to rime units and were able to spell consistent words more accurately than exception or unique word items and applied lexical (retrieval) strategies more frequently to consistent and exception words (Nation, 1997; Farrington-Flint, Stash & Stiller, 2008b).

The third objective was to develop and apply a new coding framework for the classification of self-reported reading strategies alongside the identification of early word-reading errors. The development of a new coding system was designed to further describe how children are applying phonological skills to words that they are unfamiliar with. In order to develop this new framework the errors made in reading were analysed and the data was coded to see what classifications these errors came under (Savage, Stuart & Hill, 2001). The relationships between the errors made and the strategy use was also investigated over time in Study Four.

The final contribution employed a repeated measures, cross-sectional study (over one academic term) to examine the development of word-reading strategies and reading errors over time (see Study Four). This allowed a critique of stage and more fluid models of reading development and looked at how children are able to adapt their strategy use to suit the different types of words presented. This final study also examined how the different classifications of errors are made over time and if this has any impact on reading development.

Chapter Two

Theoretical Models of Early Reading Development

2. A definition of reading

Reading is described as a way of gaining knowledge from printed symbols through 'perception of language by the eye' (Spencer, 2000). The process of how we interpret these symbols that we are seeing to gain understanding is complex. Although the term 'reading' can involve many different processes, in this thesis 'reading' refers to word recognition and how children are able to read aloud (correctly pronounce) the word that they are presented with. Appendix A contains a glossary including the definitions for the terminology used in this thesis.

2.1 Introduction

The purpose of this chapter is to provide a critical overview of the skills required in learning to read and the different theoretical models of early word reading development. It is argued in this chapter that traditional models of reading development which include the cognitive-developmental model (Marsh, Friedman, Welch & Desberg, 1981; Seymour & McGregor, 1984) and stage models of reading (Frith, 1985) which follow a fixed invariant sequence of discrete distinct stages, can at best offer an incomplete account for children's reading development. More recent, non-stage models such as Ehri's (1995; 1999; 2002) mediated phase account of reading acquisition, provide a more detailed and accurate account of the way in which children develop early reading skills. While mediated phase models appear to offer the best explanation for children's early reading acquisition, there is considerably little research that has explicitly examined how children use reading strategies to progress through these stages and therefore requires further research. Finally, the word recognition models are critically discussed to see which model provides the closest fit to children's reading and how this helps us to understand the strategies that are being used to read.

2.2 Phonological units in reading

Phonological awareness has been described as the process that occurs when speech is broken down into smaller representations. In order to examine phonological awareness the tasks involve attempting to manipulate individual phonemes (the smallest unit of sound) and reflecting upon how these are combined to create speech. Morais (1991) defined phonological awareness as the ability to segment words into their constituent parts. There has been some debate about what type of units are classified as phonological units; a phoneme is certainly a phonological unit, but some authors talk about onset and rime (rhyme) as a key phonological skill. This debate about phonemes (small phonological units) and onset and rime (large phonological units) will be discussed below.

The link between the development of early phonological skills and the progress that children make in learning to read has been widely acknowledged (c.f. Bruck & Genesee, 1995; Castles & Coltheart, 2004; Goswami & Bryant, 1990; Share & Stanovich, 1995; McBride-Chang & Kail, 2002). Teaching children these phonological skills through intervention studies has shown an increase in reading performance (Ehri et al., 2001; Gillon, 2000, 2005). However, there is conflicting evidence about whether small phonological units (individual grapheme to phoneme correspondences) or larger phonological units (using rime units) are more useful in learning to read. This debate has a direct effect on current theoretical models of children's early reading acquisition. More importantly, this debate has implications for the way that reading is taught in school and can have a direct effect on policy decisions about the teaching of literacy skills at primary school. While phonological skills may be crucial to explaining early reading development, the link between children's awareness of different phonological units and their explicit attempts at word reading still remains an unknown and largely under-researched topic.

The section will begin by outlining the distinction between small and large phonological units in relation to children's early reading development and argue that both units are fundamental to explaining the progress that young children make in learning to read. In light of these different phonological units, the chapter will then critically address some of the previous models of early reading development demonstrating how further research is required to fully examine the processes involved in learning to read using more experimental measures.

2.2.1 The development of early phonological skills

This section reviews the literature concerning the importance of phonological awareness in relation to children's early reading development and argues that phonological skills are fundamental to explaining the progress that children make in learning to read. When examining children's early reading acquisition one approach is to examine the strategies that they are using to read novel words. These strategies can overlap with research looking at phonological skills. Using a small phonological unit would mean using a strategy such as sounding-out (applying the GPC mappings) and blending the phonemes together to produce the pronunciation of the word. Another strategy which can be applied is the use of analogy, using the onset and rime in a word.

There has been ongoing debate regarding the types of phonological skills that predict later reading progress and the order in which children learn these skills. These are discussed in terms of small versus large phonological units. Using small phonological units means that the child is able to manipulate individual sounds and apply grapheme to phoneme correspondences. The small phonological units are all used on an individual level and require awareness of each phoneme and letter name.

Alternatively phonological skills can be applied via large-phonological spelling-sound units. These larger phonological units involve using the rime in words and reading groups of graphemes together. Onset and rime is an example of a large-phonological unit. Onset and rime allows children to generalise common endings in words and just change the onset. For example in the word 'king' the /k/ sound is the onset and /ing/ is the rime. This rime can be seen in many other words (such as 'ring', 'sing' and 'thing') and the child is able to simply manipulate the onset to achieve the correct pronunciation of the word. These phonological skills, once mastered, can be used as strategies to learn to read novel words. The evidence looking at both small and large phonological units is reviewed below with an argument that both types of phonological skills are important to learning to read. Research has suggested that these skills develop in a sequence and that younger children are more capable of working with large phonological units first, then once this is mastered they can learn to use individual phonemes (Stanovich, 1992; Gombert, 1992; Anthony & Lonigan, 2004).

2.2.2 Large phonological units

Reading via large-phonological units involves using the rime in the word (analogy) to generalise sounds and produce a pronunciation. Pre-school rime skills therefore can have a positive impact on being able to apply these analogies (Bradley & Bryant, 1983).

Bowey (1995) looked at kindergarten children and found that final phoneme identity could predict 14 – 19% of the variance in reading, but the best predictor was the use of onset and rime, which accounted for 24 – 28% of the variance. Goswami and Bryant (1990) reviewed studies looking at rime awareness and found a causal link between the use of onset and rime and progress in later reading. One way in which an early awareness of rime links to alphabetic literacy is through the ability to make orthographic analogies. Goswami and Bryant (1990) suggested that the use of onset and rime was the first phonological skill that was used in learning to read and that the ability to manipulate individual phonemes is a later acquired skill. Their theory states that learning to manipulate phonemes is a consequence of learning to read. This has been termed the interactive analogy model of reading and states that children are able to learn shared onsets and rimes and apply them to novel words in order to produce a pronunciation of that word (Goswami & Bryant, 1990; Goswami, 1993). One of the studies that Goswami and Bryant (1990) review is Bradley and Bryant (1983). Bradley and Bryant (1983) used a longitudinal design to look at reading progress with children who initially could not read any words. The sample size was large with a starting sample of 403 and children who showed some emergent reading were excluded from the study. The children were given rime and alliteration oddity tasks. The results showed that the children were able to complete these tasks with relative ease and the scores on the tests were predictive of later success in reading. These studies all support the view that large phonological units are learnt first and once the child has started reading and spelling words the smaller phonological units will be learnt. Other studies have also found that awareness of individual phonemes and the ability to manipulate sounds in words can be very difficult and is learnt after onset and rime. Liberman, Shankweiler, Fischer and Carter (1974) found that young children struggle to separate phonemes with this approach. Based on these findings it would suggest that children rely more heavily on onset and rime during emergent reading.

However, there have been some criticisms of the approach used to study these large phonological units. Much of the evidence for the interactive analogy model of reading comes from studies employing the clue-word paradigm (c.f. Goswami, 1986; 1988; 1990; 1993). This is where a clue word is given and the child is told its pronunciation. The children are then asked to look at some words and read them. Some of the words are analogous to the clue word and therefore the rime can be used and the child just needs to decode the onset. Deavers and Brown (1997) examined the clue-word paradigm and suggested that the nature of the task was forcing the children to read using an analogy strategy, rather than reading via individual phonemes. This task is not showing that children cannot read via small phonological units, but rather is showing that they are able to use large-units. Some research examining large versus small phonological units has found an alternative view of learning to read.

2.2.3 Small phonological units

There is considerable evidence to show that small phonological units (i.e. phonemes) are important in explaining the success children make in learning to read. Muter, Hulme, Snowling and Taylor (1998) found that it was segmentation of individual phonemes and not rhyme (rime) awareness that was a predictor of early childhood reading. The study screened the children to be non-readers and used a sample of 38 children. The children were tested using a large battery of psychological measures at three testing points throughout the two year study. The battery of standardised measures included rhyme detection, rhyme production, rhyme identification as well as the Wechsler Preschool and Primary Scale of Intelligence (Wechsler, 1967). The main findings were that there was a difference between segmentation (small phonological units) and rhyme awareness (using large phonological units). The path analyses found that rhyming was not a predictor of first year reading ability, but the ability to segment and manipulate phonemes was a predictor for both reading and spelling. The main predictor for reading in Year Two was reading level in Year One. These results are supported by Hoien et al. (1995) who found that the phoneme factor in their analyses was important for later reading ability. The results also suggest that letter name knowledge is a predictor of reading acquisition. The finding that letter name knowledge is highly predictive of reading acquisition provides support for some traditional stage theories of reading that state that you need letter name knowledge to progress on to become an alphabetic reader (c.f. Frith, 1985; Seymour & MacGregor, 1984).

Previous studies have shown that the use of small phonological units are separate from the use of onset and rime (Muter et al., 1998; Hoien et al., 1995). Similarly, Carroll, Snowling, Hulme and Stevenson (2003) found two distinct factors contributing to this phonological awareness showing that rhyming is distinct from phoneme identification. This suggests that the skills required for using smaller phonological skills are different from those needed to use analogy. However, there has been some disagreement which suggests that perhaps the skills required for both types of phonological awareness are the same. Anthony and Lonigan (2004) systematically reviewed four studies which had found a similar view that rhyming was distinct from the ability to manipulate individual phonemes. They reanalysed the findings from Wagner et al. (1997), Lonigan et al. (1998), Muter, Hulme, Snowling and Taylor (1998) and Muter, Hulme and Snowling (1997). The reanalysis used structured equation modelling and confirmatory factor analysis to examine whether the different phonological skills were distinct from each other. The results showed that the skills were not distinct, but some age differences emerged. Younger children found the larger units easier to manipulate and this impacted on their initial development in reading. The older children however were able to use both the smaller and larger units with the same success showing that the ability to manipulate individual phonemes could develop later. There is more support for the idea that a child uses large phonological units before learning to manipulate smaller phonological units. Goswami (1999) found that smaller units appeared to be more important to reading acquisition after the child had started some formal reading training. Goswami found a developmental sequence that the children tended to first learn to segment syllables, then use analogy and onset and rime, followed finally by the use of individual phonemes. Gombert (1992) describes the developmental sequence of learning phonological awareness as occurring due to changes in the mental lexicon. The use of syllables and onset and rime are controlled by epilinguistic knowledge and these develop first. The ability to manipulate and segment individual phonemes is classified as metalinguistic awareness and this is usually developed through literacy tuition. Similarly to Gombert's theory of developmental change is phonological awareness, Stanovich (1992) describes the development of phonological skills to be on a continuum. This is explained in terms of going from a shallow to deep approach; the shallow representing the larger units and then later using a deeper approach and breaking down words into individual phonemes.

However, while Gombert's metalinguistic theory of reading shows that both small and large phonological units are important for early language acquisition (Gombert, 1992; Stanovich 1992; Goswami, 1999), it is important to now critically examine how each of these phonological units are applied and how they can complement each other.

2.2.4 Applying phonological units in reading English

One key theoretical issue concerns the actual application of different phonological units to early word-reading. The Psycholinguistic grain size theory (Ziegler & Goswami, 2005) states that the consistency of the language being taught can inform whether children are able to best apply a small or large phonological unit. This stated that the smaller grain size is less useful when learning to read English because of the inconsistency in grapheme to phoneme correspondences. However, in a more consistent orthography (such as German or Italian) a smaller grain size can afford children the opportunities to learn the individual phoneme for each grapheme. Brown and Deavers (1999) assessed the evidence of small and large units and found that children need to learn to be able to use both methods in order to be achieving a good knowledge of phonology to apply to words. Bowey (2002) found that the developmental stage of the child is the best predictor of which type of strategy (using small or large phonemes) and this can calculate the best strategy to use. Goswami, Ziegler, Dalton and Schneider (2003) tested the types of psycholinguistic grain size that children were using when they were learning to read novel words. They used non-words which were designed to promote the use of a certain grain size. For example the non-word ‘dake’ would be best read using a large phonological grain size as it is pronounced in the same way as ‘cake’, ‘make’ and ‘bake’. There were also non-words which were designed to use a small grain phonological unit as they were best decoded using a GPC strategy. The results found that if the word list presented to the English children contained both types of non-words then the reaction times on the task were slower than if the list was made-up of just one type of grain size. The reason for this slower reaction time is that it requires switching from using a small to a large grain size or vice versa. However, this effect was not found in the German readers who showed no difference in reaction time. The study also found that the English readers were more accurate when reading pseudohomophones, than simple non-words. This suggests that when reading English the whole-word phonology is taken into account and this means that the English readers are reading the phonology of the word as a whole.

It is clear that phonological skills are crucial for the progress that children make in learning to read. It is argued that the way in which children are applying these phonological skills (whether they use the small or large units) can be identified through an explicit examination of their self-reported strategy use. Certain strategies can show that the child is using a certain type of phonological skill. For example, on a regular word if a child is using small phonological units, they would be decoding words on a letter-by-letter and sound-by-sound basis. If they are applying a large phonological unit then they may be applying an analogy strategy. The psycholinguistic grain size theory suggests that to read English we need to incorporate both types of phonological grain size to allow accurate pronunciation of the words. By examining strategy use it may start to inform us about the way that phonological units are used in early word reading in different types of words; providing a window on the interplay between phonological skills and actual orthographic-based word reading. The following section considers the implications that large and small phonological units may have in teaching literacy in schools.

2.3 Implications of phonological units for teaching children to read

There has been considerable debate about how phonics should be taught in schools and if there is an advantage to promoting the application of small or large phonological units. The analytic phonics approach has a reliance on large phonological units and works on the basis of reading the word as a whole first, and then examining the composite sounds and learning the large phonological units in the word. With the analytic phonics approach the child is learning to use a common starting sound, or the onset and rime and these strategies are used to learn to read other words (Ehri et al., 2001). On the other hand, synthetic phonics teaches the child to explicitly focus on and use small phonological units. The main skills which are taught are the ability to use grapheme to phoneme correspondences, the skill of blending the sounds, how to segment words and sounds. There has been a lot of debate about whether phonics should be used to teach children to read and if it is helpful, then how should this be taught.

The National Reading Panel (NRP) examined the difference between schools using the two types of phonics approaches (analytic and synthetic). They came to the conclusion that there was no significant difference between the analytic and synthetic phonics training and that based on these conclusions it was difficult to promote one over the other. Torgerson, Brook and Hall (2006) furthered this using a meta-analysis of previous studies from peer-reviewed journals selected according to the same criteria as the NRP, but the studies were only included if they contained a randomised control trial, where the children were assigned randomly to groups and each group received a different type of training. The main findings from this study supported Ehri et al. (2001) in the NRP study that phonics instruction has a significant impact on teaching children to read. When looking at analytic phonics versus synthetic phonics, however, there were only three studies including a direct comparison using a randomised controlled design and there was no significant effect found between the two types of teaching.

While no main effect of synthetic and analytic phonics was found across the three studies there were differences within the individual studies. Johnston and Watson (2004) placed children who had just started school into three experimental groups with differing teaching methods: a synthetic phonics group, an analytic phonics group and an analytic phonics with extra phonological awareness training group. The children in the synthetic phonics group showed more advanced reading skills; more specifically they were more successful at reading irregular and non-words. The children in the synthetic phonics group were also better at using analogy as a way of learning to read novel words. This is an unexpected finding as the analytic phonics approach should teach the use of analogy and allow the children to apply this strategy when reading. The authors concluded that synthetic phonics is a better way of teaching children to read, but there is still a lack of empirical evidence to support this assertion. Within the UK the current message from the Rose Review of Reading is that children should be taught via a phonics route. The schools selected in the present research were all following a synthetic phonics approach promoting a reliance on small phonological units.

It is important to note however that phonics training does not provide the complete answer to teaching reading. The National Reading Panel (NRP) highlighted that training in comprehension and fluency had positive impacts on reading (Ehri et al., 2001). The key message here is that the phonics approach should not stand-alone.

2.4 Developmental models of children's reading development

It is recognised that phonological units are particularly important for children's early word reading and play a fundamental role to their reading success. However, to build up a whole picture of children's emergent reading it is necessary to understand how phonological units can contribute to becoming skilled readers and what the developmental trajectory for a beginning reader may look like. Traditional stage models of reading development have a fixed set of stages through which children learn to read. A key argument in this thesis is that children may not be learning to read in such a methodical way and that more flexible models such as Ehri's (1995; 1999; 2002) mediated phase model of reading could offer a more reliable account of understanding the development that children make in learning to read.

2.4.1 Early models of reading development

Early models of reading focussed on different ways of reading, and how these could influence success. Gough and Hillinger (1980) stated that reading rarely happens without receiving instruction. They devised a model whereby emergent reader's use cue reading by applying visual cues and reading words that they have learnt as a whole, such as environmental print. One problem with reading using visual cues is that similar words can be easily confused and there is no way of decoding words previously unseen. As the child's reading develops the cue reading is replaced by cipher reading where the word is decoded into graphemes and phonemes. This model is relatively simple and does not fully explain how children learn to read. Mason (1980) divided the cue reading phase by examining where they were getting their information from. This was divided into information gained from the context or simply gained from visual recognition. The final stage of Mason's model (similar to Gough & Hillinger, 1980) involved reading using decoding from letter-sound. These early models provided a foundation from which more advanced and detailed models were born; these will be summarised below. However, a key argument is that while these models provide a detailed characterisation of the processes involved in both early reading and spelling, more detailed analyses of the actual strategy choice are required to fully acknowledge the transition through these different stages fully.

2.4.2 The cognitive-development model of reading acquisition

One of the earliest models of word reading stated that learning to read is a gradual process that occurs in a fixed invariant sequence of stages (c.f., Marsh, Friedman, Welch & Desberg, 1981). Marsh et al., (1981) proposed a four stage model of reading development based loosely on Piaget's original (1952) model of intellectual development. The first stage involved learning to read words via 'rote association' and guessing based on context. The child does not apply any phonological knowledge to the words at this stage, but can read words within a sentence. Stage two of the model sees the children using familiar words to guess the pronunciation of others. The authors term this 'discriminate net guessing' as the children are identifying enough information in the word to simply discriminate that word from similar words. At this stage they also begin to use the rhyme in the word. Stage three of reading development typically develops around the age of seven years old (Marsh et al., 1981). At this point the grapheme-phoneme correspondences are mapped and rules are applied to reading in order to 'decode' the words. The final stage of reading contains the most sophisticated strategies used in reading such as analogy. Marsh et al.'s model of reading development has been criticised as although there is observational evidence supporting many of the stages, there is no appreciation of early phonological awareness or speech skills.

The main issue with the cognitive-developmental model of reading development is that the stages lack both theoretical grounding and supporting evidence from longitudinal work. Stuart and Coltheart (1988) reviewed the evidence used to support each stage of the model and found that it was based on specific studies that were not longitudinal. For example the evidence for stage one of the model was provided by Weber (1970) who through an examination of errors found that children were making less contextual errors and therefore stated that the errors were in graphemic information. Marsh et al. (1981) suggest that the studies by Barr (1975) and Cohen (1975) show that phonological processing increases during reading development and cause the transition between stage two and three. However although these studies do show a steady development of phonological skills there is little examination of phonological processing in earlier or later stages. Stages three and four are supported by studies by Marsh et al. (1981) included in the same paper. The study used non-words in the place of nouns in a story. Some of the non-words were CVC regular and others could be read using an analogy strategy (large phonological units). The strategy that the child was using was decided using the pronunciation and not any verbal explanations that they may have provided. The results showed that the younger readers used substitution more regularly and that those in stage three could use analogy if required to. However, in stage four analogies were used much more easily. This is suggesting that children are initially using smaller phonological units to pronounce unfamiliar words and larger phonological units are being used later in reading development. These studies are methodologically flawed as they are simply examining the difference between complex and simple decoding by showing that simple decoding tasks are mastered earlier. Stuart and Coltheart (1988) state that whilst this is an intuitive finding, it is very simple and would be hard to find a child who could not complete a simple decoding task more successfully than a complex one. The final issue with this model is that there is no discussion about how skilled readers are able to retrieve orthographic representations automatically. Therefore it does not fully explain the extent of reading development.

The lack of longitudinal evidence means that there is little to support the idea that children progress through these stages in this order and the model does not accept that there may be individual differences in learning to read. Within English, given it has an irregular orthography, there could be word based individual differences due to the complexity of the GPC mappings in certain words. In order to further examine the processes that children go through in order to learn to read there is a need for longitudinal studies using the same children.

2.4.3 Stage models of reading acquisition

Similar to cognitive-developmental models of reading acquisition, stage models offer a series of progressions in a fixed order through which the child's reading develops. Frith (1985) based her own model on the cognitive developmental theory by Marsh et al. (1981). The model identified by Frith is speculative, as it is based on the observational research used by Marsh et al. (1981). This model changes the four stages of the cognitive developmental model into three phases; the logographic, alphabetic and orthographic. Within the logographic phase of reading children read words as a whole if they are familiar, however, they will often refuse to read unfamiliar words as they do not possess the decoding skills to start to break the word down. This phase corresponds with the first two stages of the Marsh et al. (1981) model. Powell, Plaut and Funnell (2006) found further support for Frith's (1985) logographic phase of development. The results of their behavioural study showed that at the first time of testing the children read words better than non-words as the children are most likely recognising words as a whole unit and learning the shapes. Frith identified the next stage as the alphabetic phase within which the readers begin to decode by applying grapheme-phoneme correspondences. In the final phase, the orthographic phase, words are read straight from their orthographic units and do not involve phonological decoding. The final strategy to be acquired is analogy (as in the Marsh et al., 1981 model). The strategies in Frith's model develop sequentially with the earlier strategies forming pre-requisites for the next stage of development. However, pre-learnt strategies are not lost and the children are still able to return to that strategy. Previously applied strategies may require some retraining; this is described as 'merging' (Frith, 1985).

Stuart and Coltheart (1988) looked at models of reading acquisition in order to establish the model of best fit. They found some criticisms of Frith's model. One of the problems is the way in which 'grapheme' is interpreted, as Frith appears to be describing a grapheme as a single letter, not a unit. Perhaps therefore Frith's alphabetic phase is covering letter to sound correspondences instead of grapheme to phoneme. There is no mention of how children are able to transfer letters into sounds and no mention of how they decode the words in Frith's model. Another criticism of Frith's model, highlighted by Stuart and Coltheart (1988), is that the orthographic phase of reading is vague and there is limited description of how this varies from the logographic.

As Frith's model was based on the cognitive-developmental theory (Marsh et al., 1981) it is not surprising that the stages and ways of moving between stages are very similar. Therefore, this model does not take into account that children can concurrently use more than one strategy to assist them in reading. This model also fails to take account of contextual information as well as early phonological knowledge and as Frith acknowledges that the model is purely speculative then it does not appear to be providing an accurate representation of early reading acquisition.

2.4.4 Seymour's model of reading acquisition

A more focussed and better articulated model of reading acquisition is that of Seymour and MacGregor (1984) which is built on the findings by Marsh et al. (1981) to conceptualise the progress that children make in learning to read. This model has three stages which are broad and at times the reader may be classified as being partially in two stages, as the model has a little more flexibility. The stages in the model are labelled as Frith's (1985) model which are the logographic, alphabetic and orthographic stages. However the achievements in reading and the development of strategies within these phases are different. The first stage involves reading using a limited sight vocabulary and like the other models visual cues are relied upon. The next phase involves learning how letter-sound correspondences inform reading and this forms the alphabetic phase. The final phase is the most important as it sees the orthographic information being internalised with an appreciation for analogy and spelling occurring in this stage. This model has been described as a dual lexicon as the logographic and orthographic lexicons are essential and Seymour describes these elements as becoming permanent parts of the reading system.

Seymour (1990; 1997; 1999; Seymour & Duncan, 2001) developed the dual foundation model based on previous developmental theories and incorporating research into these stages of reading. Seymour and Elder (1986) monitored in detail the emergent reading patterns of school children and found support for Frith's logographic stage of reading as the children were able to read words they were familiar with, but were not able to decode novel words. However, Stuart and Coltheart (1988) criticised the work as there were no direct measures of phonological awareness. Seymour and Elder report that their test school used a whole-word method of teaching reading and therefore the children were not taught to use phonology. Another study by Seymour and Evans (1992) used a school teaching mixed methods to assess reading development (including phonics and whole-word teaching). They found that the children were able to use both logographic ways of reading (using visual cues and learning words as a whole unit) as well as reading through phonics (the phonological information).

The model developed by Seymour (1999) as Frith (1985) and Ehri (1992) is based on the assumption that to be able to learn to read children will need to have linguistic awareness as well as orthographic awareness and that there are also two key foundation processes, the logographic and alphabetic. The first phase called 'phase zero' captures readers' early linguistic awareness, often described as pre-literacy. This has been categorised as being in two parts; epilinguistic awareness (identification of a sound) and metalinguistic awareness (the ability to manipulate and delete phonemes). The studies have suggested that pre-literate learners only have epilinguistic awareness and are not able to fully manipulate sounds. Duncan and Seymour (2000) found that specific training on rhymes with pre-literate readers assisted in the development of understanding rhymes within words, but did not predict later reading ability. Furthermore a path analysis suggested that the only predictor of later reading skill was having knowledge of some letters at pre-school.

The 'phase one, foundation literacy' is a critical stage in the acquisition of letter-sound correspondences. Within this phase children also develop the key foundations for reading; an alphabetic knowledge and an orthographic knowledge. Within English this phase of learning can take up to two years as the deep orthography means that both the logographic and the alphabetic must be learnt at the same time, but they involve very different aspects of learning. Phases two and three, orthographic and morphographic literacy occurs after the foundation literacy phase. Within this phase metalinguistic abilities are mastered such as an understanding of phonological units and onset-rime. Duncan, Seymour and Hill (2000) found that when presenting non-words containing rime units used in real words, the frequency of the rime in real words had a significant impact on whether they were able to read it. They also found that children's ability to apply to use analogy was linked directly to reading age and that those showing a reading age of above 7.5 years were more skilled at using analogy.

Seymour's model (1999) revealed a similar pattern of reading development to Marsh et al. (1981) and Frith's (1985) models, however the author states that stages do not require a pre-requisite as seen in the other models. The present model of reading development is based on building up a set of key skills required for reading. The author also discusses how the model is adapted to suit both deep and shallow orthographies as there is consideration of both the lexical and non-lexical skills. It is important that models of reading development are adapted to suit a deep orthography as a phonological strategy does not always guarantee a correct pronunciation.

Stuart and Coltheart (1988) argue that earlier stage models of reading acquisition have very little understanding of phonological knowledge and assume that all children are using the same route to learning to read. They reject the logographic phase of learning to read arguing that reading happens in two phases; partially orthographic with a limited knowledge of phonology and complete orthographic which emerges when their phonological skills are more advanced. Perhaps children are actually using different routes depending on their ability and they may start reading at a different level in comparison to other readers. Based on this assumption then stage models of reading are too restrictive and a more flexible design is needed to reflect children's early word reading.

2.4.5 Mediated phase model of reading development

It has been argued that the prior models of early word reading (c.f., Marsh et al., 1981; Frith, 1985; Seymour & McGregor, 1984) are based on the identification of distinct and qualitatively fixed stages of word reading that do not allow for the flexibility of processes involved in learning to read. However a more valid model of reading is Ehri's phase model of early reading development (1995; 1999; 2002) which acknowledges both flexibility and variability in the types of approaches that many children make in the early stages of word reading. It also emphasises the importance of sight word reading through all phases of reading, not just in skilled reading. Ehri (1991) identified four different phases of word reading characteristic of beginning readers. For unfamiliar words these were using (a) explicit phonological decoding, (b) applying GPC rules (c) the use of larger phonological units (e.g., analogies and morphological rules) and (d) the ability to predict words from those already stored in memory (indicative of sight word reading). Ehri highlights that the goal is to become a skilled reader and that the best way to achieve this is being able to read words by sight. Sight word reading is the most efficient strategy to read familiar words. In effective sight word reading the word can be read as fast as a single digit (Ehri, 1999). By reading words by sight we no longer need to attend to the phonological properties of the word and therefore can concentrate on the meaning and understanding. Sight word reading is therefore a key faculty for skilled reading. In order to read words by sight Reitsma (1983) found that exposure to the word just four times was enough to familiarise and store the word.

Share (2004) found that in a sample of Israeli third graders the majority were able to recall words after being exposed to the word once.

Many studies have provided evidence that sight word reading is used for pronouncing familiar words. Ehri and Wilce (1983) tested latencies on reading familiar words, CVC non-words and single digits. The results showed that the familiar words were read much faster than the non-words. This shows that sight reading is the fastest and most efficient strategy for reading familiar words. The second experiment looked at the latencies for less-skilled readers to learn to unitise the words. The results found that children were less accurate in decoding non-words and remembered the real words more efficiently even after practice with the non-words.

The stroop effect has also been used as a tool to identify the use of sight word reading as a strategy. Guttentag and Haith (1978) showed that children at the end of the first grade can show signs of sight word reading on a stroop task when asked to ignore the written word and just attend to the visual stimulus (for example a picture of a 'chair' with the written word 'dog'). Children in late first grade often attended to the irrelevant words automatically (confusing the response), in contrast it was found that children at the start of the first grade showed little interference from irrelevant written words. This suggests that as little as seven months of reading instruction can cause sight word reading to appear in familiar words in first graders. Ehri and Wilce (1979) also used the Stroop task in order to identify sight-word reading. They developed a word recognition model with three phases of reading development based on LaBerge and Samuels (1974). Their model suggested that phase one involved words going from unfamiliar to familiar using component letters and identifying the sounds. Phase two sees familiar words being automatically recognised without being specifically processed and in phase three the speed of reading the words increases. In order to test their theory they used first and second graders and used a Stroop task. They trained the children to recognise the distracter words and then measured the interference that they caused. The prediction was that the word training would increase the interference by the words. They found that the children who were unfamiliar with the distracters at the start learnt to recognise them and in the post-test they found that there was a strong inference by the distracter words. However, there was an unexpected finding for children who were familiar with the words at pre-test. These children simply learnt to read the words faster, which had the effect of decreasing the interference. This is due to less attention needing to be paid to the word for recognition and also a reduction in time to process the word. This means that the children trained to read the word faster could attend to it quicker and then attend to the picture, thus not impacting on the task. These results were explained as occurring because the children who were less familiar with the words at the pre-test had learnt the words and in post-test they were not attending to them. However, those who simply became faster at recognising the words showed less interference as the delay by the distracters was less as they recognised them faster. Ehri and Wilce (1979) said that this displayed evidence that there was a difference between phase two and phase three in their word recognition model.

However, applying sight word reading is not necessarily a conscious decision unlike applying other strategies such as analogising, decoding or predicting word pronunciations. Ehri (1999) developed the mediated phase model which places readers into categories depending on their development, but unlike a stage model the readers do not have to complete one phase before using another method of reading. The phases also provide an indication about the different strategies used in reading and spelling. As it is a phase model, readers can regress to an earlier phase if the stimulus merits it and each phase does not require a pre-requisite before progression. Ehri (1999) states that these phases are very important in an educational setting as they can assist in recognising ‘poor’ readers and diagnosing reading difficulties at an early age.

The first phase in reading acquisition is the pre-alphabetic phase. This sees readers recognising words and ‘reading’ them based on the shape of the word and using visual cues. During this phase it may be pictures in story books or colours that assist them in reading and recognizing words. Masonheimer, Drum and Ehri (1984) changed letters in commonly recognised environmental print such as famous trade marks and asked the children if they could find an error with the writing. They found that most children did not pick up on the change even though they had been warned there could be an error. This is showing that the children are attending to the visual cues, such as the colour and shape of the word, and not the individual letters. However the criticism with this study is that visual cues are perhaps also used by older readers for recognition of environmental print, even though other strategies are available to them. This effect therefore could be created by the type of task as the environmental print may be read using another route.

Evidence for this phase is provided by Bloodgood (1999). This study examined which letters children in the pre-alphabetic phase were able to recognise. Using three to five year olds the study found that even though they could read hardly any of the primer words they were able to recognise their own names and some names of their classmates. When asked how they recognised their name, many said they knew the first letter. Trainman and Broderick (1998) also found that many pre-alphabetic readers were able to write their names, but they could not name the letters individually. This suggests that children are using perceptual memory rather than an understanding of the meaning of a letter shape.

It may appear at this phase that children are able to sight read words, however they do not actually understand the relation between the graphemes and phonemes and therefore are only recognising the shape of the word. Semantic priming is also used as a method of reading in the pre-alphabetic phase. Children are often able to predict words based on the context and errors made will often be context specific, such as reading 'apple' as 'orange'. As the children in this phase have limited or no knowledge of the alphabet system they are unable to decode words and therefore have no way of understanding novel words.

The partial alphabetic stage is a more advanced way of reading than the pre-alphabetic phase as it involves a new understanding of the alphabet and some phonological knowledge. In this phase children begin to use the sounds of the letters and develop grapheme to phoneme correspondences (GPC rules). Readers use a few of the letters in a word to decode, this means that words with similar structures can be confused and prediction is still used as a strategy for unknown words. Savage, Stuart and Hill (2001) found that the first and last letters are used to recognise words in this phase and therefore common errors in reading are mistaking words with the same initial and final letters. Common phonemes in familiar words are committed to memory and are retrieved easily.

Evidence that the pre-alphabetic and partial-alphabetic phases are distinguishable comes from Ehri and Wilce (1985). Using nonsense spellings for real words they assessed the children's ability to memorise them. There were two different types of spelling; one was based on letters that visually looked unusual and one was based on the phonetic sounds. The results showed that pre-alphabetic readers were able to remember the visual spellings much better than the phonetic and the partial-alphabetic readers (who now had phonological knowledge) were able to better recall the phonetic spellings. Similarly Roberts (2003) experimentally manipulated preschoolers' letter name knowledge. The results showed that those with a good understanding of the alphabet and the letter names were better equipped to apply phonology in decoding. Byrne and Fielding-Barnsley (1989; 1990) investigated the training required to take a child into the partial-alphabetic phase of reading. They found that knowledge of phonological units was important and that children need to be taught how to segment initial sounds. During this phase readers are able to decode simple and familiar words using GPC rules, however complex non-words are still really difficult.

The partial-alphabetic phase is characterised by the emerging use of phonological information, however sight word reading is the most efficient strategy and therefore familiar words will be read via this strategy. Barron and Baron (1977) found that even children as young as first grade could learn to sight read familiar words without having to use the phonological properties of the word to decode it. They applied two tasks; one using a rhyming task (e.g. a picture of a broom and the word 'room') and a meaning task (e.g. a picture of an orange and the word 'apple'). The children were asked to decide which pairs went together whilst completing an interference task (repeating the word 'double' aloud to interfere with vocalisation). The results found that the interference task had an impact on matching up the pairs that were connected phonologically (the rhyme task), but not the context-linked pairs. This supports the view that familiar words can be read from sight at an early age, if they have been familiarised.

When the children have a full knowledge of the alphabet and more advanced phonological knowledge, they enter a phase where they read by forming connections between familiar letters and producing completed sounds. In this phase non-word reading ability is good because decoding is possible using GPC rules. Sight word reading is used extensively during the full-alphabetic phase for familiar words and if a word is unknown there is now a bank of strategies to call upon. Ehri and Wilce (1987) experimentally examined readers at both the partial (the phonetic-cue readers) and full alphabetic phases of reading (the cipher readers). The readers were matched and then they were placed into one of two groups. One group received training to learn to decode non-words over 5 – 11 sessions with each session lasting 20 minutes. The other group were simply given instruction in the GPC mappings and practiced these for 2 – 3 sessions. When tested at the end of the study the partial-alphabetic readers were still unable to read most of the words in the task, however the full-alphabetic readers could read most of the words. The partial-alphabetic readers also made many errors in reading by confusing similarly spelled words.

Finally, the consolidated alphabetic phase begins during the full alphabetic phase and continues with a greater understanding of phonology and by storing shared strings of letters to memory, i.e. ‘tion’ and ‘ing’. During this final phase the process of accessing words is much faster and sight word reading is the most effective strategy for reading words that have been seen before. A new strategy that becomes available in the final consolidated alphabetic phase is the use of analogy to decode and pronounce a novel word. Ehri (1995) cites support for the consolidated alphabetic phase from a study by Ehri and Robbins (1992) using first graders with some decoding skills. There were two conditions; one where the students were taught a set of words and a set of analogous words and one where they were taught a set of words and a set with similar sounds. The first group were able to learn to read the analogous words faster than the second group could learn their word lists as the shared letter patterns in the analogous words made it easier to learn.

In this phase all types of words should be available for decoding using a specific strategy. In terms of non-words the readers are able to use the phonological knowledge to map the graphemes to phonemes or apply analogy using word that is familiar to them. Skilled readers would typically read exception words via sight word reading (retrieval) due to the complexity of the GPC mappings in these words. Therefore the application of a phonological strategy does not necessarily guarantee success.

Ehri's (1995; 1999; 2002) phases of development better reflect the fact that children can vary in the way they are reading different words and allows for movement through these different phases over time. The overall goal in Ehri's model is to achieve sight word reading, which is not only the fastest way of reading, but it is also vitally important in English as decoding errors are likely to occur in many irregularly spelled exception words. When examining whether sight word reading happens in more transparent orthographies, Defior, Cary and Martos (2002) and Wimmer and Goswami (1994) found that German, Spanish and Portuguese readers also apply sight word reading even though decoding would work equally well on all words due to the shallow orthography of these languages, as it is simply more efficient. This suggests that by committing familiar words to memory not only are you able to read faster, but you are able to read the text for the meaning in the appropriate context (Ehri, 2005). Within Ehri's phase model familiar words will predominantly be read using sight word reading, however unfamiliar words will be analysed using different strategies. The strategies used to decode novel words can vary depending on the phase of development and therefore an analysis of reading strategy use can place readers into certain categories of the mediated phase model.

One criticism is that the evidence supplied for the consolidated alphabetic phase uses first graders and therefore this is suggesting that the final stage of reading can be achieved at a very early age (Beech, 2005). Beech suggests that this does not reflect true reading development which can continue into adulthood. However Ehri (1999) has argued that the phases are very flexible and perhaps the readers may achieve the consolidated alphabetic phase for shorter words, but still need to use an earlier phase for decoding longer and less familiar words.

In summary Ehri's phases of development seem to be more flexible and are a better representation of real reading development than earlier traditional models of reading and spelling development, such as Frith (1985). Ehri's phases are based on the processes that are dominant within each of the four different phases and this is a very important way of examining reading development because they illustrate that different strategies may be dominant at different phases of word reading. This acknowledges a multidirectional approach that children can concurrently use processes characteristic of different phases at the same time, though this needs to be examined specifically. The main limitation is that the evidence for these phases is rather weak and less compelling as children at different phases are compared. In order to provide a clear understanding of these phases verbal reports of strategy use could be collected as this would identify familiar and unfamiliar words throughout development.

However, the fact that use of analogies later in reading as a more advanced strategy raises some debate. While some researchers argue that such strategies are available to young children in the very early stages of learning to read (Farrington-Flint & Wood, 2007; Goswami, 1988; 1990; 1993) others have documented how children need a well-developed sight vocabulary as a basis for making analogies between familiar and unfamiliar words (Ehri, 1998; Ehri & Robbins, 1992). This questions the extent to which analogies are used in the consolidated alphabetic phase of reading (as outlined by Ehri). In fact, it is important to note that such claims are often based on experimental studies (or clue word studies) that specifically train children to recognize words based on similar rime units using clue-word prompts. These clue-word experiments promote the use of analogy as a strategy and can over-estimate the use of such a strategy. In order to fully examine analogy use, it needs to be examined in naturalistic reading. Given that these findings are task dependent then it is likely that these studies often over-estimate the extent to which analogies are used spontaneously in the context of children's early word reading (Deavers & Brown, 1997; Roberts & McDougall, 2003; Savage, 1997).

Ehri's phase model is a flexible account, which explains how children are able to rely on sight-word reading even at a young age. The previous models of reading development that have been discussed do not allow for the flexible transition and although evidence is used to provide a basis for each stage, there is little longitudinal data to show the overall shape of reading development. An examination of strategy use is one way of looking at how the children are reading the words and therefore identifying the stage/phase of their development. Previous studies that have examined children's strategy use in literacy (spelling and reading) have found that strategy use is more varied and that within a word list the children are able to adapt their strategies to suit the word presented (Rittle-Johnson & Siegler, 1999; Kwong & Varnhagen, 2005; Farrington-Flint et al., 2008a).

2.4.6 Share's self-teaching hypothesis

The argument presented so far states that while phonological skills play a predominant role in learning to read, a closer examination of how these small and large phonological units are used in the early stages of learning to read, remains important. Moreover, unlike stage models of word reading, Ehri's (1995; 1999; 2002) phase model provides a clearer and more valid account of learning to read given that she acknowledges flexibility in these reading processes. However, the self-teaching hypothesis (whilst not a model of reading development) plays a predominant role in providing further explanation for the development of reading processes in line with changes in orthographic representations. Specifically, this approach seeks to explain changes in reading processes according to the nature of the words that the children are attempting to solve.

Share's (1995) self-teaching hypothesis recognises that children rely on a range of different reading processes to secure orthographic representations to memory leading to the recognition of known words by sight. This focuses on word-level orthographic representations (and not global changes as outlined in Ehri's account). The hypothesis is based on the idea that phonological recoding takes place when a child is given an unfamiliar word to read. Each time a child decodes a word on their own using the GPC rules or an analogy strategy they make a new word-specific representation of that word. As with Ehri's model of reading, it has been shown that children are able to make these representations after exposure to the word on few occasions (Ehri & Saltmarsh, 1995; Reitsma, 1983). In order to achieve these word-based orthographic representations the phonological recoding needs to be learnt based on each item. This creates an item-based approach, dissimilar to the cognitive-developmental model and others following the stage-like approach. In order to accurately use the self-teaching approach knowledge of letter-sound correspondences, some ability of phonological sensitivity and the ability to use context for pronunciation are required. Share (1999) tests the hypothesis by using homophonic pseudowords introduced into pieces of text. The 40 children from the second grade were exposed to the target non-words in a piece of text. The participants saw the words four or six times during the text (depending on the experimental group they were placed in). Three days after exposure to the texts the children were asked to complete an orthographic choice, naming and spelling task containing the same pseudowords and also some foils which were very similar. The orthographic choice task consisted of the children being shown four words; the target word that they had previously seen in the text, a word which was the homophonic alternative, one with the letters displaced and one with one letter displayed as a visually similar letter, and they had to decide which the target word was. The results showed that phonological recoding was used in order to read these words and turn them into orthographic representations, as the accuracy in the orthographic choice task three days after reading the text was good. Repetition after four exposures in the text added little improvement in performance suggesting that the appropriate orthographic representations were made with four (or less) exposures to the word. Further, the children appeared to be learning the word according to their own pronunciation (from reading it aloud). This is clear as the children who made mispronunciations of the words were picking a foil which was closest to that mispronunciation, rather than the actual word at post-test. These findings support the findings of Reitsma (1983) showing that children need relatively few exposures to words before they can be read by 'sight-word reading.' Share (1999) went on to see if phonological information was important to learn to read these words. The children were asked to read pseudowords under conditions that minimized the use of phonological information (being asked to repeat the word DUBBA aloud). The results of this study showed that children were still using some automatic phonological recoding (as it was impossible to eliminate phonological recoding) and then the non-words were being stored as orthographic representations. The findings of these experiments showed that phonological recoding is essential in creating orthographic representations of words.

The self-teaching hypothesis is based on an item-by-item approach to reading and shows that children can learn to read a word by sight after relatively few exposures to the word. It is based on the letter-sounds principle and is using the pronunciation of the word. It is suggesting that children are able to use phonological recoding on their own in order to create new orthographic representations. This can all be achieved once they have letter-sound knowledge and are able to pronounce words. The self-teaching hypothesis forms a theory of how children are able to read novel words and describes some of the processing, however it does not form a model of reading development and can therefore be applied alongside other models.

2.5 Theoretical models of word recognition

There are two main models of word recognition which explain how we are able to read a word when it is presented. Dual route models propose two separate pathways for word recognition, depending on whether the word is already encoded. Coltheart (1978) outlined a model showing a dual route for reading. This was characterised by two routes for information which worked independently of each other; a lexical route and a non-lexical route. The lexical route is used for words which are familiar and can therefore be retrieved as an orthographic representation. Within the lexical route it is also possible to further subdivide this pathway into a recognition route and a semantic route using the meaning of the word. The non-lexical route relies upon the grapheme to phoneme correspondences (GPC) and other phonological information to decode the word and create a pronunciation. The non-lexical route using the phonological information can be characterised by the use of strategies such as sounding-out, analogy or the use of onset and rime. The primary distinction between the two pathways in the dual-route model is the types of words that are read using each route. The lexical route can be used for reading familiar or exception words (which cannot be decoded due to irregular GPC mappings). On the other hand the non-lexical route can be used to decode any regular novel words and also non-words. This dual-route model has been updated many times to provide a closer accuracy in reading to humans (Coltheart et al., 1993), including the creation of a computational model based on the dual route architecture called the Dual Route Cascaded (DRC) model (Coltheart et al., 2001; Rastle & Coltheart, 2006).

The other model of word recognition is the connectionist model, first developed by Seidenberg and McClelland (1989). This was a 'triangle' model of reading which showed the connections between graphemes, phonemes and semantics in a 'semantic' and 'phonological' pathway. This model differs from the dual route model as the pathways do not work independently, rather they both contain interactive units which are wired together (similar to neurons) and weights cause the connections to read the words. This model does not distinguish between different routes and words are simply read in the most effective way. The original model by Seidenberg and McClelland (1989) did not accurately represent human reading as the precision on non-words was poor. Seidenberg and McClelland (1990) suggested that increasing the training corpus of words could improve the non-word reading skill. The model was further developed to produce reading ability more similar to humans (model known as PMSP - Plaut et al., 1996). The PMSP had the grapheme units being uni-directionally connected to phoneme units in order to better explain reading of novel or non-word items. This model however was not able to produce an accurate exemplar of surface dyslexia and it was further developed (Powell, Plaut & Funnell, 2006). While both models of reading development have been adapted in order to more accurately represent reading development, they still exist as there are still strengths and weaknesses of both models with different theorists choosing their favourite.

The main difference between the dual route and connectionist models of reading development is the way in which it is constructed. The connectionist models (i.e. triangle model and PMSP) are developed using backpropagation based on showing stimulus–response pairs and training a learning algorithm (Coltheart et al., 2001). The dual-route models have been described as being 'hand-wired rather than learnt' (Coltheart et al., 2001; 205). The architecture of the dual-route model is more engineered by the modeller. This means that the processes are more explicit, whereas connectionist models can mask some implicit processes. There have been many comparisons of the two theories in order to try to establish the model with the 'better fit' to human data. Table 2.1 compares the two different word recognition models and summarises the studies comparing the models to human data.

Table 2.1 Comparison of the dual route and connectionist models of word recognition.

Dual Route Model	Connectionist Model
Model is made up of serial processing and the routes work independently of each other.	Model is made up of parallel processing and the pathways do not work independently.
The model is modelled by the engineer and is hand-wired. This means it does not 'learn' to read in a similar way to humans.	Model 'learns' to read via backpropagation and using stimulus response pairs.
When compared to undergraduate non-word reading the dual route model showed longer latencies (Seidenberg et al., 1994).	**The connectionist model was able to produce a good fit (99%) to the adult reading on non-words (Seidenberg et al., 1994).**
Dual route model was able to adequately match adult data on a lexical decision task (Coltheart et al., 2001)	Parallel processing means that lexical decisions are slower than in adult data (Coltheart et al., 2001).
Rastle and Coltheart (2006) found that the dual route model matched the adult data when looking at effect of phoneme positioning in irregular words and position sensitive stroop.	Connectionist model could not replicate adult data when examining effect of phoneme positioning in irregular words and position sensitive stroop (Rastle & Coltheart, 2006)
There is evidence that children do have access to a non-lexical route for reading and that this is separate from the lexical route. People with Surface Dyslexia show impairment on the non-lexical route, but they are able to read via the lexical route without problems (Castles & Coltheart, 1993; 1996).	PMSP connectionist model compared with children's reading development found that it could not replicate latencies for reading non-words (Powell, Plaut & Funnell, 2006).
There is also evidence from Hyperlexia which shows that there are two separate pathways for reading (Aram, 1997)	Connectionist model required 300 exposures to learn to read, which does not match children's reading development (Coltheart, 2006). The connectionist model also overrides previously learnt words when presented with a new list (McCloskey & Cohen, 1989).

N.B Bold denotes a finding showing support for that model over the comparison

2.5.1 Comparing the word recognition models to human reading

As Table 2.1 suggests, dual route models provide a closer fit to human data on reading (denoted by a bold typeface). Coltheart et al. (2001) compared the DRC computational model using the dual route architecture with the connectionist models looking at other predictors of reading ability in adults using a lexical decision task (deciding if a printed letter string is a real word or not). They found that models using serial processing (the DRC) provided a more natural account of lexical decision making. The three main effects that they were looking for were longer latencies associated with low word frequency, lexicality effects and an impact based on orthographic neighbourhood characteristics. The study found that the DRC was able to adequately match the human data suggesting that the DRC is a better representation of word recognition processing than connectionist accounts. Similarly, Rastle and Coltheart (2006) went on to examine whether human reading is happening in serial or in parallel as this is the main difference between the dual route models (serial processing) and the connectionist models (parallel processing). They highlighted some examples in reading that could not occur if the processing was happening in parallel (refuting explanations provided by those supporting connectionist models). The first effect that they found is related to the position in a word of an irregular grapheme to phoneme mapping. If for example the irregular mapping is the first phoneme in the word it can have a slowing effect on reading latencies (i.e. ‘chef’), however the effect becomes smaller when it is the second or third phoneme in a word. Rastle and Coltheart (2006) found that the DRC model was able to replicate these findings and showed a similar slowed reading effect when the positions of the irregular phonemes were manipulated. However, they found that the parallel processing in the connectionist account meant that these effects were not seen and therefore the fit to the human data was poor. Similar effects were seen when looking at the position sensitive stroop.

When compared with children's reading there are differences in the fit of the models to human data. Powell, Plaut and Funnell (2006) investigated the connectionist model in relation to children's reading. When comparing the performance of the connectionist model on the non-word reading task the results found that the model was unsuccessful at replicating the findings and had much longer latencies. In order to retrain the model to ensure that it was able to read at the same level as the children, the model was provided with a phonological knowledge, as studies have shown that children with phonetic and letter name knowledge progress more effectively in reading (Muter, Hulme, Snowling & Taylor, 1997; Stuart & Coltheart, 1988). After this additional GPC training the network was much better matched for the data finding more words being successfully read at time one and slightly more non-words being read at time two. However, the reading errors made by the children and those made by the model still differed even after the phonological training. The children tended to make a 'guess' at a word if they did not know it using a real word with a similar letter or structure. The model however produced non-words when making errors. One explanation is that the vocabulary held by children is much more advanced than the training corpus of words the model is trained with.

One explanation of the differences between the connectionist model and the children's data could be to do with the way in which the connectionist models 'learn' to read. As mentioned above, the way in which the connectionist computational models and the DRC (dual route) computational models 'learn' to read is different. The DRC is all based on modelling and does not 'learn.' This would suggest that at face value the connectionist model is a closer fit to children's reading behaviour as it also learns to read, however if it is not learning in the same way as children then it is not providing a good representation of emergent reading skills. Coltheart (2006) examined the number of exposures that the connectionist model needed in order to learn to read the words. The connectionist models required many more exposures and repetitions of each word compared to naturalistic reading in children. The model by Plaut et al. (1996) required 2,998 words to be presented 300 times before the words were learnt. Share (1999) stated that children only needed a word presenting once or twice with the correct pronunciation before they were able to create an orthographic representation of that word which could then be called upon at will. This is suggesting that the connectionist models are not learning in the same way as the children as they require more frequent exposure to the words and they need to have a larger vocabulary in order to make generalisations to other words.

Overall it would seem that there is little reason to favour connectionist models as although they do 'learn' to read rather than being modelled, they are not representing the same pattern of emergent reading as children. Jackson and Coltheart (2001) argued in support of the dual route model that children do learn to read using dual pathways and that they can use the lexical route if the word is familiar to them, but otherwise they will rely on decoding via the non-lexical route. The dual route models have also been used with success to replicate reading disorders such as developmental surface dyslexia (Castles & Coltheart, 1993; 1996) where the children have an impairment on the non-lexical route or hyperlexia (Aram, 1997) which shows an impairment in the semantic system. It is also possible to map strategy use onto the dual route model in order to access the information about which route is being employed allowing an examination of how children can switch between the dual routes for accessing different words.

2.5.2 Summary of word recognition models

The models of word recognition suggest that in order to read novel words (or familiar words) there is more than one process required. The research suggests that the dual-route model and the connectionist models both employ the same processes to read words, but the difference is whether the processing is done in serial or parallel. This means that an orthographic skill is needed to read words from memory as a whole, but in order to decode words which have not previously been encoded it is necessary to have phonological skills. The previous studies comparing the two main models of word recognition show that although they are both able to provide a good fit to adult reading when provided with non-words (Seidenberg et al., 1994), the dual route model shows a better representation of adult reading ability when tasks such as lexical decision are applied (Coltheart et al., 2001). When looking at children's reading the connectionist model is found to 'learn' to read in a different way to children and the internal memory in the computational model does not match the ability of children's lexical memory skills. Therefore although the dual route computational model (DRC) is modelled and does not 'learn' to read via key skills, the two pathways can be used to identify the different strategies that children are using to read. The non-lexical route for example allows use of strategies such as GPC rules (sounding-out), whilst the lexical pathway relies on sight-word reading. Reading disorders can also be identified through a failure in one of the pathways to reading (Castles & Coltheart, 1993; 1996).

2.6 Chapter summary

This chapter has critically discussed the importance of phonological units in relation to children's early reading development and has examined different theoretical models of learning to read. The development of children's reading strategies has been discussed through the stage models which suggest that children use different strategies dependent on their emergent reading skills and an analysis of the ways in which reading is taught. The argument presented here is that earlier models of reading (Marsh et al., 1981) and fixed stage models (Frith, 1985, Seymour & McGregor, 1984) describe the development of reading as occurring in a fixed invariant sequence of skills without acknowledging individual differences in the progress that children make in learning to read. Fixed stage models suggest that children learn to read using one method and then once that has been mastered they will move on to another way of reading. These models predicted the way that children were learning to read at different ages but did not take into consideration the early phonological skills acquired by the child. It has been argued therefore that Ehri's (1995; 1999; 2002) mediated phase model of reading acquisition provides a much more flexible and valid approach to categorise the processes involved in learning to read without the need to have fixed sequences or stages. Nonetheless, whilst this mediated phase model of reading acquisition is more flexible than earlier approaches, there is still little field evidence as yet in support of these phases of reading and currently little examination of the strategies that children use to read during their early reading acquisition.

Finally, it was argued that while Ehri's model focused on global changes in reading, it is also important to consider changes on the individual word level. For instance, Share's self-teaching hypothesis emphasises the importance to characterise children's word reading on the basis of individual word level representations (and not global changes) stating that children could learn to make different orthographic representations about novel words based on those they already know. In order to further examine which of these theoretical models of reading acquisition provides a true reflection of children's reading a close examination of reading strategies is required. Chapter Three reviews some of the prominent studies that have examined the development of children's early word-reading strategies and how they can adapt over time.

Chapter Three

Application of Theoretical Models

3 Introduction

As argued in Chapter Two, many previous models of reading development are too structured and involve fixed invariant stages through which a child must pass in order to become a proficient 'reader.' However, there is limited evidence for the application of different processes and further work that examines shifts in reading strategies is required. While previous research examining developmental shifts in self-reported strategy use is summarised, it is clear that very few studies have actually examined the possible validity in taking self-report accounts. For example, while previous studies examining strategy use on a task have used verbal self-reports (asking the child to report on how they completed the task) to examine the underlying cognitive processes (c.f. Rittle-Johnson & Siegler, 1999; Kwong & Varnhagen, 2005, Farrington-Flint, et al., 2008a), none of these studies actually provide any indication to the accuracy or validity of using self-report methods, especially in young children (see full discussion in Chapter Four). To provide a background to this discussion, the current chapter considers the importance of studying children's strategy performance across algorithmic and non-algorithmic domains, before specifically reviewing previous research in the context of children's literacy development. A closer examination of the use of reading errors as a method for examining strategy performance is also discussed.

3.1 Changing strategy use

When examining strategy use on task it is important to examine if the strategy chosen is dependent on the task, or dependent on the stage of development. The traditional stage models of reading development state that the strategies applied to reading a novel word are stipulated by the stage of their development (c.f. Marsh et al., 1981; Frith, 1985). However strategy use could be more fluid and be task dependent. Siegler (1996) suggested that children are able to choose a strategy from a range that is available to them to best suit the problem. This forms the foundation of the Overlapping Waves Model based on the three assumptions that children can use a variety of strategies, diverse strategies continue to exist over time and that experience can bring change in strategy use as well as developing new strategies. The overlapping waves model charts this strategy development and states that learning can be influenced by choice, variability and change (Siegler, 2005). As Siegler (2002) argues, *'the overlapping waves approach better captures the dynamic, continually changing character of development and focuses attention on discovery of new approaches as well as on choices among existing ones'* (Siegler, 2002, p 36).

The overlapping waves model has been used to track the development and change in use of strategies in learning. It shows how some strategies become used less frequently and some emerging strategies are used more primarily. Other strategies are used for a short period of time (when it is believed that they will yield a correct response) and then begin to decline. The model shows that at any period of time multiple strategies may be used and change in strategy use can even be seen intra-individual. Studies examining the overlapping waves theory identify combinations of these strategies in each study and on occasion all can be identified (Siegler, 2005). It is important to look at studies that have previously examined strategy use and investigate the methodology that they have used to tap into the cognitive processing.

Research in algorithmic domains (where any strategy applied correctly could execute a correct response) such as mathematics have shown that children often use a wide variety of strategies and that strategic variability is quite evident even in children of the same age (see Kwong & Varnhagen, 2005; Siegler, 1987, 1988; Rittle Johnson & Siegler, 1999; Siegler, 1996). These studies have suggested that children are able to adaptively choose the best strategy for the problem, in order to produce the most accurate answer in the fastest time, reflecting the overlapping waves model. There has been considerably less research conducted in the non-algorithmic domain (where execution of a strategy may not guarantee success) such as spelling and reading.

3.1.1 How and why does strategy use change?

Alibali (1999) examined the way in which strategy choice can adapt and change using third and fourth graders who were presented with equivalence problems to solve. In order to identify the influence of instruction and feedback on strategy choice they were placed into five different groups; a control group, a group receiving feedback, a group receiving gestured instruction, one receiving verbal instruction and the final group were given instruction using analogy. The study found high levels of variability in strategy use to solve the mathematical problems throughout the study. They found that those in the groups receiving instruction (in the varied ways) developed new strategies during the study and the adoption of these new techniques was likely to be gradual over time. However, 24% showed strategies emerging abruptly during the microgenetic testing. In traditional cross-sectional designs strategy change can appear abrupt when in fact it is biased by the data collection, however in the microgenetic design the frequent testing periods are designed to avoid this occurring. This suggests that in fact strategy use can emerge very suddenly, perhaps as a result of instruction. In order to capture the strategy use in this study Alibali used a combination of self-reported strategy use as they solved the problems and recording their gestures during computation. The results from the analysis of the gestures (behaviour) highlighted strategies which were not mentioned at all in self-reports. This especially seemed to be at the point of experimentation with a new strategy. Perhaps the participant at this stage does not feel confident with the use of the strategy and therefore would prefer to verbally state that they are using a previously existing strategy, whilst their gestures suggest a new strategy is being trialled. The findings also showed that strategy change and development was not simply a consequence of instruction or feedback as the control group who did not receive any assistance in the problem solving also showed changes in strategy use over time. The ways in which strategy choices adapted during this research gives empirical support for Siegler's overlapping waves theory of abundant variability. The next section discusses the application of Siegler's overlapping waves model and studies examining strategy use in more detail.

3.1.2 Strategy use in algorithmic domains

The majority of research into strategy choice and application of the overlapping waves theory has been in the algorithmic domain (Siegler & Shrager, 1984; Siegler, 1987; Siegler & McGilly, 1989; Geary, 1990; Maloney & Siegler, 1993; Lemaire & Siegler, 1995; Rittle-Johnson & Siegler, 1999). Within the algorithmic domain any strategy, if applied correctly will execute a correct response on a task. For instance, in the algorithmic domain of mathematics a child will be able to execute a correct response to the addition problem 4 + 2 using different strategies, such as counting on from the largest addend (counting on from 4), counting all (starting at 1 and counting the 4 and then the 2) or using a number line.

Lemaire and Siegler (1995) examined children's strategy use in multiplication using a longitudinal design. The children were aged eight to nine years old and were all attending a French Primary school. The task included 81 multiplication sums that were divided into two sets and were repeated over three testing sessions. The children were asked to complete the sums and their observable behaviour was recorded as well as reaction times. The results showed that accuracy improved over the trials and reaction times declined. In terms of the strategies that were used across the testing periods retrieval was used on 63% of the sums and repeated addition was only used 20% of the time. The children all used at least two strategies in order to calculate their responses. The change in strategy use over time showed a shift towards retrieval as this is the fastest and most efficient strategy for gaining a correct response. The findings from this study show that new strategies were being introduced across the testing sessions and there is a greater use of strategies which are faster and more efficient to apply. The overall pattern shows that the children appear to be selecting the strategy that is most efficient for them on that particular problem corresponding with all of the assumptions of the overlapping waves model.

3.1.3 Comparisons between the algorithmic and non-algorithmic domains

The previous studies have identified that there is variability in strategy use in the algorithmic domain and this section examines the research examining student's strategy use across both the algorithmic and non-algorithmic domains. By definition the non-algorithmic domain means that even if a strategy is applied correctly it may not produce a correct response such as reading or spelling. For example when sounding out a word which does not adhere to consistent grapheme to phoneme correspondence rules then the result will be incorrect (for example, the word 'pint' or 'yacht').

Siegler (1988) examined strategy use across algorithmic and non-algorithmic domains, concentrating on addition, subtraction and word identification (word reading). A sample of 36 children from the first grade (aged six years old) were asked to complete 14 addition problems, 14 subtraction problems (which were an inversion of the addition sums) and read a word list of 50 items varying in letter length from two to eight letters. They were instructed that they could solve the problem/read the word using any method that they wanted and strategy use was measured by examining solution times and behaviour observation. The study collapsed strategies into retrieval from memory and back-up strategies (using GPC rules, mixed methods and analogy). The results from this first experiment found that percent correct using retrieval was 89% in reading, 82% in addition and 69% in subtraction. In order to test the fit of the results to the distribution of associations model (Siegler & Shrager, 1984) Siegler examined the correlations of percent back-up use, percent errors and median solution time. The model is based on the idea that for every problem there is a representation (an association of varying strength related to the correct response) and a process (the strategy applied). Therefore if a child is presented with an addition problem they would set a confidence criterion of achieving the correct response and a maximum number of searches (the maximum number of strategies that can be attempted). If the problem is familiar then the child will simply retrieve the answer and providing this meets the set confidence criteria, this will be the final answer. However if the problem is unfamiliar then the child may need to try several strategies in order to meet the confidence criteria. The distribution of associations is impacted by previous exposure to the problem, pre-existing knowledge of associations and answers generated by the first solution used. Therefore the model predicts that longer solution times suggest the use of back-up strategies. The results of this study found high correlations ($r = .83$ for word identification) suggesting that the results from this study are appropriate to the cognitive model (distributed associations model). Siegler classified these children into three distinctive groups based on their performance across all three tasks using a cluster analysis. Siegler found that "good students" used retrieval most frequently, but had less confidence in doing so and did not always achieve accurate responses with this strategy. "Not-so-good students" tended to rely more on back-up strategies as their confidence in retrieval was limited. The remaining group were termed "perfectionists" and they showed a different pattern of strategy use. When using retrieval the "perfectionists" showed high accuracy and they also showed fast solution times. However they used retrieval less often (on 42% of trials) suggesting that it was only applied if it was going to achieve a correct response.

The paper by Siegler (1988) also included a second experiment applying similar tasks, but recording strategy use by asking for a retrospective verbal self-report as well as analysing observable behaviour on a sample of 34 first graders using a more challenging word list and mathematical problems. The results of experiment two showed a very similar pattern of accuracy and solution times; however it highlighted the use of back-up strategies when there was no observable behaviour by using self-reported strategy use. If back-up strategies were being concealed by not showing any observable behaviour then they would have been coded as retrieval during experiment one; therefore you would expect to see less 'use' coded as retrieval in experiment two. The results support this view as retrieval in experiment one across all tasks was 63% and it had dropped to 45% in experiment two. There was also a reduction in retrieval solution times in experiment two showing that those problems solved with retrieval were solved more quickly.

Both experiments overall show that there are clear individual differences based on the knowledge and confidence in using certain strategies, such as retrieval. This study has educational implications as it suggests that students struggling academically should be taught more effective back-up strategies, rather than be encouraged to retrieve information (Siegler, 1988). In terms of reading development this is now implemented with the emergence of the phonics approach through the National Literacy Strategy. However in mathematics typically children are encouraged to be able to retrieve answers to relatively simple sums and multiplications and perhaps more teaching related to effective use of back-up strategies is required in the domain of mathematics.

The results from this study have been replicated by Kerkman and Siegler (1993) finding the same pattern of K-means clusters. Farrington-Flint, Vanuxem-Cotterill and Stiller (2009) looked at the strategy use across both domains using two mathematic tasks (addition and subtraction) and two literacy tasks (reading and spelling). The sample size was 50 children aged five to eight years old. The strategy use was collected using retrospective verbal self-reports in line with previous work (Rittle-Johnson & Siegler, 1999; Kwong & Varnhagen, 2005). The main findings of the study were that individual differences existed across both domains in the strategy used. There were also age-related improvements with the older children gaining more accurate responses on all tasks, than the younger children. When examining the algorithmic domain (mathematical tasks) the most commonly applied strategies were using finger modelling and counting-on strategies. In the literacy tasks the predominately used strategies were GPC rules or retrieval directly from memory (indicative of Ehri's sight word reading). Comparisons were run between the types of strategies applied on the tasks in the algorithmic domain and those in the non-algorithmic domain. The results found that the children using more advanced strategies on the mathematical tasks were using more sophisticated strategies on the reading and spelling tasks.

These studies are finding that there is a similar pattern of strategy use in the non-algorithmic domain as in the algorithmic domain. The children appear to be using a different pattern of strategy use depending on the task at hand. Studies examining strategy use in spelling and reading are discussed below.

3.2 Strategy choice in the context of children's literacy

The previous section has discussed the importance of studying strategy development within the context of algorithmic domains (e.g., mathematics) and studies spanned both domains. However, unlike algorithmic domains correct use of any strategy does not necessarily guarantee success in reading or spelling given the nature of the English orthography. The current section examines studies that look at how strategies are applied in these domains.

3.2.1 Measures of strategy use in Spelling

Relatively few studies have taken explicit measures of strategy choice within the context of reading and spelling. In a landmark study, Rittle-Johnson and Siegler (1999) tested 30 children in Grade one and then retested 23 in the second grade. They asked children to spell words under two conditions; an allowed condition (where any strategy could be applied) or the prohibited condition (where they were instructed not to use back-up strategies and to solve the problem as quickly as possible). The children were asked to provide a retrospective verbal self-report of how they had spelt each individual word. The overt behaviour was also observed to see if there were any signs of a strategy being applied, for example if they were using sounding-out it was often possible to hear them sounding-out each letter. Both the overt behaviour and self-reports were then assessed for inter-rater reliability. The results showed variability, adaptive choice and change in strategy use over time. The strategies identified included retrieval from memory, sounding-out, retrieval combined with sounding-out, using rules and visual checking. In the first grade the mean number of strategies used to read the words was 3.0; with retrieval and sounding-out most frequently cited on 88% of trials. By the second grade the children were using a mean of 4.5 strategies with the most commonly applied strategies remaining as retrieval and sounding-out. Between the first and second grade there was an increase in the use of retrieval, using rules, visual checking and a decrease in the use of sounding-out to spell the words. Retrieval was also the most accurate strategy with 86% correct in the first grade and 96% correct in the second grade through the use of retrieval.

In a similar study, Kwong and Varnhagen (2005) examined children's spelling development using a microgenetic approach (short-term longitudinal design). They used 11 children in Grade one asking them to spell a series of regular CVC non-word items. The children were asked to give a retrospective self-report after spelling each word and the experimental sessions were videotaped to look for any overt behaviour displaying the strategy they were using. The sessions were carried out over four to seven weeks and were terminated when the children were using 80% retrieval strategies in the spellings. For those children who did not begin to use retrieval the sessions were terminated when they were consistent in their use of each strategy. They collapsed the results into quartiles (as children completed a different number of sessions) and found improvements in accuracy and speed across quartiles. The strategies identified were phonology, analogy, retrieval and 'other' including guessing. Phonological strategies were identified by all but one child and most frequently the children reported the use of two or more strategies. The results supported the use of the overlapping waves model suggesting that children selectively choose the strategy which is most efficient for each problem and became faster and more efficient over time. The results furthermore showed that five children in the sample switched to using advanced strategies such as retrieval over time, but those children who continued to use less sophisticated strategies, such as phonology, became more efficient at producing the correct response. This study shows that the microgenetic approach can be very efficient at tracking the changes in strategy use over time and provides detailed strategy use reports. Using this microgenetic approach it is possible to follow individual development over time and in this instance it was possible to see if children shift alliance in the strategies used.

More recently, Farrington-Flint, Stash and Stiller (2008b) examined spelling strategies in 34 children in Year four (aged eight and nine years). They examined their spelling using a word list of forty-five word items based on three categories of words; consistent words, unique words or exception words. The children were asked to spell the words and give a retrospective self-report of the strategy used to spell the word. The trials were videotaped and an independent rater looked at 20% of the footage and an agreement on coding was reached 99% of the time. The aim of the study was to look for further support showing variability in strategy use in spelling by looking at accuracy and strategy use over time in a microgenetic study. Baseline measures of reading ability (BAS II Single word reading), spelling ability (BAS II Spelling) and vocabulary (BPVS) were also taken in order to categorise spellers based on their standardised scores. The results showed a gradual increase in accuracy for all word types across the three testing periods. The children also showed a variable pattern of strategy use. Twenty-nine children across the trials showed a shift towards the predominant use of retrieval and four shifted in the opposite direction towards the use of back-up strategies.

Some children also remained consistent in their strategy use across the trials. When analysing the difference between the manipulated word types retrieval was used more frequently producing more accurate responses on the consistent and exception words. Analogy was used very little as a strategy throughout the experiment and had a mixture of success in producing an accurate response.

When examining the results looking at ‘skilled’ and less-skilled’ spellers it shows that ‘skilled’ spellers use retrieval significantly more than ‘less-skilled’ across all three word types. When looking at percentage of accurate retrieval used this shows no significant difference between the two groups on consistent and exception words. However, for unique words ‘skilled’ spellers were significantly more accurate using retrieval than ‘less-skilled’. This suggests that unique words cause more of a problem for ‘less-skilled’ spellers and that they have less of a reliance on retrieval when producing a correct response on these words.

The findings from Farrington-Flint et al. (2008b) produce support for the view that strategy use is adaptable to suit the problem at hand. It can also show that these less-skilled spellers are showing an over reliance on back-up strategies, reflecting the pattern of strategy use typically seen in younger spellers. By using manipulated word types it allows a more detailed analysis of where strategies can fail to produce a correct response and how children deal with these situations. The authors identify that a problem of the study remains that overt behaviour was not measured in this study and therefore strategy use is measured purely using self-reporting. In order to analyse the different groups (‘skilled’ and ‘less-skilled’) spellers a median split was used. This method is controversial and therefore a cluster analysis may provide a more appropriate method of classification. The median split is controversial as readers around the median point are placed into groups, however their scores may be very similar. Age is also not taken into consideration and this median split may simply reflect the older children being the 'more skilled' in spelling. Cluster analysis would enable clusters to be formulated by using more criteria than simply the accuracy and therefore it would be possible to place the children into clusters reflecting strategy use as well as accuracy and latencies.

These studies suggest that it is possible to see a change in strategy use in spelling and that differing strategies are used for spelling different types of words. When examining children's reading development, does the same pattern of strategy use appear? Further investigation is required into the strategies that are used in early reading development.

3.2.2 Strategy choice in the context of early word-reading

Examining reading strategy use is a very important way of tapping into the developmental phases of reading acquisition. However few studies have examined the development of reading strategies specifically. Marsh, Desberg and Cooper (1977) studied the developmental changes in reading strategies using a sample of 40 fifth graders, 40 eleventh graders and 40 college students. The word list was ten pseudo-words specially created to have two different pronunciations depending on whether decoding or analogy was used as a strategy to decode them. There were two conditions; a free response where participants could use any strategy or a forced choice where the experimenter pronounced the words in both ways and asked which one was correct. The results found a significant difference based on age and this suggests that there is a developmental change in strategies used. In the free response condition the younger participants predominantly used GPC rules and the college students tended to use analogy. However in the forced choice condition the young participants also chose analogy more frequently. The authors suggest that this account gives further support for stage models of reading acquisition. However there are some limitations of the study which suggest that perhaps there is not as much support for stage theories as previously suggested. One limitation is that there was only one word list and the words were not manipulated for the different ages and therefore the younger participants may have struggled more. There were also no baseline measures of reading ability taken and therefore some participants may have been displaying signs of reading difficulties. The pseudo-words chosen did not appear to have any reliability or measures of frequency taken. The authors also state that it appears that analogy supplements GPC rules as a useful strategy; in many of the stage models more advanced strategies such as analogy replace other strategies and would not be understood to work together.

There has been significant work showing that strategy use in spelling can vary depending on the word and that the child is able to adaptively choose an appropriate strategy (c.f., Farrington-Flint et al., 2008a; Kwong & Varnhagen, 2005; Rittle-Johnson & Siegler, 1999; Farrington-Flint, Vanuxem-Cotterill & Stiller, 2009). These studies have highlighted differences in solution times and accuracy when compared with the measure taken of strategy use (whether behavioural observations, self-reported strategy use or a combination was applied) and shown support for the Overlapping Waves Theory (Siegler, 1996). When choosing an appropriate spelling strategy, the literature suggests that children at a very young age are able to choose a strategy suited to the specific problem based on their confidence criteria that it will produce the most accurate response possible in the fastest time. Studies applying the microgenetic approach have mapped these changes over time and show how strategy use can vary over a relatively intense period of time, in comparison to traditional studies showing global changes on a cross-sectional design.

However there has been very little research concerning the development of strategies in relation to theoretical models of children's reading development. It is argued that an important limitation with previous models of reading acquisition is that they very often assume age related changes in children's development, usually along a fixed invariant sequence of stages (Marsh et al., 1981; Frith, 1985; Seymour & Duncan, 2001). Ehri's (1995; 1999; 2002) mediated phase model of reading development however examined change in reading ability using phases which could occur with more flexibility and could involve regression to a previous stage. The following studies examining strategy use in reading show how the fixed stage models do not fully replicate realistic reading development and how Ehri's theoretical model and the Overlapping Waves Model could portray an enhanced depiction of emergent reading.

Relatively few studies have examined strategy choice in the context of early reading. Farrington-Flint and Wood (2007) examined the use of strategies in relation to children's reading using a clue-word experimental task to test the use of analogies in reading. In this task, one word is shown to a child as a 'clue word' and then the non-word is produced. On some trials the clue word can assist the children in the correct pronunciation of the non-word (e.g. moon and soon) but on other trials there is no overlap between clue and test words (e.g., moon and ball). This study looked at the varying strategies used in reading non-words as well as examining the speed, accuracy and frequency of retrospective verbal self-reports. Sixty children (aged five and six) were included in the study and participated on three separate occasions on the experimental tasks. The results showed substantial variation in strategy use; consistent with the overlapping waves theory. They found that 43% of children were applying three strategies, compared to only 8% using one strategy. The data was also analysed for accuracy and speed; this found that the strategy applied had a great impact on the accuracy and speed of reading the non-word. In the problems where the clue word assists, analogy and GPC rules (sounding out) were the most frequently applied strategies. In the unrelated control (where the clue word does not assist) the most frequently used strategies were GPC rules. This suggests that children are able to select the best strategy to produce a correct response, or the fastest response to a problem. Furthermore when looking at predictors of success in reading non-words the only unique predictor was percent analogy use.

However there are a number of important limitations with the design of their study. First, the findings by Farrington-Flint and Wood (2007) cannot be generalised to reading because the study does not represent a naturalistic study of reading. They focussed primarily on an artificial clue-word paradigm to assess viability of analogies in the context of reading. Second, the clue-word paradigm has been criticised as it could emphasise the use of analogy in the task as the children are told that the first word could assist them in the interpretation of the non-word (Deavers & Brown, 1997). Third, they simply examined reading strategies at one particular time and failed to consider changes in the frequency of strategy reports over time. A longitudinal or microgenetic approach would help to strengthen these claims with regard to strategy change over time.

In order to apply the examination of strategy use to a more naturalistic setting, Farrington-Flint, Coyne, Stiller and Heath (2008a) used real word items in order to investigate strategy use in everyday classroom settings. Sixty-five children (aged five – six years) read an experimental single-word reading list of 40 words in three trials set over a three month period. The children were asked to give retrospective verbal self-reports after reading the words and these were use to identify and code the strategy being used. The study found that generally there was a shift towards using more sophisticated strategies such as retrieval from memory over time, however there was also evidence that strategies used were variable between trials by the same child. The results also showed that when phonological strategies were applied by ‘skilled’ readers they were more likely to gain an inaccurate answer than the ‘less-skilled’ readers. This could be because the ‘less skilled’ readers have more practice at using the phonological strategies. This pattern however needs further exploration in order to further understand the relation. In order to achieve the distinction between ‘less-skilled’ and ‘skilled’ readers a simple median split was performed using the results of the baseline measures. Although there were children at either extreme, classifying readers that fell around the median point was very difficult. This study could have been improved methodologically by using a cluster analysis in order to examine difference between reading profiles. Siegler (1988) used the cluster analysis approach and found three distinct groups portraying differing patterns of strategy use, accuracy and solution times. Future research looking at the differences between groups of readers would be best advised to apply clustering algorithm to establish fixed homogenous groups.

The main limitation of the study by Farrington-Flint et al. (2008a) is that the word types were not varied to see how children decode exception or unique word items. This is important because stimulus characteristics may influence the types of strategies used across trials. For instance, Farrington-Flint et al. (2008b) have recently shown with the context of spelling development, that the classification of word type can have an important impact on the choice of strategy and therefore this gives scope for further detailed microgenetic study to investigate strategies used in manipulated word types in reading across different stimulus characteristics to explain word specific changes in reading strategies.

3.2.3 Summary of strategy use

The adaptability of strategy use has been established in the algorithmic domain and studies examining the non-algorithmic domain have suggested that a similar pattern exists in spelling. There has been little examination into strategy use when applied to reading particularly when looking at differing types of words and the impact that they have on strategy use. Trying to capture strategy use can cause problems as it is very difficult to encapsulate the underlying cognitive processes; this is discussed further in Chapter Four.

3.3 Reading errors

Reading errors have been described as another way of accessing discrete information about the types of strategies that are being applied during reading (Greenberg, Ehri & Perin, 2002). The current section shows that the study of reading errors can be used as another way of examining children's reading development and that certain types of errors are indicative of later success in reading. It is argued that using existing categories for examining reading errors can provide a better foundation for developing a useful coding framework to capture changes in reading performance more clearly.

3.3.1 Classification of reading errors

Examining children's reading errors can be another insightful way to provide evidence about how children are learning to read novel words and which strategies they are using to do this (Biemiller, 1970). Error analysis has been used in different ways over time. The older research looked at errors made in reading pieces of text, but more recently there has been a shift towards using a single word reading approach to look at specific miscues in phonemes within the words. Early studies examined errors based on the graphic similarity of the word to the target word (Cohen, 1974 – 1975) and contextual errors (Allen & Watson, 1976). Whilst these do not provide information about how the child is reading each individual word they were influential studies which were used to provide evidence for stages in models of reading development such as the cognitive-developmental model (Marsh et al., 1981). Leu (1982) identified methodological issues with the analysis of reading errors within text. It was suggested that there was a lack of framework for analysing errors and so the different studies were not comparable (c.f. Cohen, 1974 – 1975; Allen & Watson, 1976). There was also bias occurring in the choice of texts that were used to analyse the errors as there was no way of measuring the difficulty of the text. Leu also stated that using this type of error analysis did not tap into the skills that children were using to learn to read the words, but simply looked at how they were making in-text errors.

Stuart and Coltheart (1988) looked at classifying reading errors using a new taxonomy system based on a single word reading task. They developed a framework based on shared letters between the error made and the target word. The errors were classified into errors sharing the initial letter, letters sharing the final letter, errors sharing both initial and final letters, contextual errors and refusal to answer. The use of contextual errors and errors sharing the final letter decreased in use over time. However they found that scaffolding errors (preserving the initial and final letters) were significantly correlated with reading ability and a correlate of reading age. Stuart and Coltheart (1988) also noted that the use of errors preserving the initial letter and scaffolding errors emerge at the same time that children are able to successfully complete the phonemic segmentation task and could name at least half of the letters in the alphabet. These findings have also been replicated by Stuart (1990) and Savage and Stuart (2001) who also found that the number of phonemes that a child could correctly identify was related to the number of scaffolding errors made in reading, suggesting a link between phonological awareness and scaffolding errors.

Savage and Stuart (2001) examined the use of rime-clued and head-clued analogy use to see if there was any advantage of using the large phonological unit (onset-rime) over a small phonological unit. The study also investigated the relationship between scaffolding errors made at pre-test with the post-test accuracy to see if orthographic representations are underpinned by phonemes or rime units. Savage and Stuart used the same taxonomy as used by Stuart and Coltheart (1988) however they used shared phonemes, not shared letters. Therefore in this study a scaffolding error consists of the preservation of the initial and final phonemes (e.g. 'Pork' read as 'Park'). Savage and Stuart (2001) found that 74% of the pre-test errors fitted into the category of scaffolding errors or refusal to respond. The findings of the study were that both rime and head clued analogy use were correlated with scaffolding errors and scaffolding errors were strongly correlated with reading ability. The second experiment with a large sample showed that scaffolding errors were a strong correlate of head-clued vowel inference use after vocabulary had been controlled for. This found that overall scaffolding errors are highlighting an awareness of phonemic structure of a word, but not the use of large phonological units such as onset-rime. Although this study found that scaffolding errors were correlated with reading ability on the task, they did not examine the impact that scaffolding errors could have on future reading success.

Savage et al. (2001) analysed reading errors among a sample of 43 children (aged six and eight) tested on two occasions (two years apart) using an experimental single word reading task containing 24 regular CVC word items. Reading errors were coded as unrelated errors (random), orthographic overlap (one letter consistent), errors preserving initial phoneme, errors preserving final phoneme, errors preserving first and final phoneme (scaffolding errors) and refusals. The results showed that scaffolding errors made up 54.7% of errors and refusals were 28.6%. The BAS II single word reading score at age six was also correlated with the reading ability two years later. Study Two by Savage et al. (2001) looked at scaffolding errors and non-word reading. Thirty children were tested on one occasion on the same twenty-four CVC words as in Study One, but they were also given a non-word reading task. The results show strong positive correlations between the BAS II single word reading scores, scaffolding errors and non-word reading. Scaffolding errors predict a significant amount of reading ability even when non-word reading ability was entered into the regression analyses. Further work on scaffolding errors also confirmed that the quality of errors made at age six still remained a strong, unique predictor of reading success at age eight, even when vocabulary scores were taken into account (Savage & Stuart, 2006). Overall, this demonstrates that the quality of children's reading errors can be a useful predictor of the progress they make in learning to read.

3.3.2 Summary of reading errors

The study of reading errors to date has found that scaffolding errors are the most frequently made errors and these studies highlight the importance of scaffolding errors to predict later reading success. However there has been little examination of errors made on specific types of words, or how the other types of errors (such as errors preserving just the initial phoneme) impact on reading ability. Through the examination of the errors made in reading it should be possible to see which parts of words children are learning to recognise first. Combining the analysis of reading strategies used to read the words and error analysis on those words read incorrectly could begin to give a clear picture of reading development.

3.4 Chapter summary

This chapter has identified that strategy use can vary dependent on the task. This adaptability can even occur during a task and previous studies have highlighted that children are able to select a strategy that they think will produce the most accurate or fastest response on that problem. Strategy use in reading has not been widely researched and could allow an insight into understanding emergent reading skills and identify how the theories of reading development reflect the data.

This chapter has also discussed some of the literature examining reading errors and how scaffolding errors have been correlated with later reading success. In order to further examine reading errors the data could be combined with the self-reported strategy use in order to look at how they are reading the words when the errors are made.

Chapter Four

Methodology: Capturing Strategy Use

4. Introduction

In order to examine children's strategy use in the context of their early word reading, it is necessary to find a way to understand how they are decoding the words and which strategies they are applying. Previous investigations have used retrospective verbal self-reports as a way of recording strategic behaviour and monitoring children's performance in reading and spelling (Farrington-Flint et al., 2008a; Kwong & Varnhagen, 2005; Rittle-Johnson & Siegler, 1999) This involves retrospectively asking each participant to explain how they were able to solve the task.

Generally, there is growing awareness of the importance of using self-reports as a research tool to study both spelling and reading. However, questions can be raised with regard to the validity of using verbal self-reports. To what extent are people, especially children, able to provide an accurate record of the strategies or are they simply providing an explanation ad-hoc? Therefore a closer examination of the validity of self-reports is required.

The purpose of this section is to examine the importance of validating the use of verbal self-reports within the context of children's early word reading. It is argued that inadequate attention is often paid to providing any sort of validation of children's strategy choice within early reading without any systematic comparison of different self-report techniques (retrospective vs. concurrent). While previous work has found that verbal reports can be valid under certain conditions, there has been little examination of the validity in terms of a single word reading task.

4.1 The validity of self-reports of strategy use

Ericsson and Simon (1993) set out guidelines under which verbal reports are thought to be valid. The guidelines reflected conditions under which verbal self-reports could be relied upon. They stated that the best verbal reports were those derived directly from the Short Term Memory (STM) as it reflected the consciousness, whereas information from the Long Term Memory (LTM) was more likely to include inferences about how they were solving the problem (or ad-hoc justifications). Ericsson and Simon (1993) also stated that generalised descriptions of processing could be false and may not reflect the cognitive processing. In order to avoid such conditions they suggested asking participants to verbalise as they were completing the task and not at the end. The validity of the verbal self-report can also be impacted by not being reliably coded by the experimenter. Previous studies (c.f. Rittle-Johnson & Siegler, 1999) have used inter-rater reliability to avoid experimenter bias in coding.

A further issue is that previous studies have not recorded specifically what was said to each child to ask for the verbal report data (Pressley & Afflerbach, 1995). This is important because we need to be assured that the children are not being primed to use any given strategy. Therefore, a standardised list of instructions should be used to avoid giving away any strategies. Interpretation of self-reports can also involve making inferences to fit the verbal report neatly into categories for analysis (Pressley & Afflerbach, 1995). This can be misleading and create falsely coded strategies and therefore if the child is not clear, probing questions need to be used to be certain that the experimenter understands how they solved the problem.

4.1.2 Previous research in literacy employing the use of verbal self-reports

Siegler (1988) looked at strategy use in mathematic tasks and children's single word reading ability. The two experiments used differing methodologies to collect strategy use; Study One used overt behavioural observations and reaction times and Study Two used verbal self-reports as well as observable behaviour. As both studies showed similar findings for the solution times on the task and accuracy, Siegler concluded that giving a self-report did not impact on the task. He also concluded that providing a verbal self-report of strategy use could actually reveal strategy use that is not detected using observations of behaviour alone, as Study Two revealed the use of back-up strategies, where no behaviour was overt. This is providing support for the use of self-reports as a methodology for capturing strategy use, but does not reveal whether the children's self-reports are accurate.

Rittle-Johnson and Siegler (1999) used both overt behavioural observations and retrospective self-reports to capture the strategies being applied. Where overt behaviour was recorded, this was used as the primary source of information about the strategy being used and if there was no obvious behaviour then the self-report would be used. When examining the validity of the self-reports, Rittle-Johnson and Siegler (1999) compared the relationship between the behavioural measure and the verbal self-reports with regard to the children's accuracy and speed on the spelling task. They found consistently that trials classified as retrieval had faster reaction times than those classified as back-up strategies. The speed of processing suggested that the trials coded as back-up involved more cognitive processing to decode the word than when a word is familiar and is retrieved directly from memory. The finding that trials coded as retrieval had significantly faster reaction times reflects the findings of Siegler and Stern (1998) who found 92% of reaction times were either fast (under four seconds) or slow (over eight seconds) suggesting a difference between insight and computation in solving a task. In terms of methodology Rittle-Johnson and Siegler concluded that relying simply on measures of overt behaviour would have shown a less accurate pattern of strategy use and therefore combining these data with the verbal self-reports gave a more accurate and valid representation.

Kwong and Varnhagen (2005) also used retrospective verbal reports while examining children's spelling of non-word items. Behaviour was also observed, but these observations were not included in the coding of strategies. Kwong and Varnhagen (2005) stated that the only behaviour that reflected strategy use was sounding-out and they believed this could be influenced by searching for letters from memory, resulting in inaccurate strategy coding. However the use of verbal self-reports used alone is also controversial and by excluding the data on behavioural observations this could reduce the validity of the study.

The exclusion of behaviour observations in the study by Kwong and Varnhagen (2005) provides an interesting contrast with Rittle-Johnson and Siegler (1999) as they primarily coded performance using the overt behaviour and only used the reports when no strategy associated behaviour was observed. Therefore although Kwong and Varnhagen took a recording of overt behaviour, this was not used to code the strategy use and only the retrospective self-reports were used. Rittle-Johnson and Siegler found good levels of agreement between the behavioural observations and the self-reported strategy use, however how valid is self-reported strategy use when used solely for assessment? Obviously one main problem with the use of behavioural observations is that the child may not display any signs to signify what strategy they have applied, however a major problem with self-reported use is how truthful the report provided is.

4.2 Reactivity and veridicality of self-reported strategy use

The two main issues that can impact on the validity of verbal self-reports of strategy use are the reactivity and veridicality of the report. The reactivity is measuring whether being asked to give a self-report is changing the nature of the response, for example impacting on the accuracy. Russo et al. (1989) highlighted that there can be many causes of reactivity when verbal self-reports are given. The vocalisation demands can simply alter the nature of the task and distract the participant, particularly when being asked to give a concurrent self-report (during the task). Similarly, the additional aural stimulation that is provided could become a cognitive distracter. Another issue could arise from attempting to vocalise automated processing (see section 3.3.3 for more detail). Finally they stated that the reflection on their own strategy use could have additional learning benefits which could be disruptive during the task. Although many of these issues would arise more frequently when asked to concurrently provide a verbal protocol, they could arise during retrospective reporting as well.

Veridicality can also cause issues when applying verbal protocols as a method of capturing cognitive processing. Veridicality looks at how truthful the self-report is and how accurately it is reflecting the strategy use. It is very difficult to examine the veridicality of self-reported data without another measure that it can be compared with. In comparison there are measures that can be used to examine reactivity, such as reaction time in the experimental condition compared with a control group.

Russo, Johnson and Stephens (1989) examined the validity of self-reports of strategy use across four different tasks, additional problems, anagrams, gambles and Raven's matrices (Raven, 1958). There were three conditions, a concurrent reporting condition, a retrospective reporting condition and a control group. The participants were all asked to complete all tasks in all conditions and therefore it was a repeated measures design. The results found that there was an alteration in accuracy on two out of the four tasks, suggesting that there was some reactivity, especially in the concurrent condition. They also highlighted prolonged reaction times across the condition where the participants were asked to give a verbal self-report. The authors also identified very little veridicality in the study and stated that the reports were not very valid on the current tasks. The authors conclude that although this study has not found that verbal protocols are the perfect way to collect information about cognitive processing, it is still probably the most efficient way to examine strategy use.

However, there were methodological issues with the study which could have impacted on the findings. Firstly, the veridicality was examined by comparing the types of reports in the concurrent condition with those provided in the retrospective condition. There was no additional measure taken that could be used as an additional measure of strategy use, such as behavioural observations. Another issue with the design is that they used a repeated measures study which meant that the participants were involved in all conditions. Whilst the authors have discussed the advantages and disadvantages of this design it could still have an impact on the findings.

Robinson (2001) carried out a similar study examining the veridicality (how truthful or accurate the report is) and validity of self reports using subtraction problems. The students were all involved in a videotaped session in which they were asked to solve subtraction problems. The students were randomly assigned to one of three conditions; concurrent verbal report, retrospective verbal reports and a control condition where no self-report was requested. In order to look at the validity and reactivity of the verbal self-reports accuracy and latencies were compared between the three conditions. If giving a verbal report affected the strategy used they would expect a difference between the no report condition and the other two conditions where a report was provided. The results suggested that verbal reports are not reactive; therefore they do not influence the answer being given. However the findings did suggest slightly longer latencies in conditions where a verbal report was requested. The veridicality was examined by comparing the self-reports in the concurrent and retrospective conditions and looking at the types of reports and how they related to the problem. For example a higher incidence of using counting-on was expected in the more difficult subtraction problems, compared with the simple ones.

Robinson (2001) concluded from the study that the reports were valid forms of data and that the insight that they provide can be invaluable in assessing strategy use and issues with strategy use. The study also concluded that retrospective verbal reports are easier and more natural to give than concurrent, which could have an impact on concentration, although concurrent reports were believed to be more suitable for younger children. Therefore the findings from this study were varied as generally they believed retrospective self-reports to be easier to use. Robinson's study however found differences between the different age-groups investigated and the results suggested that in younger children retrospective self-reports may not be as valid as in older children. Again this is an issue which requires further exploration in the domain of reading. Another issue that arises from the methodology of this study is that to examine the veridicality of self-reports an extra measure which could be used to predict strategy use would be helpful. Robinson (2001) simply compared the self-reported strategies with the expected strategy use; however there was no additional measure such as observations of overt behaviour.

The first proposed study therefore intends to validate the role of verbal self-reports in the domain of reading. In this study, the distinction between concurrent verbal reports (whilst they are solving the task) and retrospective verbal reports (after the problem has been solved) will be examined in addition to comparing the effects of these two different report styles measures of observable behaviour will be taken to validate these verbal report methods. The solution times to read each word will be compared between conditions and the observable behaviour will be correlated with the self-reported response.

4.2.1 Validity of verbal self-reports of sight-word reading

Whilst some strategies can be further examined through the use of a comparison between behavioural observations and self-reports, it is much more difficult to investigate the use of sight-word reading (retrieval). One of the criticisms of this approach is that strategy use could develop as an unconscious process before the child is able to verbalise this cognition.

Siegler (2000) discusses the use of inversion problems (A + B – B) as a way of analysing the use of unconscious strategy use. Siegler and Stern (1998) found that 92% of solution times for inversion problems could be categorised into two categories; fast (under four seconds) or slow (over eight seconds). These reaction times in themselves could therefore be used to make assumptions about the strategy use. After doing a few of the inversion problems children are able to give fast answers, as the correct response is always the digit represented by A. In the slower reaction times it is safe to assign the strategy use to computation, where the child is using other mathematical strategies available to them to solve the problem; such as counting on fingers or counting on from the highest addend. On the inversion problems Siegler and Stern found that strategy use could be defined as, computation of the problem, using the retrieval shortcut, or unconsciously using the retrieval shortcut. In the latter strategy the child is answering the problem accurately and the solution time is fast, but when asked to give a verbal self-report they are reporting using computation. Siegler and Stern (1998) wanted to examine this unconscious strategy choice stating that before a strategy becomes used consciously it is applied in an unconscious manner. Thirty-one second-graders completed mathematical problems once a week for a period of eight weeks. The participants were placed into two groups; one where the sums were all inversion problems and one with a mixture of mathematical questions. They found that children in the first group discovered the shortcut solution more rapidly and that this was first discovered as an unconscious strategy choice 90% of the time. In subsequent trials the shortcut strategy had to be rediscovered and this was again unconscious and then became conscious and was reported as applying the shortcut. This suggests that self-reports used alone can mask some strategy use which may be unconscious to the participant. Using a mixed-method of capturing strategy use could add an important dimension to analyses of strategy change.

Solution times in this study are used to identify the difference between the strategies used to solve the problem. In reading most back-up strategies have an observable behaviour that could accompany them however; sight-word reading (as defined by Ehri, 1999) is the instant retrieval of a familiar word from memory. Ehri and Wilce (1983) have found that reading using sight-word reading can produce latencies as fast as saying a single digit as the response can be said instantly, therefore it could be possible to find a difference in solution times as Siegler and Stern found with the inversion problems.

In order to further examine this issue of conscious versus unconscious strategy use there will be further validation of the strategy termed retrieval (Ehri's sight word reading). While reaction time data suggests that children are retrieving words from memory (indicative of quicker performance), the lack of observable behaviour associated with retrieval means that it is more difficult to validate. The first study of this thesis proposed to validate the self-reported strategy use of retrieval (sight-word reading) by using a rapid naming task after the initial experimental task. The rapid naming task will include all of the same words and they will be flashed up on the screen for 500 ms (reducing the use of back-up strategies). The accuracy on this rapid naming task will be compared to the score on the main experimental task. Therefore if the children are reporting the use of retrieval on the main task it is expected that they would be able to read the word on the rapid naming task. Conversely if they reported the use of a phonological (back-up) strategy on the main task and were then able to read the word under the timed conditions this could suggest unconscious strategy use.

4.3 Chapter summary

Russo et al. (1989) and Robinson (2001) have found that verbal self-reports of strategy use can provide an indication of strategy use. However, further investigation into the validity of these verbal self-reports of strategy use are required to ensure that they are valid and are providing accurate representations of the strategies being used. The issue of the veridicality of the self-reports is particularly pertinent, as this has not been fully examined in previous studies. Examining verbal self-reports using the three experimental groups as used by Robinson (2001) with a single word reading task will allow any changes in the accuracy or solution times to be identified. Furthermore the correlations of the self-reports and behavioural observations as well as the rapid naming task to validate the self-reported use of retrieval (Ehri's sight word reading) will add another facet to the validation.

Chapter Five

Study One: Validating Children's Use of Verbal Self-Reports

5. Introduction

The initial study of this thesis examined the validity of verbal self-reports as a discrete measure of capturing strategy use in emergent readers. The main goal of the present study was to examine the validity of verbal self-reports within the context of children's early word reading through a direct comparison between different reporting methods (concurrent vs. retrospective reports) and across children in Year One and Year Two. Examining the validity of verbal self-reports in the context of reading was particularly important as if they were found to be a valid way of collecting this data, then this methodology would be used to collect strategy use in the remaining studies of this thesis. A second goal of the current study was to identify developmental shifts in children's reading strategies from Year One and Year Two and to assess the reliability of age-appropriate experimental word items that could be included within the remaining studies of the thesis.

Traditional stage models of reading development are based on an invariant sequence of discrete, fixed stages that lack flexibility in explaining the processes by which children initially learn to read (e.g., Marsh et al., 1981; Frith, 1985; Seymour & McGregor, 1984). More recent models of reading combine flexibility with choice, allowing movement between phases and with greater emphasis on the strategies that children use to learn to read and how these adapt over time (Ehri, 1995, 1999, 2002). One way to access the information about how a child is learning to read is through an examination of the strategies that they are applying when they are reading words. As argued in

Chapter Two, there is growing support for Ehri's (1995; 1999; 2002) mediated phase model of reading development. Inherent in this model is that many young children can move flexibly among a range of different reading strategies even in the early stages of reading acquisition, and the empirical studies have also shown that the transition between different strategies does occur (e.g., Rittle-Johnson & Siegler, 1999; Varnhagen, McCallum & Burstow, 1997). For example, within the domain of spelling, Rittle-Johnson and Siegler (1999) and Kwong and Varnhagen (2005) have both shown variability in the frequency and accuracy of children's reported strategy use (using retrospective verbal reports) in their attempts to secure orthographic representations to memory. In order to tap into the strategies that children are using, the previous studies mentioned have used verbal self-reports as one measure of strategy use. However, very little is known about the actual validity of verbal self-report methods as a measure of children's early word reading strategies. As strategy choice is not always a conscious decision, whether people can provide an adequate self-report of strategy use was a key issue. This becomes even more pertinent when using this technique with children or beginning readers.

A central goal of Study One was therefore to assess the validity of verbal self-reports within the context of children's early word reading. As outlined in Chapter Three and Four, Siegler (1987) discussed the potential merits of using verbal self-reports of strategy use as a very insightful way to understand how children solve tasks as they aid our awareness that children can often use a variety of strategies to solve similar tasks and that the strategy used can vary over time. However, Siegler also notes that there have been issues with the validity of self-report data. Ericsson and Simon (1984) looked at how accurate retrospective verbal self-reports were and found that although the adults were asked to give a report of how they solved a task immediately afterwards, the reports were not always accurate. Based on this, the assumption would be that children's verbal self-reports would be even less accurate. Ericsson and Simon (1993) provided guidelines under which verbal self-report data should be more accurate. They stated that the verbal self-report needed to be taken from the short term memory and therefore needed to be given immediately after or during the task. They suggested that using a concurrent self-report (asking the participants to verbalise what they are doing) could have a greater accuracy than asking them retrospectively.

It is argued that the thorny issue of validation can be partially solved through a more detailed analysis of accuracy and solution-time data under different self-reporting methods (concurrent vs. retrospective accounts) (Siegler, 1987). This was illustrated in an earlier study by Robinson (2001) who examined variation in strategy reports across different reporting conditions within the context of subtraction. The students were placed into one of three conditions: concurrent verbal self-reports, retrospective verbal self-reports or the no report condition. The students were then asked to complete the task and give a report depending on which condition they were in. The accuracy on the task was compared across self-report conditions and no significant difference was found; suggesting that being asked to give a self-report does not affect the data collected, apart from response time which was longer for the concurrent report condition. However, Robinson (2001) concluded that retrospective self-reports are easier to provide and remain valid forms of collecting information about children's strategy use within the context of subtraction. Whilst this study suggests that self-report data is valid, it is not set within the domain of reading and the type of task in the current study was quite different given that no response or strategy will ever guarantee success (Rittle-Johnson & Siegler, 1999). The validity of self-report data when used on an experimental single-word reading task was still unknown and therefore required further examination. It is argued that a direct comparison of strategy choice across different reporting conditions (retrospective, concurrent and a control group) would allow a full examination of the validity of verbal self-reports within this context. Furthermore, examining the validity and veridicality of verbal self-report data could be achieved by comparing the accuracy and solution time data of all strategies across reporting conditions.

A further issue concerning children's ability to provide self-reports was whether they understand and are able to verbalise the processing that they have used in order to read the word. Siegler and Stern (1998) assessed whether strategy use develops first as an unconscious process before we become aware of using that particular strategy. There have been studies before that suggest that strategies are first developed as unconscious procedures (Karmiloff-Smith, 1992; Kuhn et al., 1995). Siegler and Stern (1998) looked at solution times from the completion of a mathematics task and compared this with retrospective self-reports of strategy use. They found that the time latency data suggested that children began to use a shortcut before the children were able to report the use of this strategy. Siegler and Stern linked this to the gesture-speech concordance which suggests that knowledge can be portrayed through gestures before it can be verbalised (Alibali & Goldin-Meadow, 1993). For the present study this could mean children using retrieval from memory, are not able to provide a verbal self-report stating that they used that particular approach. As there is often little observable behaviour associated with retrieving a word from memory, the present study addressed this issue through the use of a rapid naming task administered after the main experimental task. The purpose of the rapid naming task was to establish if the children could recognise and retrieve the word as a whole from memory (e.g., lexical word reading) and to validate verbal reports of retrieval on the experimental single-word reading task.

Finally, the initial study examined trends in children's strategy use across different word characteristics (word frequency and letter length) to establish baseline data concerning the types of approaches being applied and how the different strategies related to accuracy or solution times. The findings were discussed in terms of year groups and any differences between Year One and Year Two were highlighted.

Four main research questions were addressed. Do different-aged children show similar levels of reading accuracy and solution times across different self-report conditions (retrospective vs. concurrent conditions), compared to a control? If the accuracy and solution times showed no differences between the three conditions then this would show that verbal self-reports of strategy use were not impacting on performance on the task. Does the nature of the verbal self-report lead to changes in children's actual reading strategies? If no differences were found between the reported strategy use in the three conditions then it would suggest that being asked to give a report does not change task performance. Are children providing a genuine report of retrieving word items from memory across both self-report conditions? Finally, baseline data were established including whether word characteristics impact on the accuracy and solution times.

5.1 Method

5.1.1 Design statement

This study was a 3 x 2 independent measures design, the independent variable had three levels (the experimental conditions) and the dependent variable had two levels (the year group of the children). The children were placed into one of three experimental conditions (the same categories as Robinson, 2001); the concurrent report condition, the retrospective report condition and a control no-report condition. In the concurrent self-report condition the children were asked to verbalise how they were reading the word whilst they were undertaking the task. In the retrospective self-report condition the children were asked how they had read the word after the task. In the control condition children were not asked to provide any kind of self-report

5.1.2 Participants

Sixty children participated in the study. Thirty children were from Year One (13 female and 17 male) with a mean age of 6 years and 3 months (SD = 3 months) and thirty children were from Year Two (18 female and 12 male) with a mean age of 7 years 2 months (SD = 3 months). ACORN data classified the area as moderate means, blue collar roots and the predominant type of housing were classified as older, rented terraces (A Classification of Residential Neighbourhoods; CACI, 2009). The children all attended a state funded primary school in Nottinghamshire and were tested towards the end of the academic year (May and June).

5.1.3 Educational context

All pupils were following the UK-based National Literacy Strategy (NLS) which used a systematically-based structured framework of instruction to teach strategies for decoding text. This included training in phonics and spelling (including phoneme and rhyme awareness), alongside knowledge of using contextual cues, grammatical awareness and single-word recognition and identification. The children were also being introduced to the THRASS (Teaching Handwriting Reading and Spelling Skills, Davies, 2006) phonics scheme which focused on using a more synthetic phonics approach to the teaching of early reading and spelling skills.

5.1.4 Screening

To measure children's word recognition, the BAS II single-word reading subtest (Elliot, Smith & McCulloch 1996) was administered to all children to ensure that they could demonstrate some initial word identification. In order to take part in the study each child had to be able to read successfully at least eight words from the first trial in the BAS II single word reading test. This screening test was applied to establish whether the children would be able to read enough words from the experimental list and to ensure that they were of similar ability. Four children were unable to identify any of the words from the BAS II reading subtest and were removed from the study.

5.2 Materials

5.2.1 Baseline measures

The following baseline measures were collected to ensure that the children in each experimental group were evenly distributed.

BAS II single word reading

The BAS II single word reading subtest (Elliot, Smith & McCulloch, 1996) was included as a measure of decoding and single word reading skill. The test consisted of nine trials in total, with each trial containing ten single-word items. The children began reading with set one. The words became more challenging as the test progressed. Each child was required to answer eight words or more correctly in each trial to proceed. Raw scores were then calculated into a standardised score (Mean = 100, SD = 15). The standardised score was then used to place each child into a percentile using their chronological age.

BPVS II receptive vocabulary

The British Picture Vocabulary Scales II (Dunn, Dunn, Whetton, & Burley, 1997) test required children to identify the picture that matches the spoken word presented orally by the researcher. The words were in blocks of twelve and began to get more difficult as the task continued. To match for the children's age group all participants began at set two as detailed in the test administration instructions. The test continued until the child correctly identified only four out of the twelve words in a block. The vocabulary score was then converted into a standardised score and subsequently into a percentile using their chronological age.

The children were randomly allocated into the three conditions and therefore the first analyses checked that the groups were evenly matched on ability based on the baseline measures. As expected given the two different year groups, there was a significant difference between the chronological age of the children across the two different year groups, $F(1,54) = 145.149$, $P < .05$, partial $\eta^2 = .729$, but not across the three conditions, $F(2,54) = .251$, $p > .05$, partial $\eta^2 = .071$. The average standardised score on the BAS II Single Word Reading was 108.93 (110.3 in Year One and 107.56 in Year Two). The average standardised scores on the British Vocabulary Scales were also within the normal limits (see Table 5.1).

Table 5.1
Means (and SDs) for age, single-word reading and receptive vocabulary scores according to verbal report condition and year group.

	Concurrent	Retrospective	No report
Year One			
BAS II single word reading [a]	107.40 (8.21)	109.6 (8.85)	113.90 (8.96)
BPVS II Receptive Vocabulary [a]	97.00 (8.47)	95.80 (8.85)	96.60 (8.16)
Year Two			
BAS II single word reading [a]	110.90 (14.64)	99.30 (14.21)	112.50 (12.55)
BPVS II Receptive Vocabulary [a]	97.90 (10.94)	91.40 (9.84)	101.80 (10.58)

Note. [a] denotes standardised scores based on chronological age norms

To ensure that the children did not vary in their single word reading or vocabulary skills across the three verbal report conditions, a series of two-way ANOVAs were carried out using condition (concurrent vs. retrospective. vs. control) and year group as the IV's and the scores on the BAS II single word reading scale as the DV. There were no significant differences between the scores on the BAS II reading scale and the year group, $F(1,54) = .715$, $p > .05$, partial $\eta^2 = .013$. There were no significant differences on the BAS II single word reading scores among the three conditions, $F2,54) = 2.445$, $p > .05$, partial $\eta^2 = .083$. There was also no interaction between the BAS scores, self-report condition and year group. This shows that the sample is evenly distributed across the three conditions. The second ANOVA also confirmed that there was no significant difference between the scores on the BPVS II vocabulary test and year group, $F (1,54) = .048$, $p > .05$, partial $\eta^2 = .001$ and no significant difference between the scores on the BPVS and the self-report condition, $F2,54) = 1.629$, $p > .05$, partial $\eta^2 = .057$.

5.2.2 Experimental single-word reading task

The Experimental Single Word Reading Task consisted of a computer presented word list (written in E-Prime 2), comprising 40 single-word items appearing individually on the screen at any one time. The instructions were displayed on the screen at the start of the experiment and they were explained to the child by the experimenter. The word list was presented on a standard laptop screen in Arial, size 50 and the text was black. The background was grey to avoid a sharp contrast on the screen. The words were randomised using E-Prime 2 software and the task took around 12 minutes to complete.

Words used in the experimental single word reading task were selected from the Children's Printed Word Database (Masterson, Stuart, Dixon, Lovejoy & Lovejoy, 2003) of all age appropriate reading schemes used in Key Stage 1 in UK primary schools. The word list was devised using validity data from a previous study (Farrington-Flint et al., 2008a) and consisted of 40 word items varying in length from four to seven letters (ten of each letter length). Initially the word list also contained three letters words, but the children were at ceiling level on these words and therefore they were removed. The words were matched for syllable length and word frequency per million, with some words having a high frequency and others having a low frequency. The words were also controlled for CV structure (as far as possible) and phoneme repetition (the phonemes in the words were varied to avoid words starting/ending with the same sounds). Cronbach's alpha internal reliability confirmed that word items were reliable (alpha value of .964 for all 40 items included in the experimental reading task).

5.2.3 Rapid naming task

The rapid naming task used the same word items as the experimental single-word reading task. The words were displayed on the screen in the same style as previously used, but were only displayed for 500 milliseconds each. The purpose of the rapid naming task was to inhibit the use of back-up strategies as a way of decoding the words. If a correct response was produced when the word was only displayed for 500 milliseconds then it was being read by sight. This time period has been used in priming studies to display the target word (c.f. Forster & Davis, 1991; Lukatela, Carello & Savić, 1998a; Lukatela, Frost & Turvey, 1998b). The purpose of the rapid naming task therefore was to establish if the children could recognise and retrieve the word as a whole from memory (e.g., lexical word reading) and to validate verbal reports of retrieval on the experimental single-word reading task.

5.3 Procedure

The children were randomly allocated into one of three experimental self-report conditions, one condition where they gave concurrent self-reports (giving a report during the task), one using retrospective verbal self-reports (asked to give a report after the task), and a control condition where no self-report was obtained. The three experimental conditions were the same as used in the study by Robinson (2001) looking at validity of self-reports in mathematical tasks. Overt behavioural observations were also recorded for all conditions. These observations of overt behaviour were specifically looking for indicators of strategy use, such as pointing to each letter or verbally identifying each individual phoneme within a given word.

To ensure an adequate level of word recognition, the BAS II single-word reading subtest was initially administered to all children as a screening test to ensure that they could demonstrate some initial ability to read at least eight words from the first trial of the subtest. Following this task, the children were asked to complete the BPVS II vocabulary test in the same 30 minute session. Children's performance on the experimental reading task followed by the rapid naming task was assessed in a second 15 minute testing session on the following day.

The experimental task consisted of a single word appearing on the screen and when the children had read the word aloud a key was pressed on the keyboard by the experimenter which removed the word from the screen. This action also captured a solution time for reading the word as the key press stopped a timer. If the child was in the concurrent reporting condition then they were asked to explain how they had read the word during the task. Alternatively, if the child was in the retrospective condition, they were asked after reading the word to give a self-report of strategy use. In order to gain the self-report the children were asked, 'how did you read that word, can you explain it to me?' If no response was provided, the experimenter then asked 'which letter did you start with?' No other prompts were provided to ensure that the children were not led into providing an erroneous response. On completion of the experimental reading task, the children were presented with the rapid naming task. The reported strategy use and behavioural observations were all coded into the computer task by the experimenter.

Following the experimental reading task, all children completed the rapid naming task. The same single-word items were used as those in the experimental single-word reading task and they flashed up on the screen for 500 milliseconds before disappearing. The children were asked to read the words as they appeared. Accuracy was recorded for this task.

The inter-trial intervals between each word appearing on the screen was set at 1000 milliseconds after the experimenter had coded the accuracy and asked for the self-report. This meant that the mean time between each word appearing was 1800 milliseconds. In the rapid naming task the children were not asked for a self-report so the average time after coding in the accuracy was 1300 milliseconds. The time interval between the words should reduce any masking effects.

5.4 Coding children's verbal self-reports

Children's verbal self-reports, as summarised in Table 5.2, were coded in line with previous studies (c.f. Farrington-Flint et al., 2008a, 2008b; Rittle-Johnson & Siegler, 1999). Children were credited with using retrieval when the child stated that they simply knew the answer, or that they had seen the word in their books. Whilst retrieval is not necessarily considered a conscious strategy choice, it may be considered an automatic response which is indicative that they have stored an orthographic representation of the word and are therefore using the lexical route to retrieve the pronunciation (Coltheart et al., 2001). The strategy that was termed 'retrieval' in this thesis relates to Ehri's sight word reading (1995, 1999; 2002). Children were credited with using a phonology-based strategy (sounding-out using grapheme-to-phoneme correspondence rules) when the child sounded out each individual phoneme and blended these together to form the word (for example p-r-a-m 'pram'). When using this strategy the children frequently recorded that they 'used the sounds in the word' as the THRASS system of phonics promotes this type of learning. They were coded as using analogy strategies when the children reported to have used another word as the basis for identifying the words in the study (for example, 'I knew that said 'ring' because it is like the word 'sing'). Children were credited with using a 'mixed' combination of reading strategies when they reported to have retrieved a common sound and sounded out the initial and final phonemes contained in the word (for the word ‘hood’ they retrieved the vowel /oo/ and added the other sounds). There were also categories for ‘guessing’ and ‘no response’. The ‘no response’ category accounted for 2% of the overall responses. The strategy use was coded solely using verbal self-reports and the behavioural observations were only used to test the validity.

Table 5.2
Strategy coding with examples of children’s self-reports and overt behaviour.

Strategy	Examples of self-reports	Overt behaviour
Retrieval	‘I just knew it.’ 'I have read it before.’ 'It is in my books.’ 'We learnt it in class.'	No overt behaviour. Word read very quickly.
Phonological	‘I used the sounds.’ 'I used the phonemes.'	Pointing to each letter and saying each phoneme separately.
Analogy	‘I know the word ____ and this rhymes with it.'	Saying the rhyming word.
Mixed	‘I knew the ending and sounded out the rest.'	Retrieving part of the word and sounding-out each phoneme and pointing.
Guessing	‘I had a guess’	No overt behaviour. Word presented as a whole.
No Answer	‘I do not know.'	Not reading the word at all.

Note: These examples of self-reports are actual responses from previous work (Farrington-Flint et al., 2008a).

The strategies discussed above relate to the stages in Ehri's model of reading acquisition. Children in Year One and Year Two all have alphabetic knowledge and therefore they are not in the pre-alphabetic phase. In the partial-alphabetic phase if the word is novel then phonological or a mixed strategy could be applied. However Ehri's (1995) model states that the child will use sight-word reading even in this early stage of reading acquisition if the word is familiar to them. In the full-alphabetic and consolidated-alphabetic stage there is a similar pattern, with analogy being introduced as a more advanced strategy (see Table 5.3).

Table 5.3
Strategies used in early word reading mapped onto Ehri's mediated phase model of reading development (1995; 1999; 2002).

Ehri's stage of development	Novel word	Known word
Partial-alphabetic	Phonological, Mixed	Sight-word Reading
Full-alphabetic	Phonological	Sight-word Reading
Consolidated-alphabetic	Phonological, Analogy	Sight-word Reading

5.5 Results

To examine the validity of using concurrent and retrospective verbal self-reports within the context of children's word reading, the result section is presented in four parts. Firstly, relative changes in the accuracy and speed of children's reading scores according to verbal report type (concurrent vs. retrospective method) were examined to establish changes in reading performance as a function of reporting condition.

Secondly, differences in the frequency, accuracy and speed of self-reported strategies for performance on the reading task as a function of verbal report type was investigated. Thirdly, differences in children's problem-solving for both verbal report conditions as a function of each item's word frequency and letter length is examined to identify how the nature of word items can change reading performance and strategy choice. Finally, the baseline data including effects of the different stimulus characteristics of the words (differences in word length and word frequency) across the two year groups and different self-report conditions were investigated. In order to examine the effect length of formal reading instruction has on the task, all analyses were carried out separately according to year group.

5.5.1 Differences in children's reading skill across self-report conditions

First, the validity of using verbal self-reports to capture changes in children's reading strategies was examined. To investigate the impact of self-reporting on the response of the task, the overall percent accuracy and solution times for the children's performance on the experimental single word reading across report conditions (including the control condition), was examined (see Table 5.4). The percent accuracy is slightly lower in the condition where the children were not asked to give a self-report for the children in Year One. However the children in Year Two have shown a different pattern with a slightly higher level of accuracy in the control condition.

A 2 (year group) x 3 (reporting condition) ANOVA was used to examine the differences in reading accuracy across year group and type of self-report. This revealed a significant main effect for year group, $F(1,54) = 11.252$, $p<0.05$, partial $\eta^2 = 0.017$, with older children demonstrating higher levels of word reading accuracy than the younger children. However, there was no main effect for reading accuracy across the self-report condition $F(2,54) = 1.791$, $p>0.05$, partial $\eta^2 = 0.06$, showing similar levels of reading ability across three conditions overall. There was no significant interaction between year group and self-report condition $F(2,54) = 2.741$, $p>0.05$, partial $\eta^2 = 0.09$.

Table 5.4
Means (and SDs) for percent accuracy and solution times on the experimental reading task as a function of self-report condition and year group

	Concurrent	Retrospective	No report
Year One			
Percent accuracy	64.50 (26.71)	61.75 (27.13)	55.25 (16.68)
Solution time	3.23 (2.57)	3.57 (2.39)	3.51 (2.99)
Year Two			
Percent accuracy	88.50 (16.68)	63.75 (33.57)	93.75 (42.90)
Solution time	2.42 (1.33)	2.87 (1.83)	1.75 (0.82)

Note. Solution times for correct responses are presented in seconds

The impact of the self-report condition was further examined by asking if solution times were affected by verbal self-reporting. Table 5.4 shows that the children in Year One had more consistent solution times across the conditions than children in Year Two. In Year Two the fastest solution time for reading the words was in the condition where no self-reports were given and the longest mean solution time was in the retrospective condition. The second 2 (year group) x 3 (reporting condition) ANOVA confirmed that there was a significant difference between the solution times by year group, $F(1,54) = 14.429$, $p<0.05$, partial $\eta^2 = 0.21$, showing that Year One children take significantly longer to read the words. However, there were no significant differences between the mean solution times on the task and the three conditions, $F(2,54) = 1.813$, $p > 0.05$, partial $\eta^2 = 0.06$. There was also no significant interaction between solution time for year group and condition, $F(2,54) = 1.381$, $p > 0.05$, partial $\eta^2 = 0.05$. This shows that although there is a difference in solution times between Year One and Year Two, there is no difference among the solution times between conditions (see Table 5.4).

The solution times for the strategy coded as 'no answer' were also significantly longer than the other strategies as the child did not know the answer and therefore did not give an answer, requiring a prompt (including this data could cause kurtosis). After removing these data points from the analysis, the ANOVA was still non-significant.

Overall the first part of the analyses found that the self-reporting condition does not have an impact on the children's accuracy or speed of reading the words, showing that metacognitive awareness does not impact on performance. This shows that being asked to give a self-report of strategy use does not change the children's performance on this reading task.

5.5.2 Changes in children's reading strategies across self-report conditions

The next stage of analysis examined differences in children's reading strategies across the three self-report conditions to establish whether the type of verbal report was leading children to adopt a particular reading strategy (see Table 5.5). Analysis of self-reported strategy use (in the combined concurrent and retrospective conditions) found that retrieval was the most commonly reported strategy and children are highly accurate when using this approach. The second most common self-reported strategy was the use of phonological decoding, although the use of a phonological strategy proved less accurate than the direct retrieval of words from memory. The least frequently used strategy was analogy. When examining the results across the year groups, the results showed that retrieval remained the most consistently used strategy across Year One and Year Two; however it is used more prevalently in Year Two. Phonological decoding was used more frequently in Year One and these children were also more successful in creating a correct response when using phonological decoding than the Year Two children. The strategy 'mixed' was also used more frequently by Year One children and had a high accuracy.

Table 5.5
Means (and SDs) for self-reported strategy percent strategy use and percent strategy correct as a function of year group

	Year One		Year Two	
	% use of strategy	% accuracy within each strategy	% use of strategy	% accuracy within each strategy
Retrieval	55.60 (49.70)	89.21 (31.06)	75.10 (43.26)	92.68 (26.07)
Phonological	26.60 (44.23)	30.52 (46.15)	15.30 (35.97)	23.77 (42.74)
Analogy	0.80 (8.63)	83.33 (40.83)	0.30 (4.50)	100.00 (0.00)
Mixed	9.80 (29.68)	46.15 (50.17)	5.60 (23.05)	44.44 (50.25)
Guessing	3.30 (17.74)	3.85 (19.61)	1.90 (13.57)	6.67 (25.82)
No answer	4.00 (19.60)	0.00 (0.00)	1.90 (13.57)	0.00 (0.00)

An analysis of the children's verbal self-reported strategies by reporting condition showed that retrieval was more frequently applied in the concurrent condition than the retrospective condition (especially in Year Two) with phonological strategies being used more frequently in the retrospective condition than the concurrent condition (see

Table 5.6). To confirm differences in strategy reports across the concurrent and retrospective condition, a series of two-way 2 (year group) x 2 (condition: concurrent and retrospective) ANOVAs were carried out with the strategy used as the DV (only percent retrieval and percent phonological strategy use were included as these were among the most common strategies reported in the study). There was a significant difference between the retrieval use by Year One and Year Two, $F(1,36) = 4.466$, $p<.05$, partial $\eta^2 =.110$, with retrieval being used significantly more frequently in the older children. There was no significant difference in percent retrieval use across conditions, $F(1,36) = 2.731$, $p>.05$, partial $\eta^2 = .071$.

The second ANOVA compared percent phonological strategy across year group and self-report condition. This found that there was no significant difference between the use of a phonological strategy across the different year groups, $F(1,36) = 2.648$, $p>.05$, partial $\eta^2 = .069$. There were also no significant differences between the use of phonological strategies across the two conditions (concurrent and retrospective self-reports), $F(1,36) =.967$, $p>.05$, partial $\eta^2 = .026$. The implications of these findings were that the different types of self-report are not influencing strategy choice on the experimental reading task.

Table 5.6
Means (and SDs) for self-reported strategy percent use as a function of year group and reporting condition

	Year One		Year Two	
	Concurrent % use	Retrospective % use	Concurrent % use	Retrospective % use
Retrieval	58.50 (49.33)	52.75 (49.98)	87.50 (33.11)	62.75 (48.40)
Phonological	28.25 (45.08)	25.00 (43.36)	6.75 (25.12)	23.75 (42.61)
Analogy	0.50 (7.06)	1.00 (9.99)	0.00 (0.00)	0.50 (7.06)
Mixed	5.50 (22.82)	14.00 (34.74)	4.25 (20.19)	7.00 (25.55)
Guessing	2.00 (14.02)	4.50 (20.76)	1.50 (12.17)	2.25 (14.85)
No answer	5.25 (22.33)	2.75 (16.37)	0.00 (0.00)	3.75 (19.02)

To further examine the validity of self-report data for the concurrent and retrospective self-report conditions, the observable behaviour was compared with all individual verbal reports across conditions using Pearson correlations (see Table 5.7a and table 5.7b). The expected observed behaviour for certain strategies was easier to identify. For the 'phonological' strategy the child could be heard articulating individual phonemes or pointing to each grapheme at a time. However the behaviour associated with retrieval is harder to define. In the case of retrieval, recovering an orthographic representation of a word from memory, there is often no overt or external behaviour. It was not possible to distinguish lack of observable data when using a retrieval strategy from a null-strategy position when the child was not engaging with the task. For example when a child does not know the answer and does not feel confident in attempting the word they will not answer, leaving a long solution time. In order to solve this issue an extra category was created; no behaviour with a short solution time to read the word. In order to calculate this a boxplot was used to find the outliers and the majority of data points. The data were heavily skewed with most children showing a short solution time, but there were some much longer solution times where presumably the children had not known the word. The median was then used to provide a split in the data (at 2000 milliseconds) to separate the children who read the word quickly with those showing longer solution times.

In order to examine the veridicality (truthfulness) of the self-report data collected in the concurrent and retrospective report conditions, the observable behaviour was compared with the verbal self-report (see Table 5.7a and Table 5.7b). Observed behaviour was recorded for both conditions and a correlation analysis was used to look for associations between the self-reported strategy use and observed behaviour. The tables have been simplified and only include the self-reported strategies of retrieval, sounding-out and mixed. This is because there was very infrequent use of the other strategies and therefore the correlations were not extending the findings.

The correlation analysis established that where observed behaviour was obtainable, it confirmed the children's self-reported strategy use across Years One and Two (Table 5.7a and Table 5.7b, respectively). Positive correlations were found between self-reported use of retrieval and no behaviour and a short solution time for Year One (.767, p <.01) and Year Two (.832, p <.01). There were also strong positive correlations for the self-reported use of sounding-out and the associated overt behaviour across both Year One and Year Two, (.829, p <.01 and .583, p >.01, respectively). This suggested that self-reported strategy use was a good portrayal of actual strategy use, when compared with behavioural observations.

Table 5.7a
Correlations among reported strategy use and observed behaviour for Year One.

Self-Reported Strategy Use	Observed Overt Behaviour			
	Short solution time, no behaviour	Sounding-out behaviour	Mixed behaviour	No overt Behaviour
Retrieval	.767**	-.472**	-.142	.452*
Sounding out	-.295	.829**	.299	-.809**
Mixed	-.101	.265	.793**	-.447*

Note: Short response time based on a median spilt at 2000 ms.
** = p<.05; ** = p<.01*

Table 5.7b
Correlations among reported strategy use and observed behaviour for Year Two.

Self-Reported Strategy Use	Observed Overt Behaviour			
	Short solution time, no behaviour	Sounding-out behaviour	Mixed behaviour	No overt Behaviour
Retrieval	.832**	-.253	-.010	.215
Sounding out	-.285	.583**	.574**	-.626**
Mixed	-.276	.396*	.946**	-.545**

Note: Short response time based on a median spilt at 2000 ms.
** = p<.05; ** = p<.01*

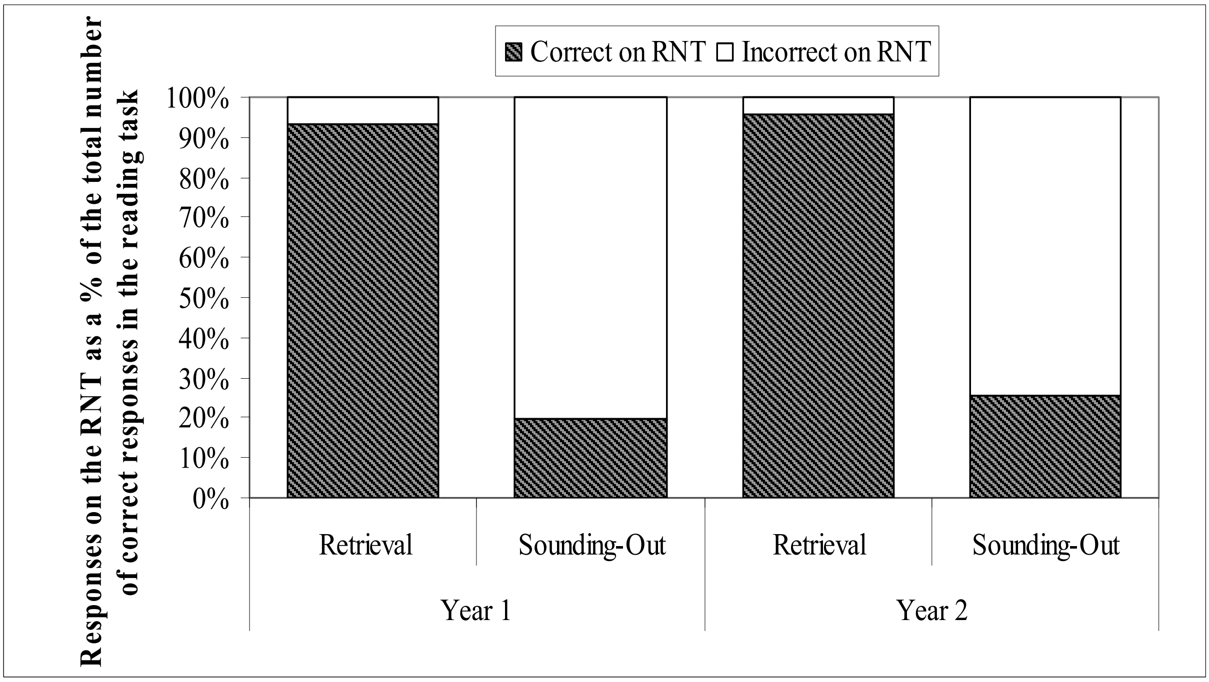
5.5.3 Validating the use of retrieval strategies

Having established that neither concurrent nor retrospective self-reports change children's performance on the experimental reading task, the next step was to attempt to examine the validity of retrieval. The validity of retrieval use was determined by comparing the children's accounts of retrieval on the experimental reading task against their performance on the same word items in the rapid naming task. It was expected that if children were using retrieval accurately (and not simply guessing the correct answer), then there would be a high proportion of correct responses on the rapid naming task, as the task inhibits the use of back-up strategies due to the limited duration that the words were displayed.

Accuracy on the main experimental task was compared with the accuracy on the rapid naming task (which used the same word list). When examining just the participants in Year One that reported the use of retrieval on the experimental reading task, it showed that 93% of the sample read the words correctly (reporting the use of retrieval) on the main task and also correctly identified the word on the rapid naming task. In Year Two there was a slightly higher percentage of 95% (see Figure 5.1). This indicated that if the child read the word correctly and reported the use of retrieval then the majority of children could read the word correctly again during the rapid naming task. In comparison, children who gained a correct response on the main experimental task and self-reported the use of sounding-out showed lower accuracy on the rapid naming task. Only 19.7% who reported the use of sounding-out were able to get a correct response on the rapid naming task for Year One and this rose to 25% in Year Two. This is showing support for the validation of the self-reported use of retrieval as there are distinct differences between the percent accuracy on the rapid naming task dependent on the strategy used.

Retrieval and guessing could produce a similar response in the single word reading task, however in the rapid naming task it is argued that a correct response was likely to be underpinned by the use of retrieval. While guessing might still occur it is more likely to produce errors under the conditions of the rapid naming task.

Figure 5.1
Correct and incorrect responses on the rapid naming task (RNT) as a percentage of correct responses on the main experimental task as a function of year group



5.5.4 Baseline data and the effect of stimulus characteristics on children's reading accuracy

The final set of analyses examined whether children's reading performance on the experimental reading task varied as a result of the nature of the word items that were presented (namely word frequency and letter length) across the two year groups. For an item analysis broken down into the individual words see Appendix D.

Table 5.8
Means (and SDs) for percent accuracy when using retrieval as a function of word frequency

	Low frequency	High frequency
Year One		
Percent accuracy	55.33 (25.76)	65.66 (29.32)
Percent accuracy using retrieval only	90.45 (29.47)	88.38 (32.09)
Year Two		
Percent accuracy	77.00 (26.70)	87.00 (23.98)
Percent accuracy using retrieval only	90.04 (30.00)	94.84 (22.14)

The words were selected to have a high or a low frequency per million (taken from the Children's Printed Word Database). The low frequency words were under 183 per million and the high frequency words were over 303 per million. They were all matched for frequency across the different word lengths. A mixed 2 (year group) x 2 (frequency) ANOVA was carried out to look for any variance between the within variable of correct responses by frequency of the words (high/low) and the between subjects factor of year group. The frequency of the word (high/low) had a significant impact on how accurately the word was read, $F(1,58) = 47.04$, $p<.05$, partial $\eta^2 = .448$. This shows that words with a higher frequency were read more accurately (see table 5.8). The year group that the child was in also had a significant impact on the correct responses, $F(1,58) = 10.349$, $p<.05$, partial $\eta^2 = .151$, however there was no significant interaction, $F(1,58) = .013$, $p>.05$, partial $\eta^2 = .000$. In order to examine if the frequency of the word had any impact on the correct responses derived using only retrieval a oneway ANOVA was carried out to look for any variance between the frequency of the words (high/low) and the correct responses from using retrieval in Year One, this was non-significant, $F(1,37) = .006$, $p >.05$, $\eta^2= .000$. This shows that there is no difference between the accuracy for high or low frequency words when retrieval is used. A similar pattern was found for children in Year Two when looking at the correct responses using retrieval and the frequency of the word (high/low), $F(1,38) = 2.575$, $p >.05$, partial $\eta^2 = .063$.

The words in the experimental single word task varied in word length from 4 to 7 letters. When examining the variance in correct responses by the within-subjects factor of word length and the between subject factor of year group. A mixed ANOVA found a significant main effect of word length, $F(3,174) = 30.654$, $p<.05$, partial $\eta^2 =.366$. This found that there is significant variance between the correct responses on the task by the length of the word. The longer words were more difficult to read and therefore result in significantly fewer correct responses. There was also a significant main effect for year group, $F(1,58) = 10.349$, $p<.05$, partial $\eta^2 = .151$ and a significant interaction between the correct responses on the words of different lengths and the year group, $F(3,174) = 8.636$, $p<.05$, partial $\eta^2 = .130$. This showed that the correct responses on the task were influenced by the year group and the number of letters in each word. Generally, for Year Two the accuracy was consistently high across all letter lengths, unlike Year One who performed better on the 4 and 5 letter words.

Table 5.9
Means (and SDs) for percent accuracy and solution time as a function of word length

	Percent accuracy	Mean solution time in seconds
Year One		
4 letters	71.00 (45.45)	4.04 (3.09)
5 letters	69.67 (46.04)	4.69 (4.11)
6 letters	50.33 (50.08)	5.91 (4.92)
7 letters	51.00 (50.07)	6.03 (5.08)
Year Two		
4 letters	86.67 (34.05)	2.27 (1.45)
5 letters	83.33 (37.33)	2.59 (1.98)
6 letters	78.00 (14.49)	2.39 (3.46)
7 letters	80.00 (40.07)	3.51 (4.17)

A mixed ANOVA was used to examine the variance in time taken to read the word by word length (within-subject) and year group (between-subjects). The sphericity assumption was violated so the Greenhouse-Geisser correction was used. The mixed ANOVA found that word length had a significant main effect, $F(1.99, 115.64) = 24.263$, $p<.05$, partial $\eta^2 = .295$. There was also a significant main effect for year group, $F(1,58) = 13.858$, $p<.05$, partial $\eta^2 = .193$. This finds a significant difference between the solution times between the year groups. However, the interaction of word length and year group was not statistically significant, $F(1.99,115.64) = 1.618, p>.05$, partial $\eta^2 = .027$. This showed that although the length of the word and the children's year group had an effect on the solution times for word identification, there was no significant interaction between the two variables.

5.6 Discussion

Study One examined the validity of retrospective and concurrent forms of verbal self-report within the context of children's early-word reading. There were four main findings. Firstly, there were no significant differences between the accuracy and speed of responses on each of the reporting conditions (concurrent, retrospective and control). This suggested that asking the children to provide a verbal self-report does not impact on the response or the time taken to produce the response. Secondly, the strategy use across the reporting conditions (concurrent and retrospective) was compared. This found there were no significant differences, suggesting that giving a self-report does not encourage use of one particular strategy. Thirdly, the results from the rapid naming task provided further validation for the strategy termed 'retrieval' as there was a good correspondence between correct responses using retrieval on the main task and a correct response on the rapid naming task. Finally, some baseline data establishing the impact of word characteristics was captured.

There was little difference in the accuracy or speed of children's word reading across the different self-report conditions, showing that the use of self-reports did not impact on children's reading performance. For both concurrent and retrospective self-report conditions, percent retrieval use was the most frequent strategy overall, whilst phonological decoding was used less frequently for correct word identification. There was a high agreement between reports of retrieval and the children's performance on the rapid naming task, confirming that self-reports of retrieval remained valid and true. These findings which directly compared different types of verbal self-reports suggest that verbal protocols from children are a valid and efficient way of capturing data about changes in reading strategy performance (c.f., Ericsson & Simon, 1993; Robinson, 2001). The validity of using verbal self-reports was confirmed for Year One and Year Two. This finding matches that of Robinson (2001), who showed self-report of strategy use does not change the response on a subtraction task. However, Robinson (2001) found that there was a significant difference in solution times across the three conditions, suggesting that giving a report of strategy use means that the task is solved slower, a finding not replicated here. This disparity could be the result of the difference in task between a mathematical task and the current focus on reading as the cognitive load is lower in a single word reading task compared with that for a computation. Due to the nature of the single-word task, the retrospective verbal self-report seemed the most appropriate to use as it is difficult to give a concurrent report whilst reading the word and supported claims from earlier studies that have used retrospective forms of self-report data within the context of both spelling and word reading (c.f., Farrington-Flint et al., 2008a; Farrington-Flint et al., 2008b; Farrington-Flint et al., 2009; Kwong & Varnhagen, 2005; Rittle-Johnson & Siegler, 1999).

The accuracy and time latency data suggested that the self- reports did not interfere with performance. The substantive correlations between the reported strategy use and observed behaviour suggested that the reports provided had a good level of accuracy and were a good portrayal of how the children were reading the words. This is in line with reports from Rittle-Johnson and Siegler (1999) who found a 70% correspondence of overt behaviour and the self-reported strategy in a spelling task.

As retrieval was more difficult to validate, the rapid naming task was introduced. When comparing the results on the main task with the accuracy on the rapid naming task, it gave further support for the use of retrieval and suggested that children were able to retrieve a word from memory once an orthographic representation had been made and were able to successfully report this in a self-report (Ehri, 1995, 1999, 2002; Share, 1995, 1999). For example, over 94% of the words that children reported to have retrieved on the experimental reading task were also correctly identified on the rapid naming task which suggests that the children are able to accurately self-report the use of retrieval from memory (sight-word reading). This provides validation for using self-reported strategy use in research aiming to identify how children are reading different words.

Examining the results of the rapid naming task and the trials where phonological strategies were used on the main task shows much less correspondence (around 20%). This 20% could be explained by priming effects; the children have seen the word previously and therefore have learnt the word. Share (2004) identified that even one exposure to a word could create an orthographic representation then this could simply be showing a learning effect. An alternative explanation is that the children are unconsciously using retrieval in the first trial. Siegler and Stern (1998) found that strategy use could be unconscious before the children are able to report its use. Therefore if the children reported the use of phonological strategies on the main task, but were still able to read the word under the timed conditions on the rapid naming task it could suggest that they were unconsciously using retrieval. Although there is some evidence that there could be some use of unconscious strategies occurring, the overall correspondence between the use of retrieval and the rapid naming task suggests that children are providing an accurate self-report.

The differences in the frequency of reported reading strategies across Year One and Year Two offered further empirical support to Ehri's (1995; 1999; 2002) mediated phase model of word reading. There were some similarities in the strategies reported by Year One and Year Two as retrieval was most commonly reported across both year groups. However Year Two children used retrieval significantly more often than Year One children suggesting that they had the opportunity to secure more orthographic representations to memory. The distribution of strategy reports (across both concurrent and retrospective conditions) suggests a developmental trend from an earlier use of primitive procedural strategies (e.g., phonological attempts) to the use of retrieval from memory. This developmental trend has been identified in previous studies for spelling (c.f. Rittle-Johnson & Siegler, 1999; Kwong & Varnhagen, 2005; Farrington-Flint et al., 2008b), and word reading (Farrington-Flint et al., 2008a), however such cross-sectional designs often neglect important changes in children's strategy performance within the same child over chronological time. However, given that there was no notable distinction between the types of strategies used across the different reporting methods (e.g., retrospective and concurrent verbal self-reports), it was decided that retrospective reporting methods would be used throughout the remaining chapters of the thesis.

The findings from the current study also provided baseline data about the types of strategies that were found and also about the differences based on the stimulus characteristics of the word list. The strategies that were found to be used the most by the children in both Year One and Year Two were retrieval from memory (sight-word reading) and phonological (sounding-out). There was lower use of mixed strategies (applying both retrieval to a part of the word and sounding-out the rest) and analogy. The larger usage of retrieval and phonological decoding can be explained by the dual route cascaded model of reading (Coltheart et al., 2001). The dual route model suggests that when we are presented with a word it can be read using either the lexical route (retrieval) which relies on semantics and ready-made orthographic representations of words, or the non-lexical route which uses grapheme to phoneme correspondences. These pathways are a good representation of the ways in which the children are self-reporting that they are reading the words. This terminology of lexical (retrieval) and non-lexical (phonological) were used to describe the strategies in future studies of this thesis.

As well as finding baseline data on the types of strategies being applied, Study One also looked at the impact of different word characteristics. The words were chosen to be high or low frequency and were all matched for CVC structure and word length. Higher frequency words were read significantly more accurately than lower frequency words. This is an expected finding as there has been extensive work showing that high frequency words are read more accurately and faster than low frequency words (Forster & Chambers, 1973; Whaley, 1978; Grainger, 1990). However, when the differences between high and low frequency words were examined by looking at strategy use it showed a different picture. If the children reported reading using retrieval, then there was no significant difference between high and low frequency words. This suggested that they had confidence in their response through the use of sight-word reading as their accuracy did not vary on the low frequency words. More specifically, there were notable differences in the accuracy at reading the words of different lengths. Within the word list there were words of four letters, five letters, six letters and seven letters. The shorter words were read significantly more accurately and also had shorter solution times. In order to fully investigate the impact of word characteristics a closer examination of strategy performance at the word-specific level is required.

The question raised for future research is to what extent the nature of word items, for example regular and irregular word items, influences children's initial reading ability and also whether there is any shift in their reliance on certain reading strategies as a result of these manipulations (see Castles, Coltheart, Larson, Jones, Saunders & McArthur, 2009; Farrington-Flint et al., 2008b). For example, within the English orthography there are many exception and unique words (containing fewer phonological neighbours and less transparent grapheme-to-phoneme mappings) so it is likely that these different types of words could have an impact on the types of strategies that children adopt in their attempt to secure words to memory (see Ehri, 1999). Therefore a look at word-specific explanations for shifts in children's reading strategies is required. Study Two, in Chapter Six, sought to extend the current findings by examining differences in reading strategies as a function of rime-unit frequency through a manipulation of different word types.

Chapter Six

Study Two: Examining Word-Specific Shifts in Children's Strategy Choice

6. Introduction

Study Two examined the word-specific changes in children's reliance on word reading strategies through the manipulation of word items based on rime unit frequency (consistent, unique and exception). Given that English consists of a quasi-regular orthography, with many variations in GPC mappings and rime unit frequencies, it has been argued that further consideration was needed with regard to how children's sensitivity to rime unit correspondences may influence their reliance on different word-reading strategies. A further objective of Study Two was to identify distinct patterns in reading strategy performance to identify different pathways to reading success.

As argued in Chapter Two, there is growing support for Ehri's (1995; 1999; 2002) model of reading development. However, it has been argued that Ehri's mediated phase model (1995; 1999; 2002) is based on examining global changes in reading and does not examine shifts in reading performance at a word-specific level. This means that it does not take into account that children may learn to read certain words before others. Share's (1995) self-teaching hypothesis is based on the idea that when a child is given an unfamiliar word to read, they decode it and therefore create a new orthographic representation. As for Ehri's model, the goal is to be able to store the word as a complete representation, so that the word can be retrieved from memory. In order to decode the word the child can use any strategy available to them. Share (1999) found that children encoded words the way that they pronounced them; so at times the orthographic representations of the words in their internal lexicon were not an accurate representation. These words then had to be phonologically recoded upon being corrected. Share's model differs from that of Ehri in that it is based at the item level and does not suggest any stages through which children progress as readers. However when combined with Ehri's model, it can be very helpful in understanding how word representations are created in order to read by sight. This can mean that whilst Ehri's model can be used to look at overall developmental shifts in reading development, Share's model can be used alongside to analyse the item based development and how higher frequency words may be learnt earlier than lower frequency words.

Recent studies have shown that children's sensitivity to rime units may influence their reliance on certain spelling strategies. For example, Nation (1997) found that while children spelled consistent words most accurately, there were notable differences in their attempts to spell words with less regular rime units (exception and unique words). Nation also found that when the children were asked to spell non-words, they were more successful when the non-words contained high-frequency rime units. With regards to the non-words it is difficult to say if the spelling is correct or incorrect as by their very nature they are made up words. The words contained frequently occurring rime units and the children were classified as spelling the word correctly if they spelt the rime unit correctly and had a feasible onset. For example, the non-word 'fick' should contain the rime unit 'ick' and could therefore also be spelt 'phick.' Farrington-Flint and colleagues (2008b) looked at possible differences in children's spelling accuracy and strategy choice when spelling items that contained frequent (consistent items) and infrequent (unique and exception) rime units and found that the children's spelling was most accurate (and somewhat quicker) when the target items contained regular rime units. More importantly, the data showed how their sensitivity to rime units influenced their use of spelling strategies highlighting a predominant increase in lexical approaches when attempting to spell consistent and exception words. The significance of rime unit frequency has been found in children's spelling performance and it is important to see how this relates to reading development.

A number of studies have attempted to examine whether children use rime units in early reading acquisition (Coltheart & Leahy, 1992; Goswami, 1993; Goswami & Mead, 1992; Nation, 1997). However, despite our current understanding with regard to the importance of children's sensitivity to rime-level correspondences in early reading, considerably less work has examined how this early sensitivity to rime-level units may influence children's reliance on word-reading strategies. That is, despite an awareness that both lexical and non-lexical word-reading strategies are evident in early word reading (e.g., Farrington-Flint et al., 2008a, Farrington-Flint & Wood, 2007; Varnhagen, McCallum & Burstow, 1997), the majority of studies have solely examined 'global' shifts in reading strategies without addressing alternative word-specific explanations (see Share, 1995). Given the relative importance of rime unit frequency on children's early reading and spelling ability (c.f. Coltheart & Leahy, 1992; Goswami, Ziegler, Dalton & Schneider, 2003; Laxon et al., 1988; Treiman, Goswami & Bruck, 1990) and the importance of flexibility in choosing among different word reading strategies (Farrington-Flint et al., 2008a), additional work is needed to assess the contribution of word-specific features in children's reading strategies. The current study therefore examines how 7-to-8 year olds' sensitivity to rime-level spelling-sound correspondences can influence their use of both lexical and non-lexical forms of word-reading strategies by examining the frequency of verbal strategy reports across differing word types.

Study Two addressed three specific research questions. Firstly, to what extent does children's reading ability differ across word items that vary in rime unit frequency? It was expected on the basis of earlier findings (Nation, 1997) that the differences in word type based on rime unit frequency (consistent, unique and exception) would influence the children's reading accuracy. Secondly, does children's sensitivity to rime-level spelling-sound correspondences influence their choice of strategy? If differences were found in the application of strategies that were used to read the words with manipulated rime unit frequency, it could suggest that the children were able to choose their strategy according to the word presented. Thirdly, do children follow distinct patterns in their choice of particular reading strategies that is indicative of their sensitivity to rime unit spelling-sound correspondences? The final aim was investigated through the use of cluster analysis, to identify distinct profiles of reading ability based on the children's reliance on different word reading strategies.

6.1 Method

6.1.1 Design statement

This study was an independent measures design, with one independent variable with three levels (consistent words, exception words and unique words). The dependent variable were the frequency, accuracy and solution time for all individual self-reported word reading strategies. The order in which the word items were presented was completely randomised across trials and across children.

6.1.2 Participants

Sixty-one children from a lower to middle socio-economic status in the suburbs of a British town participated in the study. As for Study One, the ACORN data classified the area as moderate means, blue collar roots with predominant housing in older, rented terraces (CACI, 2009). The children were recruited from Year Two classrooms in a UK primary school (comprising 30 female and 31 male) of 7 - 8 years olds (mean age 89 months, SD = 3 months). The means (and SDs) for children's scores on the baseline measures are summarised in Table 6.1.

Table 6.1
Means (and SDs) for children's performance on the baseline measures

Baseline measures	Mean score
BAS II Single-word Reading [a]	105.36 (14.09)
BPVS II Vocabulary [a]	103.03 (9.96)
BAS II Word Definitions [a]	52.06 (9.97)
Phoneme Deletion (max. score: 24)	16.46 (5.89)
Orthographic Choice (max. score: 23)	14.95 (4.61)

Note. [a] denotes standardised scores based on chronological age norms

6.1.3 Screening

The BAS II Single word reading task was applied as a screening task and the children had to be able to read at least eight words from the first sub-section of the list to continue. This screening task was the same as detailed in Study One. Eighteen children were unable to identify enough of the words from the BAS II reading subtest and were excluded from the study. The number of children excluded from the task was higher than in Study One as all of the Year Two children were screened (compared with Study One where the teachers highlighted the higher ability readers) in order to gain the correct number of participants from Year Two.

6.2 Materials

6.2.1 Baseline measures

Baseline measures were collected as Study One, including the BAS II Single Word Reading (Elliot, Smith & McCulloch, 1996) and the BPVS II Receptive Vocabulary (Dunn, Dunn, Whetton, & Burley, 1997). In addition there were further baseline measures collected (as detailed below).

BAS II word definitions

The BAS II Word Definitions subtest (Elliot, Smith & McCulloch, 1996) was included as a measure of expressive vocabulary. The children were given a word and were asked to explain what the word means. The child continued with the list of words until five consecutive incorrect answers were given. Raw scores were calculated into a standardised score (Mean = 100, SD = 15). The standardised score was used to place each child into a percentile using their chronological age. As you can see from table 6.1 the children in this sample struggled with this task and scored well below average for their age.

Orthographic choice task

The orthographic choice task (Cunningham, Perry & Stanovich, 2001) was developed from work of Olson and colleagues (c.f. Olson, Wise, Conners, Rack & Fulker, 1989; Olson, Forsberg, Wise & Rack, 1994). The task used two-word pairs of letter strings that are phonologically similar, but only one is the correct spelling in English, for example 'word'-'wurd', 'rain'-'rane' and 'streem'-'stream'. The children were given both words on a piece of paper and were asked to circle the one that was spelt correctly. As the words sounded similar, it was difficult to distinguish between the two based on phonological decoding. The task reflected the accessibility of orthographic representations in the memory and the children needed to use this skill to decide which word was spelt correctly. The children were given one point for each correct response with a maximum score of 23.

Phoneme deletion task

The phoneme deletion task (Wood, 1999) was designed to assess a child's ability to manipulate phonemes within words. The task required the children to remove the initial sound from the word and say the final sound in the word, for example, 'car' without the /k/. There were four practice items at the start and then twelve test items. The second part of the task required the children to remove the final sound in the word, for example to say the word 'find' without the /d/. The test had a maximum score of 24 with one point given for each correct response.

6.2.2 Experimental word reading task

The Experimental Word Reading Task was devised to examine how children's sensitivity to rime-level spelling-sound correspondences may influence their choice of lexical and non-lexical word reading strategies. Children were presented with 45 single-word items which were selected on the basis of variations in grapheme-to-phoneme correspondences and rime unit neighbours (words taken from Nation, 1997; Farrington-Flint et al., 2008b). Three specific types of words were included: consistent, exception and unique (see Appendix C).

(i) Consistent items contain consistent grapheme-to-phoneme correspondence rules and share similar orthographic rime units with many other English monosyllabic words (e.g., 'belt' 'felt' and 'melt').

(ii) Exception word items contain inconsistent grapheme-to-phoneme correspondence mappings and also contain unique orthographic rime units with fewer rime neighbours (e.g., ‘flood’).

(iii) Unique word items contain consistent phoneme-to-grapheme correspondence mappings but contain unique orthographic rime units with fewer neighbours (e.g., ‘scalp’).

The terminology for the different types of words presented in this study is the same as employed by Nation (1997). Consistent words may also be known as ‘regular’ words in other studies and exception words can be also termed ‘irregular’ words. The ‘unique’ words have also been referred to as regular inconsistent in previous studies.

Nation (1997) selected the word list and states that the words were matched in triads for number of phonemes, initial phoneme, part of speech and frequency (Kučera & Francis, 1967). The words were all monosyllabic nouns, except for a few monosyllabic verbs or adjectives and these were dispersed equally through the three sets of words. In the appendix the word list shows the frequency per million from the Children’s Printed Word Database and these suggest that the frequencies are not matched. However, the CPWD is based on the frequency of words occurring in reading schemes and the schools that were used for this research used a 50:50 mix of reading schemes and ‘real books.’ The word lists were shown to the class teachers before and they believed that they would be familiar with many of the words in their spoken vocabulary.

The 45 word items were presented individually and displayed in the centre of a laptop screen. The order in which the items were presented was randomised across trials to remove any potential order effects. Following each child’s attempt to identify the individual word items, they were prompted to provide a retrospective verbal self-report of the strategy they used on each trial (see Study One). Analyses revealed high levels of internal reliability for the word list, as calculated using Cronbach's alpha, for consistent (alpha = 0.91), unique (alpha = 0.87) and exception (alpha = 0.90) words.

6.2.3 Rapid naming task

The rapid naming task used the same word items as the experimental single-word reading task. The words were displayed on the screen in the same style as previously used, but were only displayed for 500 milliseconds each. See section 5.2.3 for a further description of the rapid naming task.

6.3 Procedure

All children were tested individually in the school by the experimenter on three separate occasions. Sessions were between 3 and 7 days apart. Children completed the standardised baseline measures across the first two testing sessions to avoid unnecessary fatigue. In the first session, the children completed the BAS II Single Word Reading task (Elliot, Smith & McCulloch, 1996) and the BPVS II Receptive Vocabulary test (Dunn, Dunn, Whetton, & Burley, 1997) within the first 30 minute session to ensure an adequate level of word recognition and vocabulary. In the second session, the children completed the BAS II Word Definitions (Elliot, Smith & McCulloch, 1996), Orthographic Choice task (Cunningham, Perry & Stanovich, 2001) and Phoneme Deletion task (Wood, 1999). In the third session, all children completed the experimental word reading task, followed by the rapid naming task. Full informed consent was provided for each child's participation in the study. The experimental single word reading task was administered as in Study One with the words appearing on a laptop screen and being removed when the experimenter pressed a key. Accuracy and solution times were collected as well as a verbal self-report of strategy use collected retrospectively and any observable overt behaviour.

6.4 Coding children's verbal self-reports

Children's verbal self-reports were coded in line with previous studies (c.f. Farrington-Flint et al., 2008a; Rittle-Johnson & Siegler, 1999) following the same coding framework adopted in Study One (see section 5.4). Further validity checks were carried out using the current word list with manipulated word types. This supported the findings of Study One finding that retrospective verbal self-reports were valid (see Appendix F).

For the purpose of analysis, as the baseline data in Study One found predominant use of sounding-out and retrieval, the strategies in this study are defined as lexical and non-lexical strategies as identified by the DRC model (Coltheart et al., 2001). In this model the lexical route relies upon using retrieval of the orthographic representation that has already been stored in order to read the word. Words classified as using the lexical route in the results section have been retrieved from memory. The non-lexical route relies on words being decoded using the phonological information in the word. Words that were read using this non-lexical route were read via sounding-out or mixed strategy, as these strategies all apply phonological cues.

6.5 Results

The results were presented in three sections. Firstly, there was an examination of whether children's sensitivity to rime-level spelling-sound correspondences influenced their reading by comparing differences in the accuracy and speed of their reading scores across words that vary in their rime unit frequencies (consistent vs. unique vs. exception items). Secondly, differences in the distribution of children's self-reported reading strategies were examined across the three word types to examine whether children's sensitivity to rime units is having any influence on their choice of lexical and non-lexical reading strategies. Finally, the possibility of identifying distinct patterns in the distribution of lexical and non-lexical word-reading strategies across word type was examined using cluster analysis.

6.5.1 Differences in children's word reading skill

The first analysis examined the accuracy and solution time for children's reading scores on the experimental word reading task across the three different word types (consistent, exception and unique). The means and SDs are summarised in Table 6.2. Table 6.2 shows that the consistent words were the most accurate and the exception words had the lowest accuracy. The number of correct responses was significantly different by word type, $F\ (2,120) = 25.54$, $p < .05$. Pairwise comparisons found that consistent items were identified more accurately than the exception or unique word items ($p < .01$). For an item analysis examining the accuracy on individual words see Appendix E.

Children's solution times across the three word types showed a similar pattern to the accuracy data (see Table 6.2). Consistent words were read the fastest but it was the unique words, that had the longest solution times, although the children were more accurate when reading unique words than the exception words, they took longer to produce the response. The differences on solution times between the three word types was significantly different, $F\ (2,120) = 16.37$, $p < .05$. Pairwise comparisons revealed that consistent word items were read quicker than the unique or exception items ($p < .01$).

Table 6.2
Means (and SDs) for children's percent accuracy, and solution time across word type

	Percent Accuracy	Solution time
Consistent	54.10 (49.86)	4.99 (3.29)
Exception	37.16 (48.35)	5.43 (3.55)
Unique	45.03 (49.78)	5.61 (3.60)

Note. Solution time in seconds

6.5.2 Distribution of strategy reports across word type

Differences in the frequency and accuracy of children's reported reading strategies were compared across the three word items to establish whether the manipulations in the words' rime unit frequencies (consistent, unique, exception items) were leading children to adopt a particular type of reading strategy. The strategies were broken down into lexical (retrieval) and non-lexical strategies (phonological based strategies; sounding-out and 'mixed'). As Figures 6.1 and 6.2 show, while phonological approaches were used most frequently across all word types (figure 6.1); the reading accuracy was however much lower for the identification of exception words (20%) than consistent (38%) or unique (38%) words (Figure 6.2). However, this finding was expected given that exception word items contained unusual grapheme-phoneme mappings (and low rime unit frequency) and therefore the adoption of non-lexical phonological-based reading strategies would inevitably result in low levels of accuracy when compared to words with relatively more regular grapheme-phoneme mappings (e.g., consistent and unique items). Similarly, while retrieval was used most frequently for the identification of consistent word items, this use of lexical reading was most accurate for the exception words, producing a correct response for 62% of all words read, although again this was expected given that non-lexical strategies would remain largely inefficient given the irregularity of such word items.

To examine differences in the frequency of reported strategies as a function of word type, repeated measures ANOVAs were carried out with strategy frequency as the dependent variable and word type (consistent, unique, exception) as the independent variable. The results revealed a significant difference in the use of retrieval strategies (lexical) across the three word types, $F(2,120) = 16.08$, $p < .01$. Pairwise comparisons showed that children were using retrieval significantly more often on the consistent than unique or exception word items ($p < .01$) and no difference between exception and unique items ($p > .05$). There was also a significant difference in their reported use of phonological strategies (non-lexical) across word type, $F(2,120) = 16.33$, $p < .01$, with greater use on consistent than unique words ($p < .05$) and exception words ($p < .05$). There was no significant difference in the use of phonological approaches between the consistent and exception words.

Figure 6.1. Percent frequency of children's use of lexical and non-lexical word-reading strategies across word type (95% CI)

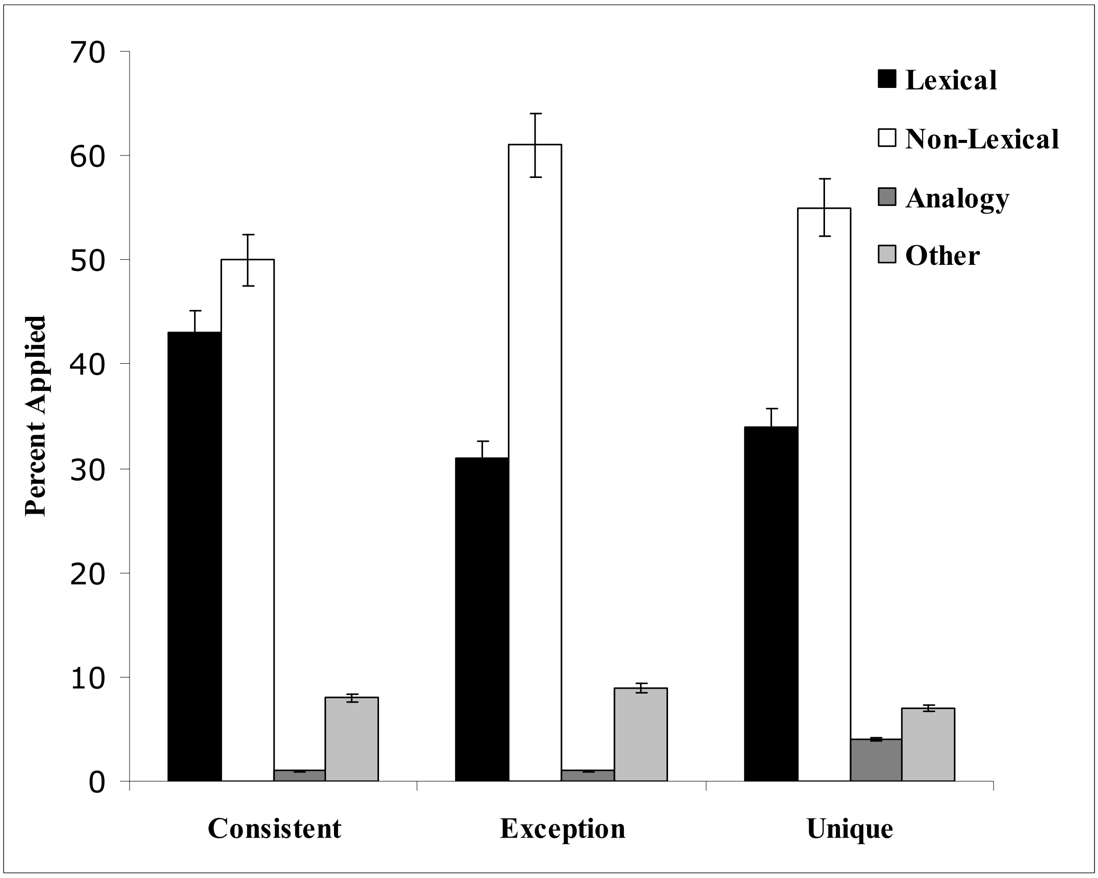
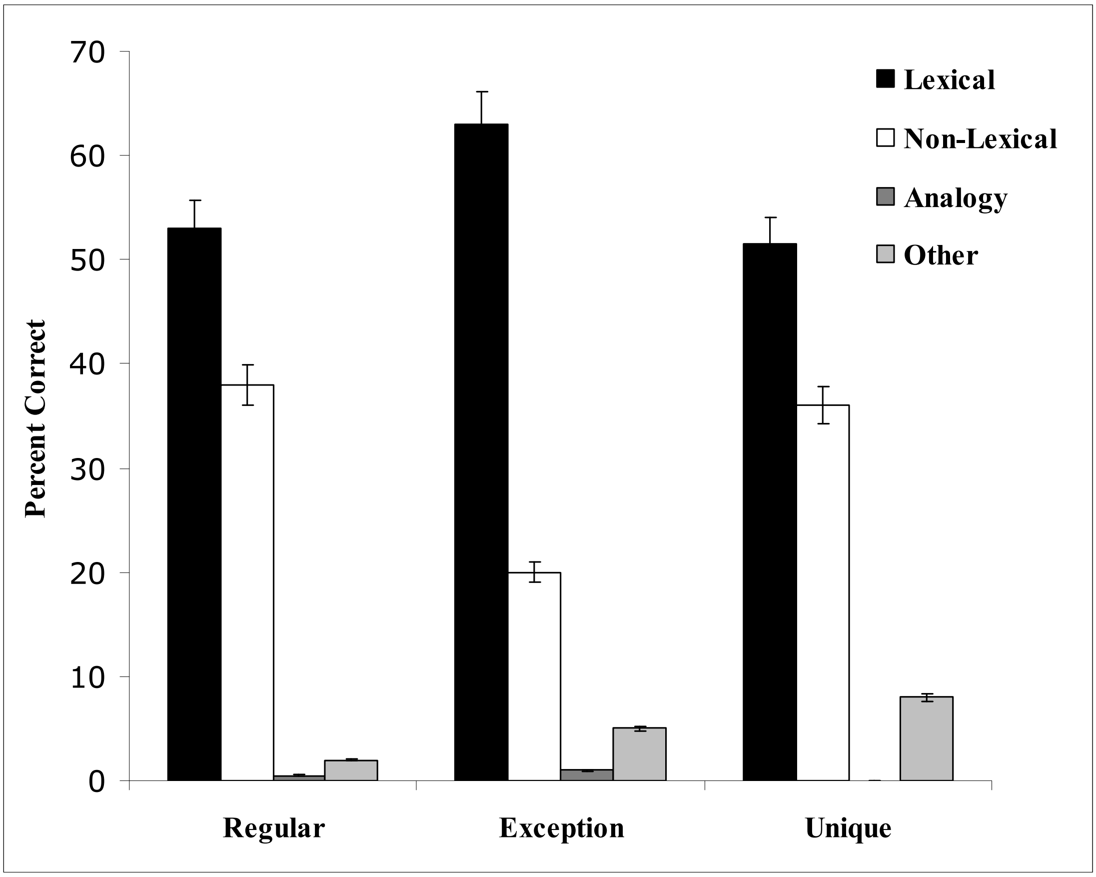


Figure 6.2. Percent accuracy in children's use of lexical and non-lexical word-reading strategies across word type (95% CI)



Given differences in the frequency of reading strategy reported across word types, the next set of analyses compared differences in percent accuracy (see Figure 6.2). Repeated measures ANOVAs confirmed a significant difference in correct retrieval use across the three word types, $F(2,120) = 4.26$, $p < .05$. Pairwise comparisons showed significant differences between the consistent and exception and the exception and unique word items, but no significant difference between the consistent and unique words ($p > .05$). There was also a significant effect for percent correct phonological strategy use across word type, $F(2,120) = 13.40$, $p < .01$, with greater accuracy on the consistent than unique word items ($p < .05$). Overall, the results highlight the differences in the distribution and accuracy of using lexical and non-lexical reading strategies as a result of children's sensitivity to rime-level spelling to sound correspondences.

6.5.3 Patterns in children's reading strategies

In line with the findings from previous work (c.f., Farrington-Flint et al., 2008a, 2008b), individual differences in children's reading ability were examined by identifying distinct patterns in children's strategy reports across the different word types (see Table 6.3). Hierarchical cluster analysis was used to examine distinct profiles in children's sensitivity to rime-level spelling-sound correspondences and its influence on their choice of reading strategies. To identify the different distinct patterns in reading ability, three data points were entered (percent correct, solution time and percent retrieval use) for each word type (consistent, unique and exception items) into the analysis. A four-cluster solution was selected which accounted for 86% of the overall variance (descriptive names are provided for ease of interpretation). As Table 6.3 shows, the *high ability retrieval group* (n = 11) gave accurate and fast responses across all word types and used retrieval in nearly all cases. These readers had 98% accuracy for consistent words, 82% for exception and 87% for unique words. The *intermediate group* (n = 15) had slightly lower levels of word reading accuracy across unique and exception word items compared to the preceding groups but read the words slightly faster than the overall mean time. They used retrieval on around half of the trials and had an average accuracy. This group also read the consistent words (68%) more accurately than the exception (44%) and unique words (48%). The *low ability* group (n = 26) were less accurate in their reading ability across all words types (consistent, 34%; Exception, 29% and unique, 21%) and showed an infrequent use of retrieval strategies, suggesting a greater reliance on non-lexical (phonological) procedures. Nonetheless the *low ability* group were only just below average in terms of their reading speed. Finally, the *slow reading* group (n = 9) were similar to the previous group in terms of their reading accuracy and use of retrieval strategies, but were particularly slow in their attempts to identify word items.

Table 6.3
Means (and SDs) for mean accuracy, solution time and percent retrieval use across word type as a function of a cluster

	High ability retrieval	Intermediate	Low ability	Slow reading
Consistent words				
Percent accuracy	97.57 (3.36)	68.44 (24.87)	33.58 (20.43)	36.29 (17.03)
Solution time	1.68 (0.22)	3.26 (0.69)	6.10 (1.13)	8.71 (1.28)
Percent retrieval use	95.75 (4.49)	59.55 (25.87)	18.46 (18.69)	14.81(14.44)
Exception words				
Percent accuracy	82.42 (15.85)	43.55 (23.21)	20.76 (17.21)	18.51 (12.37)
Solution time	1.99 (0.38)	3.97 (0.75)	6.37 (1.31)	9.36 (0.90)
Percent retrieval use	82.42 (16.13)	38.66 (19.71)	16.66 (15.11)	11.85 (6.47)
Unique words				
Percent accuracy	87.27 (12.81)	48.00 (20.03)	29.48 (19.79)	33.33 (15.64)
Solution time	2.24 (0.50)	4.10 (0.51)	6.40 (1.03)	9.97 (0.89)
Percent retrieval use	81.21 (12.93)	34.66 (14.29)	14.35 (14.19)	8.88 (11.05)

Note. Solution time in seconds.

Given these distinct patterns in word reading, a (direct) discriminant function analysis was carried out to examine whether these patterns could be explained by the children's performance on the baseline reading measures (Table 6.4). Univariate ANOVAs found significant differences among the four clusters on all of the baseline measures (phoneme deletion, $F(3,57)$ 5.92, $p < .01$, orthographic choice task, $F(3,57)$ 16.66, $p < .01$, BPVS II vocabulary, $F(3,57)$ 3.54, $p < 0.5$, the BAS II single-word reading, $F(3.57)$ 30.66, $p < .01$ and BAS II word definitions, $F(3,57)$ 3.03, $p < .05$). To further examine differences among group membership, three discriminant functions were calculated. With all three functions included in the model, there remained a significant difference among the groups, $\chi^2(15) = 83.20$, $p < .01$. However when the first function, $\chi^2(8) = 13.69$, $p > .05$ and second discriminant, $\chi^2(3) = 2.78$, $p > .05$, were removed, the model could not discriminate between the remaining groups. The results showed that it was the scores on the BAS II Single Word Reading test (.79) that significantly discriminates the *high ability retrieval group* from the remaining three clusters. This finding suggests that it is single-word reading ability that is determining the high accuracy and fast solution times on the experimental reading task, consistent with the accurate use of lexical reading strategies. The *intermediate group* was discriminated from the other reading profiles by the BPVS II Vocabulary (.86), the BAS II Word Definitions (.76) and the Phoneme Deletion task (.39). This suggests that this group were using semantics as well as phonological skills to read. Overall, the discriminate function analysis provided a good fit to the data with 64% of the data as accurately classified cases. For the *high ability retrieval group* the discriminant function correctly classified 53%, for the *intermediate readers* it was 58%, the *low ability group* were correctly classified 56% and the *slow reading* were 100% correctly classified.

Table 6.4
Means (and SDs) for baseline measures as a function of a cluster

	High ability retrieval	Intermediate	Low ability	Slow reading
Phoneme Deletion	21.45 (2.21)	18.13 (5.23)	14.00 (6.31)	14.66 (4.79)
Orthographic choice	21.27 (2.24)	14.93 (4.43)	13.50 (3.34)	11.44 (3.28)
BPVS vocabulary	103.81 (6.77)	109.46 (9.65)	100.30 (8.93)	99.22 (12.97)
BAS II Single Word	127.0 (7.64)	107.86 (12.21)	97.15 (6.60)	98.33 (10.45)
BAS II Word definitions	53.72 (8.97)	57.80 (9.24)	49.12 (10.28)	49.00 (8.51)

6.6 Discussion

The current work examined children's sensitivity to rime unit spelling-sound correspondences and their influence on using lexical and non-lexical word-reading strategies. Three key influences were recorded. First, children's overall reading performance was influenced by their sensitivity to rime unit frequency. Specifically, the children were found to be most accurate in identifying word items that contained regular rime unit correspondences (consistent items) than those containing fewer rime unit neighbours and irregular GPC rules (exception or unique items). Second, sensitivity to rime-level spelling-sound correspondences also influenced the children's reliance on certain word reading strategies. While the data shows that non-lexical reading strategies (namely, phonological strategies) were most common across all word items, these reports were least accurate for unique word items. Lexical retrieval was most accurate for unique items suggesting that children were sensitive to word-specific orthographic representations (Share, 1999). Finally, distinct patterns or 'profiles' in children's reading performance were identified when analysing their use of reading strategies across the different word types. The differences in these profiles could be explained by the children's efficiency in single word reading followed by semantic and phonological skills.

When examining the reading accuracy across all three word items, there was a notable difference between the number of correct responses given according to word type. The consistent words, those with regular GPC mappings and many phonological neighbours, were most often read accurately by the children. The word type with the lowest accuracy was the exception words. This is an expected finding given that exception word items do not have regular GPC mappings and therefore the pronunciations are harder to decode using non-lexical procedures. These words also have low rime unit frequency and therefore it is harder to use a strategy reliant on rime units, such as analogy. These findings show a similar pattern of accuracy to the studies by Nation (1997) and Farrington-Flint et al. (2008b) in as much as showing how 7-to-8 year olds can spell consistent words most accurately and found that words with irregular rime units (the unique and exception words) were more difficult. The present study found that consistent words were read with the highest degree of accuracy. Even though unique words had the same regular GPC mappings (but irregular rime unit and few phonological neighbours) they were still found to be read less accurately, lending support to studies showing how rime unit frequency can largely influence reading and spelling (c.f. Coltheart & Leahy, 1992; Nation, 1997; Farrington-Flint et al., 2008b).

The solution time data showed a slightly different pattern with consistent words being read most quickly but also with a high degree of accuracy. The unique words which have consistent grapheme-phoneme correspondence but irregular rime units had a moderate level of accuracy but as anticipated the longest solution time. This shows that the children were taking longer to read the unique words but were then more accurate when they gave a response. However, whilst the children's attempts at identifying the exception words showed the lowest levels of reading accuracy they did nonetheless show average solution time. However, this possible efficiency in identifying exception word items may be indicative of children's awareness that the use of non-lexical strategies may not guarantee success and therefore they spend less time attempting to identify such items.

While there have been studies examining the development of lexical and non-lexical strategy choice within the context of both reading and spelling acquisition (c.f. Farrington-Flint et al., 2008a, 2008b; Rittle-Johnson & Siegler, 1999; Kwong & Varnhagen, 2005; Nation 1997), there have been few studies that have manipulated rime unit frequency to assess variation in reading strategies. To investigate the differences in reading words with manipulated rime unit frequency it is important to examine the strategies used on each word type in order to try to read the word. Looking at the strategy use can also give information about the phonological grain size that the children use to read the words. The overall distribution of strategies (across all word types) showed a slightly different distribution of strategy use to those found in previous studies in as much as the most frequently applied strategy was phonological using grapheme-phoneme correspondence rules. Previous studies have found retrieval from memory to be the predominant strategy in tasks of spelling and reading (c.f. Rittle-Johnson & Siegler, 1999; Kwong & Varnhagen, 2005; Farrington-Flint et al., 2008a, 2008b). In the present study the most frequently used strategy employed a non-lexical approach, followed by retrieval of words from memory. This suggests that the children were favouring the use of a small phonological grain size (Stuart & Coltheart, 1988) and primarily using the non-lexical route for reading. The reason for the lower use of retrieval might be explained in part due to the relative complexity of the word items included, especially the inconsistent items.

When comparing the distribution of strategy reports across the different word types which varied in rime units, it was found that non-lexical (phonological) approaches were the most frequently reported strategy. Retrieval from memory was used most frequently on consistent words and least on the unique words. As consistent words have regular mappings and many phonological rime-neighbours they allow the use of non-lexical strategies, however there was a high use of retrieval suggesting that these items had been secured to memory. This could be because the high frequency rime units have already been learnt and therefore the most efficient strategy to apply is the direct retrieval of words from the mental lexicon. A further important finding concerns the limited use of analogy strategies. While the use of analogy was higher for exception words, than the consistent and unique word items, the frequency of analogy was low overall. As exception words have no or relatively few phonological neighbours, using an analogy strategy should not produce a correct response. To successfully read an exception word the fastest and most accurate way is to create an orthographic representation of that word, so that it can be retrieved from memory as a complete word. Therefore a shift towards using a lexical (retrieval) strategy for exception words is important to maintain accuracy.

The final key finding reflects distinct patterns in children's reading strategies leading to the formation of four distinct groups. The first group, termed *high ability retrievers* were excellent readers with high accuracy and fast responses on the single word items. They showed a reliance on the lexical route and showed an unbalanced reading profile using a lexical (‘Chinese’) route as discussed by Bowey (2008). The *intermediate* group showed a balanced reading profile with equal reliance on the lexical and non-lexical pathways for reading. The *low ability* group showed an unbalanced reading profile weighted towards the use of non-lexical strategies. These readers would fall into the category of ‘Phoenician’ readers as identified by Bowey (2008). The final group were identified as *slow readers* and showed a similar pattern of accuracy and strategy use (predominant use of non-lexical) to the *low ability* group, but showed much slower solution times. These findings show additional support for the DRC model of word recognition as it is possible to see the reliance on the differing pathways for reading single words (Coltheart et al., 2001). The cluster analysis has also highlighted some ‘unbalanced’ reading profiles as discussed by Bowey (2008).

However, the current study did not make any distinction between different levels of phonological recoding strategies and therefore it remains currently unclear whether children are decoding unfamiliar word items on the basis of each phoneme or whether they are using a combination of retrieval and phonological attempts (see Savage & Stuart, 1998). Moreover, while the current study has shown how the use of lexical strategies remain the most accurate reading strategy compared to other non-lexical approaches (e.g., phonological approaches) irrespective of word type, questions can be raised concerning the actual development of such retrieval methods. It is currently unknown how these lexical word reading strategies develop over time and whether these represent sight-word recognition without understanding or whether they are based on representations built up by phoneme-grapheme knowledge (see Ehri, 1999). For example, while Ehri (1999) argues that sight word reading can emerge at any point during the reading process, even in the very earliest phases, other researchers (e.g., Savage & Stuart, 1998) have argued that children may learn to read words by sight through a series of inaccurate phonological attempts. While both explanations seem plausible, future research should consider a closer examination of how children develop lexical word reading strategies and to test the possibility that both routes are viable in allowing the quick and accurate identification of word items from memory.

A further extension to the current research could therefore include a more detailed analysis of the types of non-lexical strategies that are being employed in the context of children's early word-reading. For example, insights from earlier studies have shown how the analysis of reading errors can provide an indication to variations in strategy choice. Greenberg et al. (2002) stated that examining the errors that children were making allows us to tap into underlying strategy use, while Savage and Stuart (1998) have shown how assessing scaffolding errors can lead to a more detailed assessment on using non-lexical strategies (albeit unsuccessfully). It is also important to note that many of the previous theories of reading development (c.f. Marsh et al., 1981; Frith, 1985; Ehri, 1986) have used miscue analysis to shape their theoretical accounts of reading acquisition. However, the current work has nonetheless demonstrated how the use of explicit verbal protocols, elicited by the child after their completion of each word item, can provide another insight into the possible shifts between using lexical and non-lexical reading approaches. By combining self-report data, alongside error analyses, it is argued that a more refined coding framework to capture fine-grained changes in the use of non-lexical reading strategies may be achieved leading to more detailed theoretical account of early reading acquisition (c.f., Ehri, 1999). This issue was addressed in Study Three (Chapter Seven) with a closer examination of the types of reading errors children make in their early word reading. Study Three focused on developing a stronger framework for coding self-report data.

Chapter Seven

Study Three: Scaffolding Errors and the Development of Early Word-Reading Strategies

7. Introduction

Study Three examined the types of errors that the children made whilst reading, using the error classification framework by Savage and Stuart (2001) and examined how these related to current reading ability. As argued in Chapter Three, an analysis of the types of errors made during reading could provide valuable information about the acquisition of word-reading skills and how children develop their own reading style (Greenberg et al., 2002). Reading errors have also previously assisted in providing support for stages of reading acquisition in previous theories of reading development, such as the cognitive-developmental model of reading (Marsh et al., 1981; Frith, 1985). It has also been suggested that analysing reading errors could provide a window through which it is possible to look at reading strategies.

The second purpose of this study was to identify a tighter coding framework for strategy use to be applied in the remaining chapters of this thesis through the examination of reading errors. Study Two highlighted the use of both lexical and non-lexical word reading strategies, however it did not make any distinction between different levels of phonological recoding strategies and therefore it remains currently unclear whether children are decoding unfamiliar word items on the basis of each phoneme (Ehri, 1999) or whether they are using a combination of retrieval and phonological attempts (Savage & Stuart, 1998). Indeed, the current coding framework does not specifically state which parts of the word are being phonologically decoded. In order to develop a refined coding framework, the current study examined the nature of children's early word-reading errors.

As outlined in Chapter Three, reading error analysis can provide insights into reading strategy use. Greenberg et al. (2002) compared low-literate adults and children to look at what strategies they were using and what errors they were making in reading. They found that the children's phonological skills were far superior compared to the low-literate adults and therefore the children were more likely to rely on a phonological strategy to decode the word presented. The adults were more likely to rely on visual memory skills. This meant that when looking at the errors, the adult readers were more likely to produce a real word in place of the target word. The children in comparison would often produce a nonsense word as they were using decoding skills. These findings show that using error analyses allows a greater insight into lexical and non-lexical strategy use.

Reading error analysis has been studied since the 1970's, but its focus has changed dramatically during this time. Leu (1982) looked at the previous research covering reading miscue analysis and stated that in order to move forward there needed to be certain guidelines in order to make the studies comparable. One of the main issues that required addressing was how reading errors were categorised. Early methods of categorising errors were based on 'in text' reading and were organised based on graphemic similarities (Cohen, 1974-75) or contextual errors (Allen & Watson, 1976). Stuart and Coltheart (1988) looked at single word reading errors and classified errors made on these words into six error categories. These covered contextual errors and shared letter segments. Breaking down these shared letters provided separate classifications for errors retaining the first letter, errors retaining the final letter and errors retaining both first and final letter. As the research suggests that phonemic awareness is a predictor of early reading, classifying errors based on shared letters (graphemes) instead of the phonemes will not provide adequate information about reading acquisition. This was converted to encompass shared phonemes rather than shared letters (Savage & Stuart, 1998, 2001, 2006; Savage et al., 2001).

Much of the focus on reading errors has specifically been on 'scaffolding errors.' A scaffolding error is defined as an error where the initial and final phonemes in the word are preserved; producing a real-word or nonsense word with the same boundary letters as the target word (Laxon et al., 1994).

Stuart and Coltheart (1988) found that errors that share phonological characteristics with the target word (particularly scaffolding errors) were linked to later reading success. To explain this link they examined the phonological skills in the children making these types of errors and found that they could represent common GPC mappings. Therefore scaffolding errors could be linked to superior phonological skills and to later reading skill. Savage et al., (2001) related these scaffolding errors to Ehri's phonetic cue stage as the children are able to make partial representations of words (Ehri, 1995; 1999; 2002).

There have also been replications of these findings; Savage et al. (2001) examined phonological scaffolding errors and found that scaffolding errors at age six were positively correlated with reading ability at age eight. However, scaffolding errors were even able to explain unique variance after non-word reading had been partialled out, showing that scaffolding errors were not simply a representation of decoding skill. Whilst scaffolding errors were found to be a predictor of later reading success, making an error which involved only preserving the initial phoneme or the final phoneme is not related to reading ability. This could be explained by the fact that the children making scaffolding errors have learnt how to use boundary letters which we know are important for word recognition (Pitchford et al. 2008). Although Savage et al. (2001) found that scaffolding errors seemed to be explaining unique variance, there was no measure of phonemic awareness or receptive vocabulary (which is a known correlate of reading ability) included. Savage and Stuart (2006) used a similar study including these measures and found that scaffolding errors were still unique predictors of later reading success.

However, as noted in Chapter Three, a key limitation with earlier studies was that many of the tasks used to examine reading errors were based on the clue-word paradigm (Savage & Stuart, 2001; 2006) rather than examining word recognition using a single word reading task. This is important because the clue-word paradigm can overestimate the extent to which certain phonological units are recognised or identified (cf. Deavers & Brown, 1997; Roberts & McDougall, 2003; Savage, 1997). The current study therefore examined reading errors using a single word reading task in a cross-sectional design using Year One and Year Two children (with age appropriate word lists) and looked at the distribution of all errors. The results also examined any correlates with reading ability. In Year Two the word list contained three different types of words with manipulated rime unit frequencies (as used in Study Two) and the errors made across the different word types were explored. Furthermore this study used the reading errors identified to develop a better coding scheme for classifying non-lexical (phonological) strategies that are being used to support early word reading.

Three main research questions were addressed in this study. Firstly, what types of errors were being made by the children in Year One and Year Two? This was to see if there was a similar distribution of errors to previous studies. This also included an examination of the three different word types with manipulated rime unit frequency to see if the errors differed across word types. Secondly, do the errors made explain any variance in the children's scores on the baseline measures? Previous studies have found that scaffolding errors can be used as predictors for reading ability, so the prediction was that some of the variance on the BAS II Single Word Reading task will be explained by errors made (Stuart & Coltheart, 1988; Savage & Stuart; 2001; 2006; Savage et al., 2001). Finally, the findings from the study were used to inform the new strategy coding framework for use in the remaining studies in the thesis

7.1 Method

7.1.1 Design statement

Using a cross-sectional, independent measures design, the independent variable was Year group (Year One and Year Two). The dependent variables were the frequency, accuracy and solution time for all individual self-reported word reading strategies and classifications of errors made. The order in which the word items were presented was completely randomised across trials and across children.

7.1.2 Participants

Eighty-one children participated in the study. The study used a cross-sectional design with forty-two children from Year One (21 female and 21 male) with a mean age of 6 years and 2 months (SD =3 months) and thirty-nine children were from Year Two (20 female and 19 male) with a mean age of 7 years 2 months (SD =3 months). Similar to Studies 1 and 2, all children attended state funded primary schools in Nottinghamshire and were tested in November/December 2008. All of the pupils were following the National Literacy Strategy which used a systematically based structured framework of instruction to teach strategies for decoding text. All of the scores on the baseline measures were within normal limits. The standardised scores for Year Two BAS II Single Word Reading are lower than the Year One, but still within normal limits for their age.

7.2 Materials

7.2.1 Baseline measures

Similar to Study One, the BAS II Single Word Reading and the BPVS II Receptive Vocabulary were included as baseline measures and these are described in detail in Chapter Four. Table 7.1 summarises the children's scores on the three baseline measures according to year group and shows that all scores are within normal limits.

PhAB non-word reading

The PhAB Non-Word Reading is a subsection of the Phonological Assessment Battery (Frederickson, Frith & Reason, 1997). It was specifically designed to assess the phonological processing ability of the child by asking them to decode strings of letters and give the pronunciation. The non-words were all based on regular grapheme to phoneme mappings. There were two parts to the task; the first part involved 10 one-syllable words (e.g. 'pim') and the second part involved 10 two-syllable non-words (e.g. 'ligtade'). The children were first asked to read some practice words and then they moved onto the main task. If none of the first five words were read correctly then the test was terminated. If they were able to read the words then they were presented with the next five one-syllable words. If there were six or more errors made on the one-syllable non-words then the assessment was concluded. The maximum score on the task was 20 and the standardised score was calculated using the chronological age (Mean = 100, SD = 15).

Table 7.1
Means (and SDs) for the standardised scores on single-word reading, receptive vocabulary scores and non-word reading task according to year group.

	Year One	Year Two
BAS II single word reading [a]	113.85 (13.00)	108.45 (13.44)
BPVS II Vocabulary [a]	96.17 (8.85)	98.50 (8.32)
PhAB non-word reading [a]	102.63 (24.71)	103.53 (18.17)

Note. [a] denotes standardised scores based on chronological age norms

7.2.2 Experimental single-word reading task

In contrast to Studies One and Two, in this study there was a different experimental Single Word Reading Task for each year group. The word list used in Study One was used with the Year One children (see Appendix B) and the word list (with manipulated rime unit frequencies) as used in Study Two was used with the Year Two children (see Appendix C). As this study wanted to look at the impact of reading errors it was important that the children should not find the word list too easy, to avoid ceiling effects. However, the word list still contained some higher frequency words to avoid the children becoming disengaged with the task. Similar to Studies One and Two, the experimental reading tasks consisted of an individual word appearing on the screen at any one time and when the children had read the word aloud a key was pressed on the keyboard (by the experimenter) which removed the word from the screen and captured a solution time for the word. The instructions were displayed on the screen at the start of the experiment and they were explained to the child by the experimenter. The word list was presented on a standard laptop screen in Arial, size 50 and the text was black. The background was grey to avoid a sharp contrast on the screen. The words were randomised by E-Prime 2 and the task took around 12 minutes to complete. E-Prime 2 was used to record the children's verbal responses as they attempted to identify each word item. A Dictaphone was used as a secondary storage source throughout the experimental session. The recordings were used after the experimental session to code the errors made based on the error framework by Savage and Stuart (2001). To check the reliability of the error coding 20% of the transcripts were also coded by another experimenter and an agreement of 97% was reached. The children were not asked to give a self-report of how they read the word in this study as the design was focussed on reading errors.

7.3 Procedure

All children were tested individually in the school by the experimenter on two separate occasions. Sessions were between one and three days apart. Children completed the standardised baseline measures (BAS II Single Word Reading, BPVS and PhAB Non-Word Reading) in the first testing session. In the second session, the children completed the experimental word reading task which was recorded using a microphone and a Dictaphone. Full informed consent was provided for each child's participation in the study. The experimental single word reading task was administered as Studies One and Two with the words appearing on a laptop screen and being removed when the experimenter pressed a key. Accuracy and solution times were collected. The errors were classified by the experimenter using the sound recordings.

7.4 Coding children's reading errors

The children's reading errors were coded in line with Savage and Stuart 's (2001) five categories of mispronunciations that were made during reading. The errors were categorised based on the spoken phonological representation provided by the children. The categories were chosen as the coding framework has been developed through previous studies (Savage & Stuart, 1998; Savage, Stuart & Hill, 2001). The words that were read in error of the target word could be a real word replacement or a non-word equivalent. An example of the coding framework is provided in Table 7.2.

i) Initial: Errors which preserve the initial phoneme of the target word. For example ‘rescue’ is read as ‘rest’.

ii) Final: Errors which preserve the final phoneme in the word. For example ‘dark’ read as ‘bark’.

iii) Scaffolding error: Errors preserving both the initial and final phoneme of the words, but the middle section is misread. For example identifying the word ‘reading’ as ‘ring’.

iv) Other error: Errors which do not fit into the previous categories. These errors do not share any initial or final phonological overlap with the target word.

v) Refusal to respond: The final category covers words that children refuse to read as they do not know the answer.

Table 7.2
Error coding with examples of errors made by the children for the target word 'brick'

Reading error	Example real word error	Example non-word error
Preserving the initial phoneme	bring	brog
Preserving the final phoneme	prick	drick
Scaffolding error (preserving both the initial and final phonemes)	bark	bick
Other error	chomp	pinkof
Refusal to answer	I do not know	I do not know

7.5 Results

The results were presented in three sections. Firstly, the errors categories that were made by the children were examined. This also included an analysis of whether the error made was a real word or not. Secondly, the relationship between the scores on the baseline measures and the errors made were examined using correlations and regression analyses. Finally, the errors found in this study were used to define the strategy coding framework for use in Study Four which was a repeated measures cross-sectional design looking at change in strategy use over time. As the word list used was the same as in Study Two the item analysis on these word items was not repeated on this data.

7.5.1 Types of reading errors identified

Table 7.3 shows that overall the most frequently made reading error by Year One and Year Two children was where the initial phoneme was retained and the rest of the word was read incorrectly (Year One = 43.30%, Year Two = 44.27%). The least frequent error made was where the final phoneme of the word was retained (Year One = 9.57%, Year Two = 4.10%). When looking at the scaffolding errors the Year Two children had a higher number of scaffolding errors (36.92%) compared to the Year One children (28.70%). This could be explained by the different word types (consistent, exception and unique) included in the Year Two word list as the analyses by word type show that the scaffolding errors are used more frequently on the exception words (see figure 7.1).

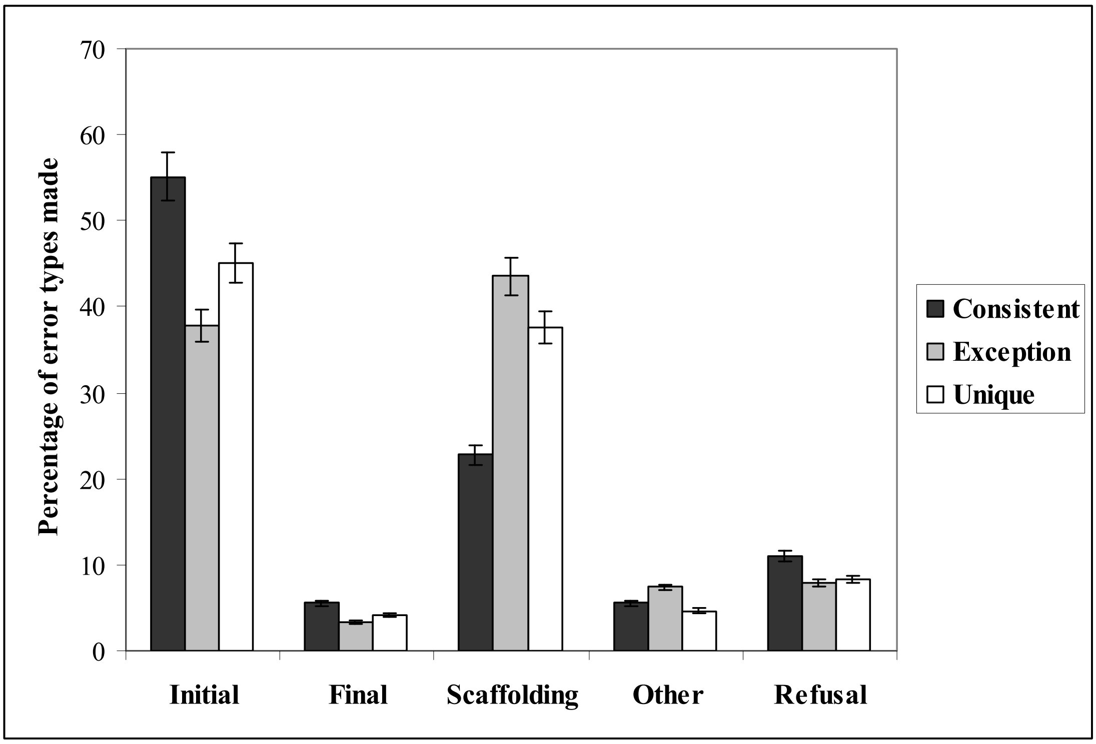
Table 7.3
Mean (and SDs) for percentage of error types for Year One and Year Two children

Error type	% of errors by Year One	% of errors made by Year Two
Initial	43.39 (49.59)	44.27 (49.71)
Final	9.57 (29.43)	4.10 (19.85)
Scaffolding	28.70 (45.27)	36.92 (48.30)
Other	10.09 (30.14)	5.98 (23.74)
Refusal to answer	8.35 (27.68)	8.72 (28.38)

Similar to Greenberg et al. (2002) the analysis continued to see if the words that the children read in error were real words or nonsense words. The responses which were analysed here were the responses which were more than a single digit, as some children simply sounded out the first letter and then left the rest. In the majority of the errors (Year One = 54.43%, Year Two = 54.06%) the children replaced the original word with another real word (such as reading the word 'Flash' as 'Flush'). Comparatively errors made that constituted a non-word (such as reading 'Notice' as 'Notika') occurred 37.22% for Year One children and 37.26% for Year Two children. The errors made with a real word were significantly more frequent than those errors made with a non-word, $t(36) = 2.383$, $p<.05$. This showed that children were predominantly replacing the word that they read incorrectly with another real word by using their vocabulary to attempt to read the word.

The reading errors that the Year Two children made during the experimental reading task were also analysed looking at the three different word types with manipulated rime units. Consistent words have frequent rime units and follow the traditional grapheme to phoneme correspondences. Exception items do not have regular grapheme to phoneme correspondences and unique word items have regular mappings, but have few phonological neighbours. When looking at reading errors made across these different word types there is an interesting pattern. Errors retaining the initial phoneme were made most frequently on consistent words and least often on exception words. Whilst scaffolding errors (errors retaining the initial and final phonemes) were made most frequently on exception words and least frequently on consistent words. This finding could potentially be explained by the strategy that children are using to read the word. The previous literature states that boundary letters are used for recognition in sight-word reading and therefore this could explain this finding. This will be further explored in Study Four.

Figure 7.1
Percentage of different error types made shown by the different word types for Year Two children (95% CI)



A series of repeated measures ANOVAs were used to see if there were any significant differences between the errors made during reading and the three different word types with manipulated rime unit frequencies. A significant difference was found between the three different word types and making a scaffolding reading error, $F(2,74) = 12.486$, $p<.01$, $\eta^2 = .252$, with the scaffolding errors being made significantly more frequently on the exception words. The high number of scaffolding errors on the exception words could be due to errors made with mispronunciation of vowels (such as ‘flood’ read as ‘flewed’). There were no significant differences between the three different word types and reading errors on the initial reading errors, $F(2,74) = .240$, $p>.05$, $\eta^2 = .006$ and final reading errors, $F(2,74) = 1.302$, $p>.05$, $\eta^2 = .034$. There was however a significant difference between the other reading errors (those that could not be classified into an existing category) and the word type, $F(2,74) = 4.465$, $p<.05$, $\eta^2 = .108$ with the most 'other' reading errors being made on the exception words.

7.5.2 Relationship between errors made and baseline measures

Previous research has found that scaffolding errors are correlated with reading ability in longitudinal studies (c.f. Savage & Stuart, 2006; Savage, Stuart & Hill, 2001). This section compared the results on the baselines measures of reading ability (BAS II Single Word Reading, BPVS Receptive Vocabulary and PhAB Non-Word Reading) with the types of reading errors made.

Table 7.4
Correlations between the baseline measures and types of reading errors

Error made	BAS II Reading	BPVS	PhAB
Year One			
Initial	.032	-.078	-.042
Final	-.048	.038	-.010
Scaffolding	.210**	-.060	.209**
Other	-.269**	.108**	-.243**
Refusal to answer	-.056	.079	.008
Year Two			
Initial	-.008	-.091*	-.116**
Final	.088*	.080	.087*
Scaffolding	.043	-.019	.100*
Other	-.033	-.037	-.062
Refusal to answer	-.093*	.167**	.024

Note. * $p< .05$, ** $p< .01$.

When examining the correlations between the baselines measures and the errors made there were different patterns of use. The Year One children had moderate correlations between the scores on the BAS II Single Word Reading assessment and scaffolding errors (r=.210) and the PhAB Non-Word Reading and the number of scaffolding errors made (r=.209). However in Year Two this pattern is different and instead there is a weak correlation with the PhAB and scaffolding errors (r=.100), but no correlation with the BAS II. This could be explained by the differences in the scores on the baseline measures between the Year One and Two children. The scores on the baselines are compared with the chronological age of the children to give a standardised score. The children in Year One were reading at a higher level (for their chronological age) than the children in Year Two (see table 7.1). This could explain the difference in the correlations between the errors made and the baseline measures.

A multiple regression was used to see if the types of errors made by the children could predict any variance in the BAS II Single Word Reading (see table 7.5). The BAS II Single Word Reading standardised score was entered as the dependent variable and the score on the BPVS and PhAB baseline measures were entered at step one. The baseline measures predicted 39.3% of the variance before anything else was entered into the model. The initial, final and scaffolding errors were entered at step two of the regression model and these were able to predict an additional 6.6%. This suggests that the scores on the vocabulary and non-word reading skills were predicting a significant amount of the variance, however the errors made were still able to explain a small amount of extra variance. This showed that the errors made were tapping into a skill which is not represented in either the BPVS or the PhAB.

Table 7.5
Multiple regression analyses predicting scores on the BAS II single word reading with the type of reading errors for Year One.

		B	SEB	β
Step 1				
	Constant	47.31	19.54	
	BPVS	.36	.18	.25
	PhAB	.29	.06	.62*
Step 2				
	Constant	32.84	22.61	
	BPVS	.45	.19	.32*
	PhAB	.27	.06	.58*
	Initial	11.57	7.85	.26
	Final	-12.93	19.01	-.09
	Scaffolding	10.65	8.31	.20

Note. R^2=.393 *for step 1;* $\Delta R^2 = .066$ *for step 2, (p>.05), *p<.05*

A multiple regression was also carried out to see if the errors made in reading by Year Two children were predictors of reading ability (see table 7.6). The scores on the BAS II Single Word Reading were entered as the dependent variable. The regression was carried out using an enter method and the scores on the BPVS and PhAB were entered in the first step. The baseline measures were able to explain 42.7% of the variance of the scores on the BAS II Single Word Reading. When the errors were entered in at step two an additional 2.5% was accounted for. This suggests that the baseline measures were having a strong influence on the current reading ability of the children and that the errors that they made were contributing very little.

Table 7.6
Multiple regression analyses predicting scores on the BAS II single word reading with the type of reading errors for Year Two.

		B	SEB	β
Step 1				
	Constant	15.52	20.21	
	BPVS	.65	.24	.40*
	PhAB	.27	.11	.37*
Step 2				
	Constant	6.45	25.15	
	BPVS	.65	.25	.40*
	PhAB	.29	.11	.40*
	Initial	12.27	12.52	.19
	Final	13.74	32.47	.06
	Scaffolding	3.72	11.83	.06

Note. R^2=.427 for step 1; ΔR^2 = .025 for step 2, (p>.05), *p<.05

The regression analyses showed that in Year One and Year Two the primary predictors of reading ability on the BAS II Single Word Reading subtest were vocabulary knowledge and non-word reading ability. The initial, final and scaffolding reading errors on the other hand explained more variance in Year One compared to Year Two children. Overall this suggests that the reading errors made in Year One were more influential in predicting the variance in reading than errors made in Year Two. This was also confirmed by the correlation analyses.

7.5.3 Fine-grained strategy framework development

The final aim of this study was to use the identified reading errors in order to develop a fine-grained coding framework for strategy coding for use in further studies. In Studies One and Two the framework that was used to code the self-reported strategy use was made up of five categories; retrieval, phonological, mixed, analogy and refusal to answer. The 'mixed' strategy category covered strategy reports where the children stated that they retrieved part of the word and used a decoding strategy to decipher the rest of the word. However, this category does not give any specific information about the part of the word that is being retrieved and which part is being decoded. Using the error analysis structure used in this study (developed by Savage & Stuart, 2001) and the qualitative data about the errors made it possible to further subdivide the ‘mixed’ strategy coding. Table 7.7 below shows how the error coding structure was used to further subdivide the ‘mixed’ strategy category.

Table 7.7
Error coding (taken from Savage & Stuart, 2001) used to develop a new coding framework for non-lexical reading strategies

Error coding	New strategy coding
Initial error (retaining first phoneme)	Retrieving the first phoneme and using GPC rules to decode the remaining letters
Final error (retaining the final phoneme)	Retrieving the final phoneme from memory and sounding-out the start. This could include common endings such as 'ing' or 'ed'
Scaffolding errors (preserving the initial and final phonemes)	Retrieving initial and final phonemes and decoding the middle sounds.

7.6 Discussion

This study had three research questions; the first was to examine what types of errors the children were making in reading using the error classification laid out by Savage and Stuart (2001). Predominantly both Year One and Year Two children were making the highest number of initial errors (errors preserving the initial phoneme), followed by scaffolding errors (errors preserving the initial and final phonemes). The errors made were also more frequently real words, suggesting that the children are searching for a word that they have already stored an orthographic representation of and has similar properties to the target word. The second goal was to look at the relationship of the errors made with the scores on the baseline measures to see if the errors were predicting any variance in reading skill. This found that the errors predicted very little of the variance after the baseline measures were accounted for. Finally, the information gained during this study was used to develop a framework to provide more detailed coding of the strategies used in reading for future studies.

The current study found a different distribution of reading errors to those found in studies by Savage and Stuart (2001, 2006). The data showed that across children in Year One and Year Two the most frequent error type was an error preserving the initial phoneme in the word. The second most frequent error type was a scaffolding error (where the initial and final phonemes are preserved). Previous studies have found that scaffolding errors occurred most frequently and that they were also a predictor of later reading ability. However, there were methodological differences in how the data were collected. Savage and Stuart (2001, 2006) used a CVC clue-word task where the children were taught to read the clue-words and were then presented with rime-clued words (words rhyming with the clue word) or head-clued words (words starting with the same phoneme as the clue-word). The nature of this task could influence the types of errors being made as a rime-clued task may create more scaffolding errors due to the nature of the words. The head-clued words however would be more likely to cause an initial reading error.

However, there was also evidence that scaffolding errors were made most frequently on a single word reading task (similar to the task in this study). The study by Savage et al. (2001) used a CVC single-word reading task and found that scaffolding errors were made most frequently in six-year-olds reading (54.7% of the errors) and that initial errors were only made 10.9%. In comparison the present study found lower levels of the scaffolding errors made across Year One and Two, but much higher rates of initial errors. This study is more comparable to the current study as it was also using single word reading rather than the clue-word paradigm. Therefore although Savage et al. (2001) used a similar single word reading task, they still found a different distribution of reading errors in similar aged children to the current study. Cross-sectionally however, the Year Two children showed a higher number of scaffolding errors than the Year One children. This could be due to the words with manipulated rime unit frequency, or it could be because the children are more likely to make scaffolding errors as their emergent reading develops. This issue was addressed in more detail in Study Four by examining how errors change over time by using a cross-sectional, repeated measures study.

The difference in the higher levels of initial errors in the present study compared to previous studies could be due to different teaching styles. Savage et al. (2001) stated that the children in their study were taught with an 'eclectic' approach to reading with phonics taught amongst text. The present study used children who were taught using a synthetic phonics approach, namely the THRASS phonics program, which teaches children to identify the graphemes and the phonemes in each word. The way in which the child is given feedback during reading could also explain variance in types of errors made (c.f. Chinn, Waggoner, Anderson & Schommer, 1993; Meyer, 1982; Evans, Barraball & Erberle, 1998; Spaai & Ellermann, 1991).

The error analyses also looked at whether the response (the incorrect item stated) was a real word given in error or a nonsense word. The study found that on average the children gave more real word responses, but only marginally. Greenberg et al. (2002) compared whether errors made were real words versus non-words in a study looking at low-literate adults and children. They found that the adults were more likely than the children to give a real word response as the decoding skills in the adults were less adequate. Therefore this suggests that in the present study you would expect to find that the children were making more nonsense errors. However, the results found that the children were giving real word responses in error of the target item more frequently than a nonsense word. Given that the children are taught to read in schools using a synthetic phonics approach this is an unexpected finding as the THRASS phonics approach suggests that the children should be applying decoding skills to break up the word into its constituent parts and then blend them to produce the response. This finding showed that the children in the present study were potentially attempting to use a 'sight-word' approach (lexical strategy) to produce a word as a whole. Alternatively they were making errors in blending the sounds in order to decode the word and were therefore using their vocabulary to find the nearest possible pronunciation from their lexicon. As in the present study did not collect self-reports of strategy use it was not possible to look at the relationship between strategy use and errors. A further examination of the strategies that were being used to read the words and how they relate to the errors made would be best examined using a repeated measures approach tracking progress over time. This was addressed in Study Four of this thesis by applying this approach.

The pattern of reading errors made on words with manipulated rime unit frequency was also examined in Year Two children. This found that errors preserving the initial phoneme in the word were made more frequently on consistent words (words with high rime unit frequency); however it was the scaffolding errors that showed an interesting pattern. There were significantly more scaffolding errors made on exception words (irregular GPC mappings and low rime unit frequency), compared with the consistent and unique words. There could be different explanations for this difference in the number of scaffolding errors made on exception words. As Study Two found that although the non-lexical (phonological) strategies were applied more often to read exception words, the exception words had the highest percent accuracy when lexical (retrieval) strategies were applied. This might be a result of the children attempting to decode the word via the non-lexical route and making errors due to the irregularity of the GPC mappings. For example some of the vowel sounds in the exception words are not pronounced in the same way as in consistent words, such as the short /oo/ sound in 'flood' which could be pronounced as /ew/ as in 'food'. Alternatively, the children could be attempting to read the words by sight and are mistaking the word for another with similar boundary letters in their lexicon. In order to further investigate this finding an analysis of the strategies applied when making these types of errors on exception words could explain why the children are making these errors.

Scaffolding errors have been the focus of many studies examining reading errors because they have been found to be a unique predictor of future reading ability (Savage & Stuart, 2001; 2006, Savage et al., 2001). Savage and Stuart (1998) found that children were able to make partial representations of the words (which were typically the initial and final phonemes) and that the vowel information was typically less developed. This concurs with Stuart and Coltheart (1988) who stated that the exterior letters have a higher relevance in word recognition. In the present study scaffolding errors were found to significantly correlate with reading ability (measured by the BAS II Single Word Reading subtest) and with decoding ability (measures by the PhAB Non-Word Reading) in Year One. In Year Two however there was no correlation with reading ability and a weak correlation with the non-word reading.

The regression analyses found that the for both Year One and Year Two the errors made were able to explain a small amount of the variance in reading ability (measured by the BAS II Single Word Reading) after the other baseline measures were partialled out. The errors made seem to have a greater impact on the variance in Year One compared to Year Two. This suggested that errors made in Year One had a greater impact on reading ability and decoding ability than in Year Two and that they were more important than errors made later on in reading. Therefore it is errors during early emergent reading that can have a greater impact on explaining variance in reading ability.

The final aim of the present study was to use the reading errors found in this study to create a more accurate, fine-grained coding framework for children's self-reported reading strategies. The framework that has been used in Studies One and Two of this thesis consisted of retrieval from memory, phonological (sounding-out), mixed (combining more than one strategy), analogy, guessing and refusal to answer. Most of the self-reports were easy to code into this framework, however the 'mixed' strategy category could involve different types of strategies and is missing key information about which part of the word was retrieved and which part was decoded. It was unclear whether children are decoding unfamiliar word items on the basis of each phoneme (Ehri, 1999) or whether they are using a combination of retrieval and phonological attempts (Savage & Stuart, 1998). The findings of this study were used to develop a more detailed strategy coding schema. In order to develop the new strategy coding framework the errors highlighted in this study were used. Greenberg et al. (2002) stated that looking at reading errors could provide an insight into strategy use and previous models of reading development have been supported by studies looking at errors made during reading (Marsh et al., 1981; Frith, 1985, Ehri, 1986). The new strategy coding framework was used in the final study of this thesis to further examine the wide range of non-lexical (phonological) strategies.

Overall this study found a different pattern of reading errors to previous studies and did not replicate the finding that scaffolding errors are predictors of later reading ability. This study has also highlighted areas that require further examination in Study Four. So far children's reading strategies and errors have been captured cross-sectionally in Year One and Year Two, but this has not been examined over time to see if there is variability over time. The final study of this thesis built on the previous studies by using a cross-sectional and longitudinal approach (across one academic term) to examine shifts in reading strategies (and errors) and importantly look for any relationships between the errors made and the strategy use.

Chapter Eight

Study Four: Examining Changes in Reading Strategies Over Time

8. Introduction

Study Four was designed to capture the variability over time in early readers' use of different reading strategies. Studies One and Two have identified that children have a number of strategies available to them and that the use of these strategies was adaptable dependent on the type of word presented. However, these studies, alongside previous studies in the literature, provide at best only a snap-shot of how the children come to identify and learn to read individual words. For a more rounded picture of how children adapt their choice of strategy, it was necessary to take a longitudinal approach, as in the present study. Siegler (2002; 2005) has identified how strategy use can vary over time through the overlapping waves theory in which he argues children are able to select and apply suitable strategies to the problem in hand. Effective strategies are employed with increasing frequency while strategies that require a large amount of processing, or are not proving to provide a correct response will be lost over time; instead of the strategies used to read a word being dependent on a fixed stage of reading development, a child can simply select a strategy from the range available to them at any phase of development. Siegler promoted the use of the microgenetic approach (collecting repeated measures data at regular intervals) to assist in capturing this change. The present study applied a similar approach using a repeated measures design over one academic term with testing sessions at two-week intervals.

As already discussed in Chapter Two, traditional stage models of reading development were based on fixed progressions in reading development and there is evidence that these models do not provide an accurate representation of children's emergent reading (c.f., Ehri, 1995; Stuart & Coltheart, 1988). More flexible models of reading development, such as Ehri's mediated phase model (1995; 1999; 2002) have shown that children are able progress or regress through the different phases of development, in a non-linear fashion, to suit the task at hand. However, much of the support for these models comes from cross-sectional studies rather than continuously reviewing individual children's adaptive use of reading strategies (see discussion in Chapter Two). To overcome these limitations, the present study used a longitudinal approach to study variability in the development of children's early word-reading strategies over the period of one academic term. Furthermore, the study was also carried out cross-sectionally among children in Year One and Year Two to examine the global differences in the emergent readers (Year One) and those with a full year of formal reading instruction (Year Two). Alongside the strategy use over time the accuracy and solution times were studied to track the success of the application of the strategies. This repeated measures approach allowed a further examination of dynamic models of reading development such as Ehri's phase model (1995; 1999; 2002) and Siegler's (1996) model of variable strategy use.

Previous studies which have attempted to specifically address the development of young children's strategy use have methodological limitations which limit the extent to which they can inform current models of reading development. For example, Farrington-Flint and Wood (2007) examined the variability of strategies in relation to children's reading using a clue-word experimental task to test the use of analogies in reading. Their results showed variation in strategy use across the different clue-word problems. However, the use of the clue-word paradigm to assess viability of analogies in the context of reading has been criticised, as it has been argued that clue-words differentially encourage the use of analogy as the children are told that the first word could assist them in the interpretation of the non-word (Deavers & Brown, 1997). The findings from these studies leave little scope to identify whether or not the children are in full control of explicitly 'choosing' a correct strategy due to the nature of the task. Farrington-Flint et al., (2008a) further investigated strategy use in early reading using a single word reading task which did not promote the use of any specific strategy. Rather than incorporating a clue-word paradigm, Farrington-Flint et al., (2008a) simply asked children to correctly identify a list of age-appropriate word items and to report the strategy that they were using in each instance. The study found that there was a shift towards using more sophisticated lexical strategies such as retrieval over time, however there was also evidence that strategies used were variable between trials even within the same child. There were two main limitations with this study. Firstly, there were only three testing sessions and they were placed three weeks apart so the study only spanned half a term, which could cause key changes in strategy use to be missed. The present study therefore built on the previous work by testing the children at regular two-week intervals over the period of one academic term. Secondly, the children only read CVC consistent words so there was no variation in the word type presented. Study Two of this thesis has confirmed that there are variations in strategy use across different types of words, but this study was based on a single testing session. Farrington-Flint et al., (2008b) have shown that, within the context of spelling development, the classification of word type can have an important influence on the choice of individual strategy and this can also lead to different patterns in how children learn to spell. In order to extend this finding further, the present study examined shifts in children's early word-reading strategies across different word types that vary in rime unit frequency (see also Study Two, Chapter Six).

A further goal of Study Four was to look at the pattern of reading errors over time and see how these vary as the children improve in their reading ability. Previous literature has highlighted the importance of scaffolding errors in children's early word reading and correlations have been established between scaffolding errors and later reading success. Analyses of reading errors have been used as evidence of developmental stages in theoretical models of reading and the errors made have been described as another way to access information about reading strategies. The combination of reading error analysis over time with strategy use affords an opportunity to examine whether the child changes his or her approach to reading a word which s/he has previously read incorrectly. This means that future strategy use could be centred on the child's confidence in their previous attempt. The amalgamation of a repeated measures design investigating reading strategies and reading errors over one academic term provided the foundation for a full examination of the development of an emergent reading 'toolkit'.

Study Three of this thesis found that a higher number of scaffolding errors were made by the Year Two children than the Year One. By using a longitudinal study over one academic term it was possible to track whether children shift towards making more scaffolding errors over time and see if this is a developmental trend. In order to further explore the pattern of errors this study analysed the types of strategies that were applied when making the errors, to see if there were any correlations between different strategies and different error classifications. As scaffolding errors preserve the initial and final information in the word, the prediction was that the children will be using more lexical (retrieval) strategies when making scaffolding errors as word boundaries are often used in lexical word recognition (Stuart & Coltheart, 1988; Pitchford, Ledgeway & Masterson, 2008). This meant that the children could be retrieving an incorrect word that has the same initial and final phoneme in the place of the target word.

Study Four had three main research objectives. Firstly, to examine the accuracy and solution times of the children's single word reading over the five separate testing sessions (every two weeks). The expected finding was that there would be an increase in accuracy over time and a decrease in solution times as the children began to learn the words and build in confidence. Secondly, the variability in strategy use over time across the Year One and Two children was analysed to find patterns in the application of different reading strategies. For the Year Two children this was also subdivided to look at the impact of the different word types. Previous studies have highlighted a shift towards the use of more sophisticated strategies such as retrieval from memory over time (Rittle-Johnson & Siegler, 1999; Farrington-Flint et al., 2008a). The present study looked at this shift in strategy use across the different word types for children in Year Two. Finally, the errors in word-reading were analysed at time one (the first testing session) and time five (the final testing session). This was to highlight any changes over time in the scaffolding errors made, as previous studies have found that scaffolding errors are a predictor of later reading ability (Savage, Stuart & Hill, 2001; Savage & Stuart, 2006). A correlational analysis also looked at the types of strategies being applied when the errors occur.

8.1 Method

8.1.1 Design statement

This study was a repeated measures design (set over one academic term) as the children completed the experimental single word reading task on all five testing sessions. The study was also cross-sectional comprising children from Year One and Year Two classrooms to allow for developmental trends to be considered. The variables were the accuracy and solution times for the words as well as the individual self-reported strategy use and classifications of the errors made. For the Year Two children there was an additional independent measures IV of word type which consisted of three levels: consistent, exception and unique words.

8.1.2 Participants

Thirty-one children participated in the study. The study used a repeated measures design over one academic term with 15 children from Year One (10 female and 5 male) with a mean age of 5 years and 8 months (SD =2.8 months) and 16 children were from Year Two (9 female and 7 male) with a mean age of 6 years 7 months (SD=3.5 months). Over the course of the study there were six children that were unable to attend all testing sessions due to absence from school. These children were removed from the study leaving the 31 children. The children all attended a state funded primary school in Nottinghamshire and were tested October to December 2009. Each testing period was two weeks apart over the period of one academic term. All of the pupils were following the national literacy strategy which uses a systematically based structured framework of instruction to teach strategies for decoding text. This included training in phonics and spelling (including phoneme and rhyme awareness), knowledge with contextual cues, grammatical knowledge and single word recognition and identification. The children were also being introduced to the THRASS phonics which focuses on a more synthetic phonics approach to teaching reading and spelling skills. Table 8.1 shows the baseline measures collected by year group. All scores were within the 'normal' range.

Table 8.1
Means (and SDs) for children's scores on the baseline measures according to year group.

	Year One	Year Two
BAS II Single Word reading Time 1 [a]	105.00 (12.36)	108.81 (13.91)
BAS II Single Word reading Time 5 [a]	110.47 (12.09)	113.69 (14.56)
BPVS Receptive Vocabulary [a]	94.53 (6.16)	95.38 (6.01)
Phoneme Deletion (max. score: 24)	13.40 (7.25)	17.56 (7.18)
PhAB Non-Word Reading [a]	104.67 (6.95)	106.31 (11.15)
Orthographic Choice (max. score: 23)	13.93 (5.07)	17.44 (3.74)
Ravens Matrices (max. score: 36)	16.67 (3.10)	18.56 (4.11)

Note. [a] denotes standardised scores based on chronological age norms

8.2 Materials

8.2.1 Baseline measures

Baseline measures for this study were collected in line with Study Two of this thesis. This included the BAS II Single Word Reading, the BPVS II Receptive Vocabulary, the Orthographic Choice Task and the Phoneme Deletion Task. Additionally a measure of non-verbal reasoning was added to assess the children's ability to problem solve and to control for a measure of intelligence.

Ravens coloured progressive matrices

The Coloured Progressive Matrices (CPM) consisted of 36 items which were in three blocks with 12 items in each (Raven, Raven & Court, 1998). The CPM was used to assess clear thinking and is a test of observational skills. The task consisted of patterns with a piece missing. There were six pieces underneath with one being the correct missing piece. The children were encouraged to look at all of the pieces and then make a decision about which was the missing piece. The first set (set A) relied on the children being able to complete a continuous pattern. Set B contained patterns that required the use of analogy to solve, thereby assessing their ability on the use of analogy. The CPM was administered according to the standardised instructions. To score the CPM the children were awarded a mark for each correct response and these were summed. The reliability data stated by the manual found an overall retest reliability in the region of r=.90 (Raven et al., 1998). More recent reliability checks on primary aged children found an internal consistency of r =.89 and a split-half reliability of r=.91 (Cotton et al., 2005).

8.2.2 Experimental single-word reading task

The experimental word lists were the same as used in Study Three of the current thesis; the Year One children received the list of 40 single-word items (see Appendix B) and the Year Two children received the list of 45 single words (sub-divided into the three different words types; the consistent words, the exception words and the unique words) (see Appendix C). These word lists were used due to the high internal reliability (Year One word list Cronbach's alpha value .964; Year Two word list Cronbach's alpha value . 893) and the age appropriateness of each list.

8.3 Procedure

In the first testing session (beginning of October) the children completed the BAS II Single Word Reading subtest and the experimental single word reading task. At times two, three and four (all testing sessions were two weeks apart) the children simply completed the experimental word reading task. On the final testing session (time five – mid December) the children were given the BAS II task and then they completed the experimental reading task. The BAS II Single Word Reading was included at pre and post-test in order to create a baseline measure of improvement over time. The remainder of the baseline measures were collected the week after the final testing period. The timeline below in Table 8.2 provides a summary of the progress of the data collection which spans over one academic term.

Table 8.2
Timeline of data collection for Study Four

Testing Session					
1 (W/C 05/10/09)	2 (W/C 19/10/09)	3 (W/C 02/11/09)	4 (W/C 16/11/09)	5 (W/C 30/11/09)	Post-Test (W/C 07/12/09)
BAS II Single Word Reading, Experimental Single Word Task	Experimental Single Word Task	Experimental Single Word Task	Experimental Single Word Task	Experimental Single Word Task, BAS II Single Word Reading	Remaining baseline measures collected

The experimental single word reading task consisted of a single word appearing on the screen and when the children had read the word aloud a key was pressed on the keyboard by the experimenter and this removed the word from the screen and captured a solution time for reading the word. The experimenter then coded the accuracy of the word item. The children were then asked to give a self-report of strategy use and this was coded by the experimenter using the strategy coding framework developed in Study Three.

8.4 Coding children's verbal self-reports

The verbal self-reports of strategy use were coded as for Studies One and Two, apart from the term 'mixed' which used the additional framework refined in Study Three. A summary of the coding framework with some examples of the self-reports provided by the children, see table 8.3.

Table 8.3
Strategy coding with examples of children's self-reports

Strategy	Examples of self-reports
Retrieval	'I just knew it.' 'I have read it before.' 'It is in my books.' 'We learnt it in class.'
Pure Phonological	'I used the sounds.' 'I used the phonemes.'
Initial mixed	'I know that part of the word (points to the beginning) and I sounded the rest out.'
Final mixed	'I know the ending of the word and I used the phonemes to blend the rest.'
Middle mixed	'I know the first and last sound and I sounded-out the middle.'
Analogy	'I know the word ____ and this rhymes with it.'
No Answer	'I do not know.' 'It is too hard.'

8.5 Coding children's reading errors

Children's reading errors were coded in line with the classifications by Savage and Stuart (2001) as detailed in Study Three (see section 7.4). In summary, the error classifications included making an initial error (initial phoneme is preserved), a final error (final phoneme is preserved), a scaffolding error (initial and final phonemes are preserved), an 'other' error (no orthographic overlap with target word) or refusing to answer.

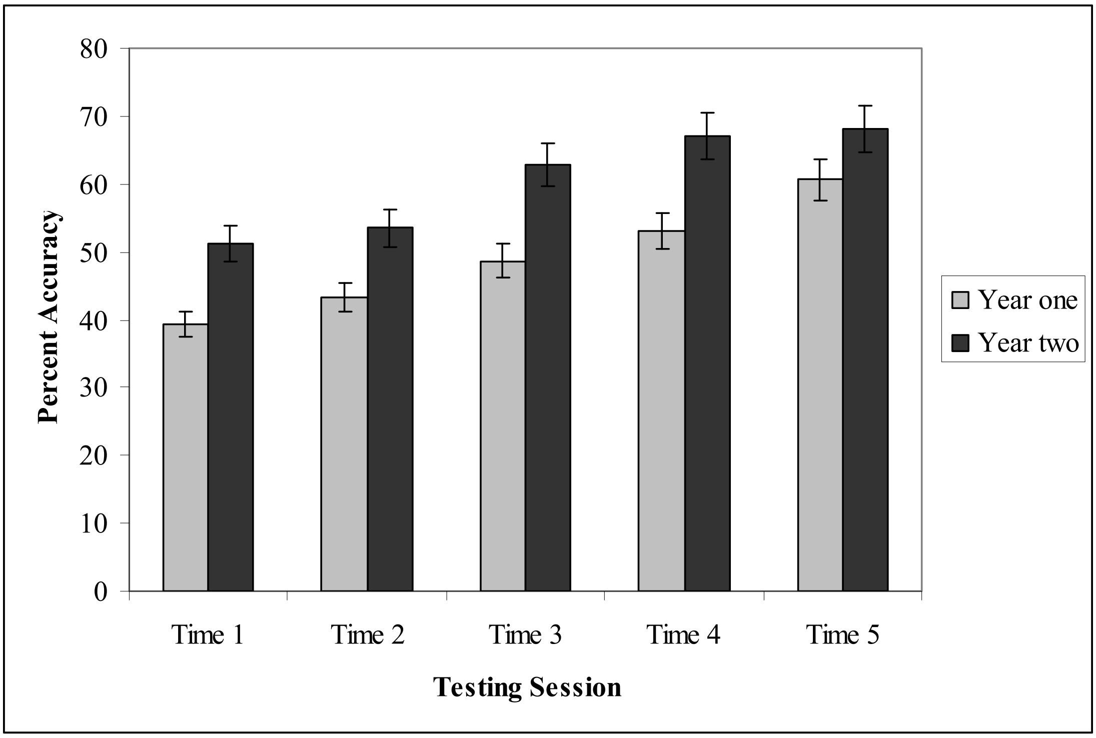
8.6 Results

The results were presented in three parts. Firstly, the accuracy and solution time for both Year One and Year Two children were discussed. Secondly the strategy use over time was examined and the Year Two word list was also subdivided into the three different word types. Finally, the error data was analysed and the relationship between errors and strategy use was explored. As the word lists used were the same as in Study One and Study Two the item analyses on these word items were not repeated on this data.

8.6.1 Improvements in single word reading over time

Both the Year One and Year Two children made steady and continuous improvement in reading the words in the single word experimental task on every testing session. At time one the Year One children had 39.33% accuracy and this rose to 60.67% at time five. The Year Two children progressed from 51.25% accuracy at time one to 68.06% at time five (see Figure 8.1)

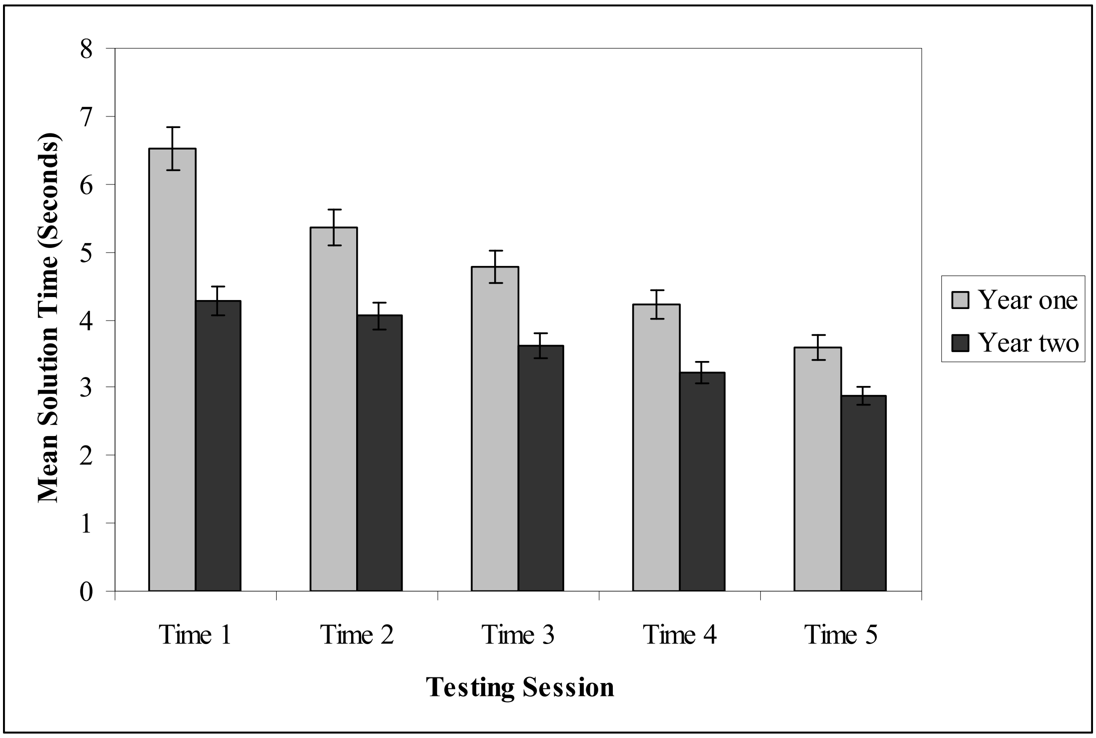
Figure 8.1
Percent accuracy across testing sessions 1 to 5 for Year One and Year Two: error bars represent 95% confidence intervals



A mixed 2 (scores at time one and time five) x 2 (year group) ANOVA confirmed a significant main effect for word reading accuracy for testing session, $F(1,29) = 58.425$, $p<.05$, partial $\eta^2 =.657$. However the main effect of the year group was not significant, $F(1,29) = .837$, $P>.05$, partial $\eta^2 = .788$, suggesting that the Year Two scores were not significantly different to the Year One scores. There were also no significant interactions between the accuracy and the year group.

An analysis of the solution-time data showed that over the five testing periods the time taken to read each word was reduced. For Year One children the mean time taken to read a single word at time one was 6.52 seconds and this reduced to 3.58 seconds at time five. Similarly the Year Two children had a mean solution time of 4.26 seconds at time one, but by time five this has decreased to 2.87 seconds.

Figure 8.2
Mean solution times across testing sessions 1 to 5 for Year One and Year Two: error bars represent 95% confidence intervals



The decrease in solution times across the testing sessions was confirmed by a mixed 2 (solution times at time one and time five) x 2 (year group) ANOVA. This found that there was a significant main effect for solution times for testing session, $F(1,29) = 41.445$, $p<.05$, partial $\eta^2 = .588$. This showed that there was a significant decline in the time taken to read the word items over time, and therefore the children were becoming faster at identifying word items over time. The main effect of the year group just missed significance and therefore there was no significant difference between the Year One and Year Two scores, $F(1,29) = 3.901$, $p>.05$, partial $\eta^2 = .119$. However, there was a significant interaction between testing session and year group, $F(1,29) = 5.258$, $p<05$, partial $\eta^2 = .153$. The interaction shows that there was a significant difference between the year groups at time one, but this had reduced by time five. Therefore the Year One and Year Two children were showing more similar profiles at time five.

The Year Two children were presented with a word list with manipulated word types and therefore it is possible to examine the accuracy and solution times across the different word types. The consistent words were read most accurately across all testing sessions, but the biggest improvement in reading across the different types of words was made on the exception words as the accuracy rose from 45.24% at time one to 65.83% at time five, an increase of 20.41% across the testing sessions.

An examination of the solution times taken to read the words showed that the children were reading the consistent words considerably faster than the exception or unique word items. The unique word items showed the slowest solution times across all five testing sessions.

Table 8.4
Correct responses (%) and solution times (Seconds) divided into the three different word types and displayed by the five testing sessions for Year Two children

	Consistent	Exception	Unique
Time 1			
Correct	63.33 (48.29)	45.42 (49.89)	45.00 (49.85)
Solution time	3.99 (2.57)	4.36 (2.70)	4.45 (2.38)
Time 2			
Correct	66.25 (47.36)	47.08 (50.19)	47.08 (50.19)
Solution time	3.62 (2.22)	4.02 (50.19)	4.52 (2.44)
Time 3			
Correct	74.58 (43.63)	58.75 (49.33)	55.42 (49.17)
Solution time	3.10 (2.05)	3.63 (2.11)	4.13 (2.56)
Time 4			
Correct	76.67 (42.38)	65.00 (47.79)	59.68 (49.17)
Solution time	2.90 (1.81)	3.15 (2.08)	3.61 (2.16)
Time 5			
Correct	77.50 (41.85)	65.83 (47.53)	60.83 (48.91)
Solution time	2.65 (1.75)	2.76 (1.72)	3.22 (2.24)

Note: Solution time in Seconds

A 5 (testing session) x 3 (word type) repeated measures ANOVA was carried out to examine the differences between the scores on the word types at each testing session. The ANOVA showed a significant main effect for word type, revealing that the children were identifying the consistent words significantly more accurately than the exception or unique words, $F(2, 30) = 39.546$, $p<.05$, $\eta^2 = .725$ Pairwise comparisons show that there was a significant difference between the accuracy in reading the consistent words and exception words ($p<.05$) and between the consistent words and the unique words ($p<.05$). There was no significant difference in the accuracy for reading the exception compared to the unique words (p=.325).

A second, 5 x 3 repeated measures ANOVA also found significant main effect solution times across word types (consistent, exception and unique words) , $F(2, 30) = 27.255$, $p<.05$, $\eta^2 = .645$. Pairwise comparisons showed that there was a significant difference between all of the word types ($p<.05$), showing that the mean solution times for each word type were significantly different. This showed that overall the consistent words had shortest solution times and it was the unique words which took the longest to read (see table 8.4).

In summary the change over time in accuracy and solution times showed that the children were becoming more accurate and faster at reading the words over one academic term. The data from the Year Two children also suggested that the type of word had an impact on accuracy. One explanation for this effect is the impact of taught literacy and schooling; however this could also be related to the strategies that were being applied to read the words.

8.6.2 Strategy choice and variability over time

Strategy choice and variability in Year One

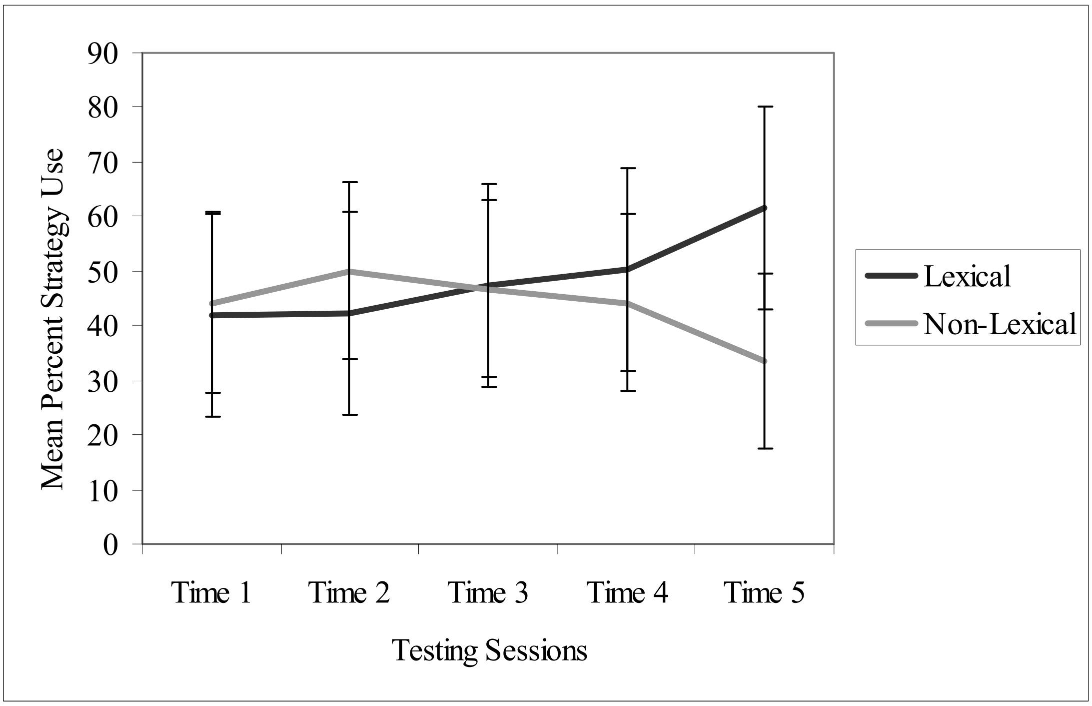
Reading strategies applied in Year One were largely retrieval and pure phonological strategies (see table 8.5). The overall pattern shows an increase in the use of retrieval (sight word reading) over time and a reduction in phonological strategies and guessing. There is little movement in the other strategies. Of the new categories created as a result of Study Three (initial mixed, final mixed and middle mixed) final mixed was used most frequently largely at times three and four, before dropping in use for time five. Overall though, there was relatively little use of strategies which rely on both lexical and non-lexical skills.

Table 8.5
Percent mean self-reported use of reading strategies displayed by the five testing sessions for Year One children

	Time 1	Time 2	Time 3	Time 4	Time 5
Retrieval	42.00 (49.40)	42.17 (49.42)	47.50 (49.98)	50.33 (50.04)	61.50 (48.70
Phonological	28.17 (45.02)	33.83 (47.35)	29.67 (45.71)	29.17 (45.49)	23.00 (42.12)
Initial mixed	4.17 (19.99)	4.33 (20.37)	3.67 (18.81)	2.00 (14.02)	1.83 (13.43)
Final mixed	8.67 (28.16)	8.00 (27.15)	10.00 (30.03)	9.67 (29.57)	6.67 (24.96)
Middle mixed	2.67 (16.12)	3.33 (17.96)	3.00 (17.07)	3.00 (17.07)	1.67 (12.81)
Analogy	0.00 (0.00)	0.33 (5.76)	0.33 (5.78)	0.17 (4.08)	0.00 (0.00)
Guessing	1.33 (11.48)	1.33 (11.48)	1.00 (9.96)	2.00 (14.12)	0.50 (7.06)
Refusal to answer	13.00 (33.59)	6.67 (24.96)	4.83 (21.46)	3.67 (18.80)	4.83 (21.46)

To further examine change in strategy use over time the strategies were collapsed into two discrete labels: lexical (retrieval) and non-lexical word-reading strategies (phonological, initial mixed, final mixed and middle mixed). Figure 8.3 shows for the Year One children that at time one and time two they were applying non-lexical strategies more frequently than lexical strategies. However, at time three there was a switch and children were beginning to use more lexical-based word-reading strategies.

Figure 8.3
Percent mean self-reported use of lexical and non-lexical strategies displayed across the five testing sessions for Year One (Error bars represent 95% CI)

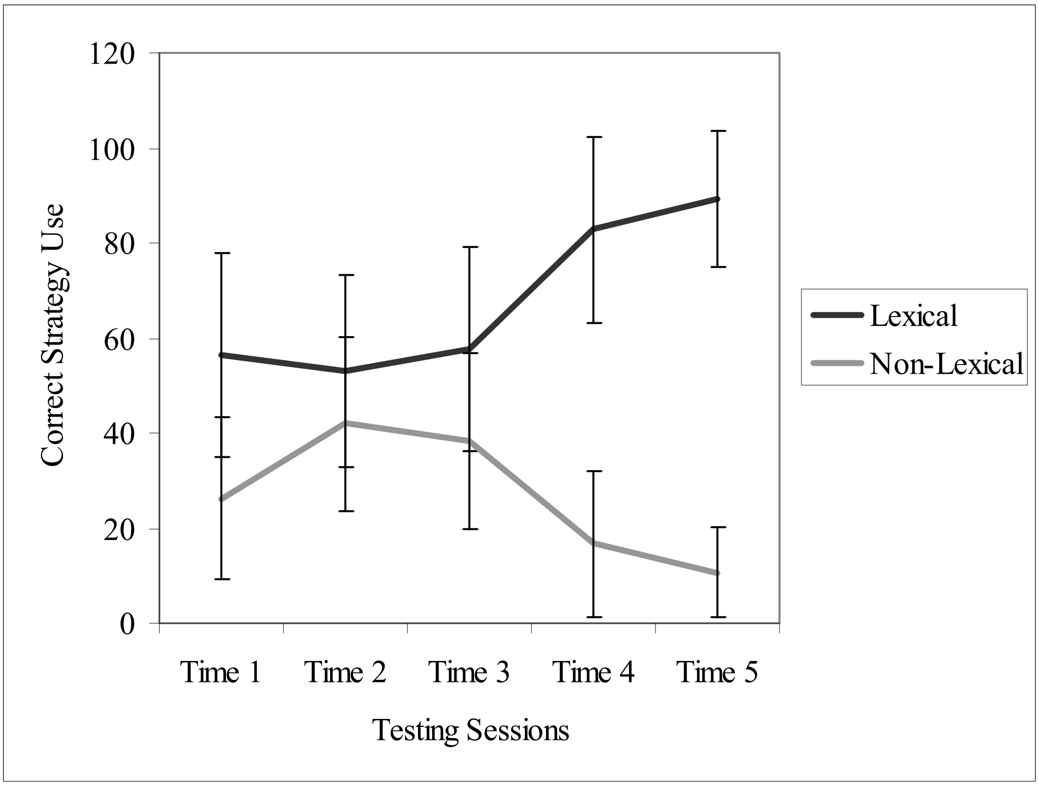


Please note –Use of analogy and guessing have been removed from the above data. Therefore scores do not aggregate to 100%.

A two-way 5 (testing session) x 2 (strategy; lexical vs. non-lexical) repeated measures ANOVA was used to examine the differences in the use of lexical strategies and non-lexical strategies across all of the testing sessions. As the sphericity assumption was violated the Greenhouse-Geisser corrections have been applied. The results show that there was a non-significant difference between the scores at the different testing sessions (T1, T2, T3, T4, T5), $F(1.647,23.055) = 1.483$, $p>.05$, $\eta^2 = .096$). There were no significant differences between the use of lexical and non-lexical strategies, $F(1,14) = .115$, $p>.05$, $\eta^2 = .008$. There was no significant interaction between the strategy use and testing session, $F(1.313, 18.383) = 1.051$, $p>.05$, $\eta^2 = .070$. Although the graph (figure 8.3) appears to show a trend the overlap of the confidence intervals shows there were variations in the responses.

When only the correct responses were considered a different pattern of strategy use emerged. Figure 8.4 shows, for Year One children, that in the later testing sessions (post time three) lexical strategies were more likely to produce a correct response. The use of non-lexical strategies to produce a correct response peaked at time two and time three, but by time four and time five they were producing very few correct responses.

Figure 8.4
Percent mean self-reported use of lexical and non-lexical strategies on only correct responses displayed across the five testing sessions for Year One (Error bars represent 95% CI)



Please note – This graph only contains correct responses for lexical or non-lexical strategies, correct use of analogy and guessing have been removed from the above data. Therefore scores do not aggregate to 100%.

A second two-way 5 x 2 repeated measures ANOVA was used to examine the differences in the use of lexical strategies and non-lexical strategies on the number of correct responses across all testing sessions. As the sphericity assumption was violated the Greenhouse-Geisser corrections have been applied. The results showed that there was a non-significant main effect for testing session, $F(1.983,29.763) = 2.982$, $p>.05$, $\eta^2 = .166$. The results for the correct use of lexical and non-lexical strategies found that there was no significant difference between the correct use of the lexical or non-lexical strategies, $F(1,14) = 2.435$, $p>.05$, $\eta^2 = .140$. There was however a significant interaction between the use of lexical and non-lexical strategies and the testing session, $F(41.711,25.671) = 3.887$, $p<.05$, $\eta^2 = .206$.

Strategy choice and variability in Year Two

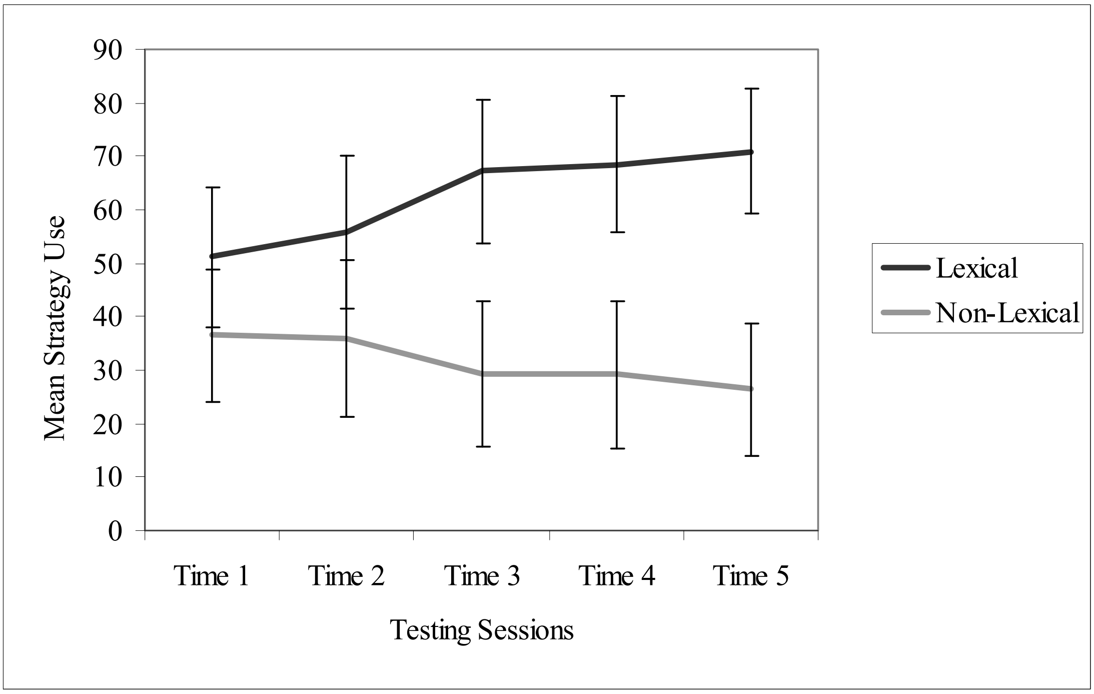
The data for Year Two children showed that there was also a dominant use of retrieval and phonological strategies. Similar to the Year One data there was an increase in the use of retrieval and a decrease in the use of phonological strategies. The use of analogy again was low and there was a reduction over time in the use of the mixed (initial mixed, final mixed and middle mixed) strategies.

Table 8.6
Percent use of non-lexical reading strategies displayed by the five testing sessions for Year Two children

	Time 1	Time 2	Time 3	Time 4	Time 5
Retrieval	51.25 (50.01)	55.83 (49.69)	67.22 (46.97)	68.47 (46.49)	70.97 (45.42)
Phonological	30.69 (46.15)	30.69 (46.15)	27.36 (44.61)	27.78 (44.82)	25.69 (43.72)
Initial mixed	2.22 (14.75)	2.78 (16.44)	0.69 (8.31)	0.42 (6.44)	0.28 (5.26)
Final mixed	1.81 (13.32)	1.39 (11.71)	0.97 (9.82)	0.83 (9.09)	0.42 (6.45)
Middle mixed	1.81 (13.32)	1.11 (10.48)	0.14 (3.72)	0.14 (3.72)	0.00 (0.00)
Analogy	0.14 (3.72)	0.28 (5.26)	0.00 (0.00)	0.42 (6.44)	0.28 (5.26)
Guessing	2.78 (16.45)	0.38 (9.97)	0.97 (9.82)	1.11 (10.48)	1.39 (11.71)
Refusal to answer	9.31 (29.07)	7.08 (25.67)	2.64 (16.04)	0.83 (9.97)	0.97 (9.89)

As for the Year One data the strategies were collapsed into lexical strategies (retrieval) and non-lexical strategies (phonological, initial mixed, final mixed and middle mixed). Figure 8.5 shows that the Year Two children had a higher reliance on lexical strategies than non-lexical with the greatest increase at time three. There was a slow decline in use of non-lexical strategies over time.

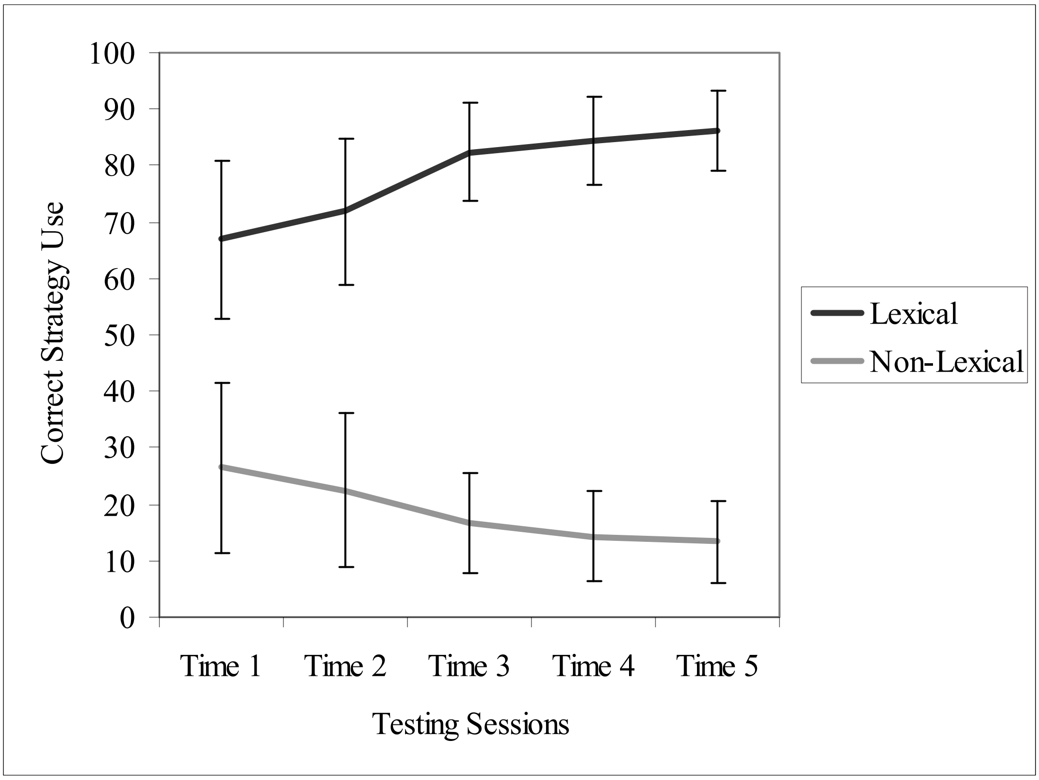
Figure 8.5
Mean percent use of lexical and non-lexical strategies displayed across the five testing sessions for Year Two (95% CI)



Please note –Use of Analogy and guessing have been removed from the above data. Therefore scores do not aggregate to 100%.

A two-way 5 (testing session) x 2 (strategy; lexical vs. non-lexical) repeated measures ANOVA was used to examine the differences in the use of lexical strategies and non-lexical strategies across all of the testing sessions. As the sphericity assumption was violated the Greenhouse-Geisser corrections have been applied. The results showed that there was a significant difference between the scores at the different testing sessions, $F(1.458,20.416) = 5.358$, $p<.05$, $\eta^2 = .277$. This is an unexpected finding as you would not expect to find the main effect of testing session significant. The pairwise comparisons revealed that there were significant differences between time one and all the other testing sessions. After further examination this appears to be due to the higher usage of guessing at time one which means that there is a smaller aggregated percentage of use of lexical and non-lexical strategies. The results for the use of lexical and non-lexical strategies found that there was a significant difference between the application of the strategies, $F(1,14) = 4.748$, $p<.05$, $\eta^2 = .253$. This showed that the lexical strategies were applied more frequently to read the words. There was also a significant interaction between the use of lexical and non-lexical strategies and the testing session, $F(2.672,37.404) = 10.021$ $p<.05$, $\eta^2 = .417$. This showed that there was a difference in the use of lexical and non-lexical strategies at each testing session in the experiment.

Figure 8.6
Percent mean self-reported use of lexical and non-lexical strategies on only correct responses displayed across the five testing sessions for Year Two (Error bars represent 95% CI)



Please note – This graph only contains correct responses for lexical or non-lexical strategies, correct use of analogy and guessing have been removed from the above data. Therefore scores do not aggregate to 100%.

When just the correct responses are considered it is clear that lexical strategies are more successful for reading than non-lexical strategies across all testing sessions.

A two-way repeated measures ANOVA was used to examine the differences in the use of lexical strategies and non-lexical strategies on correct responses across all of the testing sessions (See Figure 8.6). Again, the sphericity assumption was violated and therefore the Greenhouse-Geisser corrections have been applied. The results showed that there was a non-significant main effect across testing sessions, $F(2.038,28.532) = 2.945$, $p>.05$, $\eta^2 = .174$. There was a significant main effect for correct scores as a function of reading strategy (lexical vs. non-lexical), $F(1,14) = 7.214$, $p<.05$, $\eta^2 = .340$. This significant effect shows that the lexical strategies were used more frequently on trials where a correct response was gained than non-lexical equivalents. There was also a significant interaction between the use of lexical and non-lexical strategies and the testing session, $F(1.689,23.648) = 3.303$, $p<.05$, $\eta^2 = .191$. This showed that there was a significant difference between the scores on the different strategies (lexical vs. non-lexical) at each testing session.

The Year Two data also contained the three different word types with manipulated rime unit frequency (see 6.2.2 for a description of the word types) allowing a comparison of strategies across the different types of words.

Table 8.7
Percent use of lexical and non-lexical divided into the three different word types and displayed by the five testing sessions.

	Consistent	Exception	Unique
Time 1			
Lexical	63.75 (48.17)	48.75 (50.09)	41.25 (49.33)
Non-Lexical	24.17 (42.89)	29.58 (45.74)	38.33 (48.72)
Time 2			
Lexical	63.33 (48.29)	55.00 (49.85)	49.17 (50.09)
Non-Lexical	26.67 (44.31)	29.17 (45.55)	36.25 (48.17)
Time 3			
Lexical	80.42 (39.76)	65.00 (47.79)	56.25 (49.71)
Non-Lexical	18.33 (38.77)	26.67 (44.31)	37.08 (48.40)
Time 4			
Lexical	77.08 (42.12)	68.33 (46.61)	60.00 (49.09)
Non-Lexical	21.67 (41.28)	26.67 (44.32)	35.00 (47.79)
Time 5			
Lexical	78.75 (40.99)	72.50 (44.75)	61.67 (48.72)
Non-Lexical	19.17 (39.44)	23.33 (42.38)	34.58 (47.66)

The descriptive statistics (see Table 8.7) showed that lexical strategies were used more frequently on consistent word items across all five testing sessions. At time one lexical strategies were applied the least often to read the unique words, and the unique words had the highest application of non-lexical strategies. Between time one and time five the children were shifting towards the use of lexical strategies with the use of non-lexical strategies declining. This shift towards a retrieval strategy was most apparent on the exception words with a rise in use of retrieval of 23.75%. This suggested that the children were beginning to realise that non-lexical strategies would not produce a correct response and were therefore creating an orthographic representation of the words.

The 2 (testing session; time one and time five) x3 (Word type) x2 (strategy; lexical vs. non-lexical) repeated measures ANOVA was carried out to examine any differences between the testing session, the word type and the strategy applied. There was a significant main effect of testing session, $F(1,15) = 13.792$, $p<.05$, $\eta^2 = .479$, showing that there was a difference in scores at time one and time five. There was also a significant effect for word type, $F(2,30) = 4.51$, $p<.05$, $\eta^2 = .231$, showing a difference between scores on the different types of words. The main effect for strategy was also significant, $F(1,15) = 7.778$, $p<.05$, $\eta^2 = .341$, showing a difference in the use of lexical and non-lexical strategies. There was a significant interaction for the testing session and word type, $F(2,30) = 3.433$, $p<..05$, $\eta^2 = .186$, showing that the scores on the different word types were different at each testing session (T1 and T5). This highlighted that the differences in the scores on the three word types were consistently different. The interaction between testing session and strategy was also significant, $F(1,15) = 12.86$ $p<.05$, $\eta^2 = .462$, showing that the application of the lexical and non-lexical strategies differed by testing session. There was also a significant interaction for word type and strategy, $F(2,30) = 17.956$, $p<.05$, $\eta^2 = .545$, showing a difference in the use of lexical and non-lexical strategies across the three word types. The mean scores revealed the highest application of lexical strategies was on consistent words and the non-lexical strategies were being applied to unique words. Finally, there was no significant three-way interaction between testing session, word type and strategy applied.

Whilst it is interesting to examine strategy use across the different word types with manipulated rime unit frequencies, the full picture cannot be explored without looking at correct use of these strategies. This highlighted how effective the strategies were at producing a correct response across the different types of words.

Table 8.8
Percent use of lexical and non-lexical strategies on correct responses divided into the three different word types and displayed by the five testing sessions.

	Consistent	Exception	Unique
Time 1			
Lexical	79.74 (40.32)	67.52 (47.03)	70.71 (45.74)
Non-Lexical	41.39 (49.68)	25.35 (43.81)	26.09 (44.15)
Time 2			
Lexical	86.18 (34.62)	65.15 (47.83)	70.34 (45.87)
Non-Lexical	35.94 (48.36)	24.29 (43.19)	20.69 (40.74)
Time 3			
Lexical	87.56 (33.08)	78.85 (40.97)	78.52 (41.22)
Non-Lexical	22.73 (42.39)	25.00 (43.64)	25.84 (44.02)
Time 4			
Lexical	89.73 (30.43)	84.76 (36.05)	84.72 (36.10)
Non-Lexical	34.62 (48.04)	21.88 (41.64)	20.24 (40.42)
Time 5			
Lexical	91.01 (28.69)	82.18 (38.37)	85.14 (35.69)
Non-Lexical	28.26 (45.53)	25.00 (43.69)	22.89 (42.26)

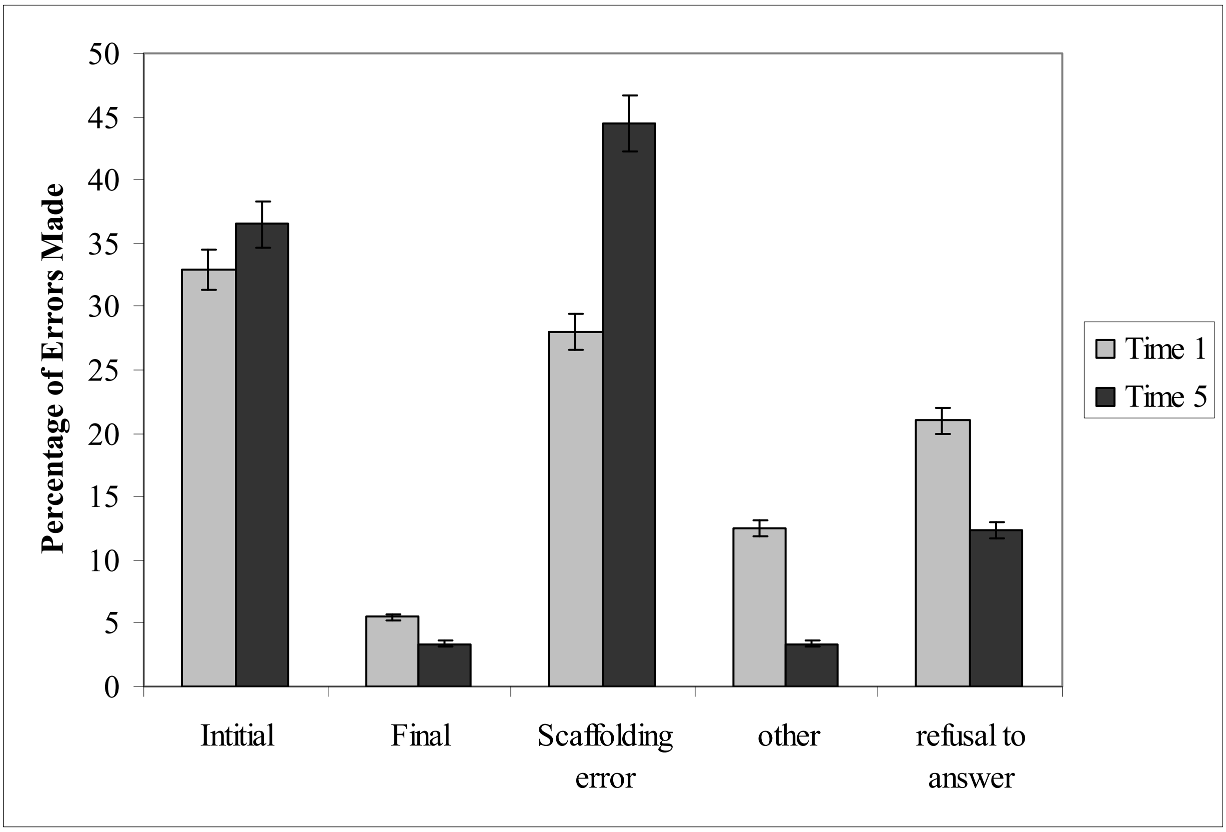
As Table 8.8 reveals, the application of each strategy when gaining a correct response across the three different word types showed that the consistent words had the highest correct use of lexical strategies. By time five the use of lexical strategies were producing correct responses on 86.11% of all words. The correct use of non-lexical strategies was much lower and showed a more sporadic pattern at producing correct responses. On exception words using a lexical strategy to get a correct response was very successful with a significant increase in correct use of lexical strategies between time one and time five. The exception words were read at a similar level of accuracy using a non-lexical strategy as the consistent words. As the exception words contain unusual grapheme to phoneme mappings then it is expected that the use of a non-lexical strategy would lead to an increased error rate. The unique words showed a lower correct use of lexical strategies and showed that non-lexical strategies were more successful at producing a correct response.

The 2 (testing session; time one and time five) x3 (Word type) x2 (strategy; lexical vs. non-lexical) repeated measures ANOVA was carried out to examine any differences between the testing session, the word type and the strategy applied on just the trials where the children produced a correct response. There was no significant main effect of testing session, $F(1,15) = 1.338$, $p>.05$, $\eta^2 = .082$, showing that there was no difference in scores at time one and time five. There was also no significant effect for word type, $F(2,30) = 2.016$, $p>.05$, $\eta^2 = .118$, showing no difference between scores on the different types of words. The main effect for strategy was significant, $F(1,15) = 30.877$, $p<.05$, $\eta^2 = .673$, showing a difference in the application of lexical and non-lexical strategies to produce a correct response. There was no significant interaction for the testing session and word type, $F(2,30) = .729$, $p>.05$, $\eta^2 = .046$, showing that the scores on the different word types did not differ across the testing sessions (T1 and T5). There was however a significant interaction for testing session and strategy, $F(1,15) = 9.164$, $p<.05$, $\eta^2 = .379$, showing a difference in the use of lexical and non-lexical strategies across the testing sessions. There was also no significant interaction between word type and strategy, $F(2,30) = .2.196$, $p>.05$, $\eta^2 = .128$, stating that the type of word did not interact with the application of the lexical or non-lexical strategies to produce a correct response. Finally, there was no significant three-way interaction between testing session, word type and strategy applied.

8.6.3 Changes in errors in children's reading over one academic term

The errors that the children made in reading were compared at time one and time five to identify changing patterns, if any, in the miscues made. Figure 8.7 shows that at time one the children made more initial errors (preserving the initial phoneme), than scaffolding errors or refusing to answer. There were very few errors made when the final phoneme was preserved and not many 'other' errors. However, by time five of testing the children had shifted in the types of errors that they were making and they were more likely to make a higher proportion of scaffolding errors (errors where both the initial and final phoneme are preserved) than the initial errors. The numbers of final and other errors had declined by time five.

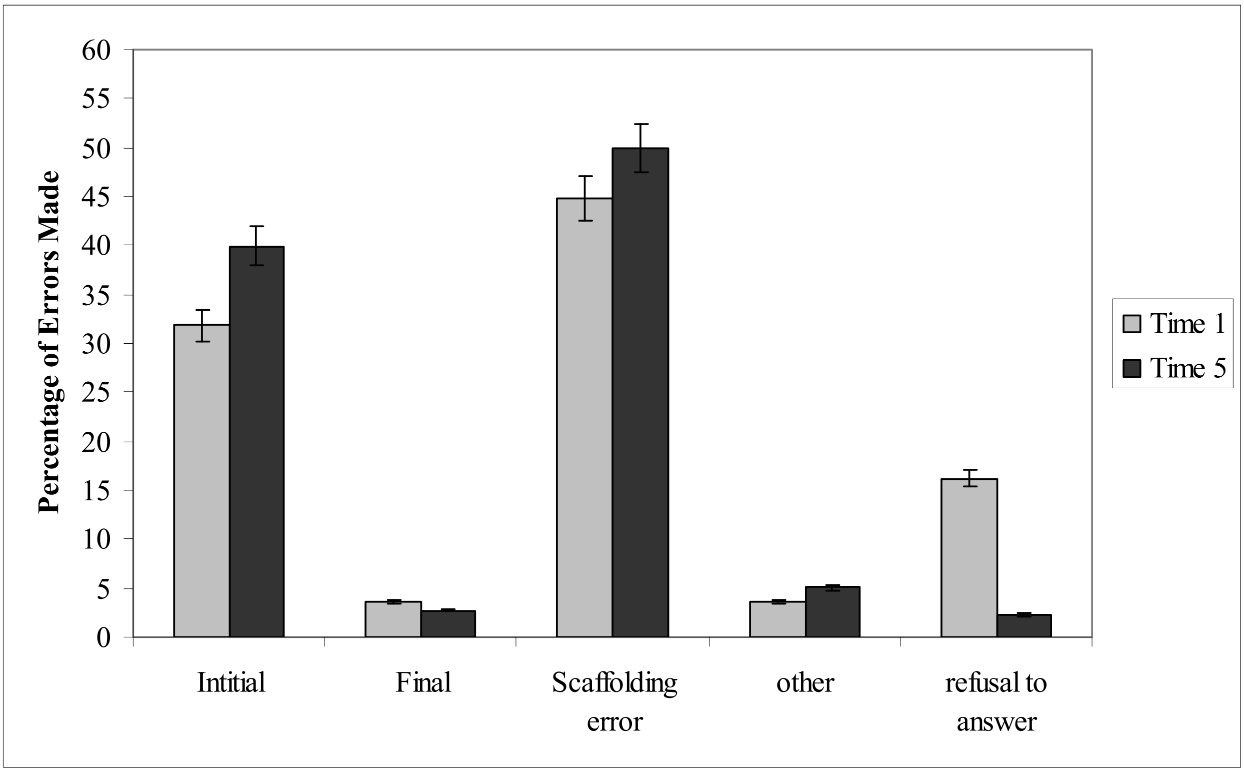
Figure 8.7
Percentage of error types made at time one and time five of testing for Year One children (including 95% CI)



Scaffolding errors have found to be the most important type of reading error as they have been found to be predictive of later reading success in previous literature (c.f. Savage & Stuart, 2001; 2006; Savage et al., 2001). Therefore the scaffolding errors made were examined further. A one way ANOVA revealed that there was a significant difference in the number of scaffolding errors made at time one of testing compared to time five of testing, $F(1,7) = 6.928$, $p<.05$, $\eta^2 = .497$. This showed there were significantly more scaffolding errors made at time five (the end of term) compared to the start of term. As scaffolding errors have been found in previous studies to predict later reading ability it was expected that by time five when the Year One children made a miscue in reading it was more likely to be a scaffolding error compared to the other error classifications.

Figure 8.8 summarises the mean number of errors made across testing sessions. There was very little difference in the Year Two children error rates at time one compared to time five. The errors that were made predominantly by Year Two children were initial errors and scaffolding errors. When examining more closely the differences between the scaffolding errors made at time one and time five there was no significant difference (F1,14) = .016, p>.05, η^2 = .001).

Figure 8.8
Percentage of error types made at time one and time five of testing for Year Two children (including 95% CI)



The comparison of types of errors made in Year One and Year Two showed that in Year One there was a significant increase in the use of scaffolding errors over time, rising from 25% at time one to 44.4% at time five. The Year Two children did not show an increase in the use of scaffolding errors; however they were already making 44.8% of scaffolding errors at time one. This implied a developmental trend showing an increase in scaffolding errors in Year One (the first year of formal reading instruction) which then slowed in Year Two. The number of initial errors made were similar between the children in Year One and Year Two. The Year Two children showed lower numbers of final errors or other errors as well as a refusing to answer on fewer trials.

In order to further examine errors in reading, a correlation analysis was carried out to look for any relationship between the type of error made and the self-reported strategy applied when they made that error. This highlighted relationships between reading errors and application of different strategies.

Table 8.9
Correlations between errors made by Year One children and strategies applied when making scaffolding and initial errors at time one and time five.

		Lexical	Non-Lexical
Scaffolding	Time one	.465**	-.486**
	Time five	.527**	-.487**
Initial	Time one	-.173**	.172**
	Time five	-.341**	.401**

Note: * = $p<.05$; ** = $p<.01$

The correlations between the errors made and the strategies applied when the errors were made found a moderate significant correlation between the application of lexical strategies and making a scaffolding error, suggesting that scaffolding errors were made more often when the children were retrieving the word from memory. This could be due to having stored a faulty representation, or showing that they are just trying to locate the word in their lexicon and have provided an incorrect response. There was also a positive significant correlation found between the application of non-lexical strategies and making an initial reading error.

Table 8.10
Correlations between errors made by Year Two children and strategies applied when making scaffolding and initial errors at time one and time five.

		Lexical	Non-Lexical
Scaffolding	Time one	.259**	-.256**
	Time five	.144*	.-.175*
Initial	Time one	-.236**	.266**
	Time five	-.138*	.171*

Note: * = p<.05; ** = p<.01

Year Two data also showed significant correlation between scaffolding errors and lexical strategies, but the relationship was weaker than for Year One. The initial errors also showed a significant correlation with the use of non-lexical errors. By time five the relationships were not as strong between the error type made and the strategy used.

For the Year Two data it was also possible to distinguish the errors between word types. This revealed a similar trend to the data portrayed in Study Three; that is scaffolding errors were made more frequently on exception words and least often on consistent words. Also initial errors were made most often on the consistent words at time one and time five.

Table 8.11
Percentage of errors made across the three different word types (consistent, exception and unique) at time one and time five of testing for Year Two children (SD)

	Consistent	Exception	Unique
Time 1			
Initial	51.56 (50.37)	31.58 (46.73)	35.35 (48.05)
Final	3.13 (17.54)	1.05 (10.26)	8.08 (27.39)
Scaffolding	35.53 (48.17)	52.63 (50.15)	43.22 (49.75)
Other	2.63 (16.11)	3.51 (18.48)	4.24 (20.23)
Refusal	15.79 (36.71)	16.67 (37.43)	16.10 (36.91)
Time 5			
Initial	58.70 (49.78)	27.78 (45.04)	42.68 (49.76)
Final	2.17 (14.74)	1.11 (10.54)	4.88 (21.67)
Scaffolding	36.96 (48.80)	62.22 (48.75)	43.90 (49.93)
Other	2.17 (14.74)	4.44 (20.72)	7.32 (26.20)
Refusal	0.00 (0.00)	4.44 (20.72)	1.22 (11.04)

Overall the findings from the error analyses of Year One and Year Two children showed similar numbers of initial reading errors. When looking at the numbers of scaffolding errors the Year One children showed a significant increase in the number made, whilst the Year Two children did not make a significant increase across the testing sessions as they were already making more than the Year One children at the start of the study. Both the Year One and Year Two children showed correlations between the type of error made and the strategy applied to attempt to read the word.

8.7 Discussion

Three main research findings were identified in the current study. The first main finding was that over the five testing periods there was an increase in accuracy and a decrease in solution time for the reading of target words across both Year One and Year Two readers. Secondly, the analysis of the strategy use and accurate strategy use showed that there was variability in the application of strategies over time and that the children were shifting towards using more efficient strategies to help them to read. This is reflecting the variation in strategy use as shown by Siegler (2002; 2005) and also a shift towards sight-word reading as identified in Ehri's phase model of reading development. The Year Two word list also included different word types (consistent, exception and unique) with manipulated rime unit frequencies to allow for a greater manipulation of word-reading strategies based on shifts in orthographic representations. The results showed there were variations in the accuracy and strategies applied to read these words across the five testing sessions. Thirdly, the analyses looked at the errors made and the correlations between strategy use and the errors made and found that there was an increase in the number of scaffolding errors made over time by Year One children, making them the most frequently made errors by time five. The Year Two children however already showed a high number of scaffolding errors at time one. There were also correlations found between the error made and the strategy applied to try to read the word.

Year One children showed a very gradual increase in accuracy with a steady improvement at each testing session. Year Two on the other hand showed a marked improvement between time two and time three with little increase in accuracy between the last two testing sessions. The reason for the difference between Year One and Year Two could be due to the word list for Year Two children with the manipulated word types. The different types of words in this list (namely exception and unique words) could be causing the children more difficulty in decoding/learning to read the words. However, when you combine the accuracy data with the strategies used it shows that there is also a significant increase in the use of lexical strategies between time two and time three for Year Two children. Therefore the best explanation for the increase in accuracy is that they are shifting towards a more accurate and efficient strategy (retrieval from memory) and this is reflected in the accuracy data. The increase in accuracy over time has been highlighted in other studies looking at change over time in spelling and reading and has been linked to a switch in strategy use towards applying lexical strategies (Rittle-Johnson & Siegler, 1999; Kwong & Varnhagen, 2005; Farrington-Flint et al., 2008a; 2008b).

As in previous research (Rittle-Johnson & Siegler, 1999; Farrington-Flint et al., 2008a), this study found a decrease over the testing sessions in the solution time taken to read the words. Over time the children in Year One and Year Two were becoming more efficient at reading the words, suggesting that the children were relying less on time-consuming strategies (non-lexical strategies) and were shifting towards lexical retrieval from memory. This finding reflects Ehri's mediated phase model (1995; 1999; 2002) which states that children can achieve sight-word reading at any stage and that this is the most efficient way to read. In order to fully examine this pattern and to see if the type of strategy used was having an impact on the accuracy and solution times the strategy use was examined.

The examination of strategy use over time showed that there was variability in the strategies chosen to read the words and that the children were able to select the strategy that they had the most confidence in using for the word item. The change in strategy use over time showed support for Siegler's (2002; 2005) overlapping waves model, as some of the strategies decline in use and others become more significant. The two main strategies that were applied by the children were retrieval from memory (lexical route) and phonological (non-lexical route). The use of mixed strategies (using a combination of retrieval and sounding-out), analogy and guessing were not applied in many cases. Applying a mixed strategy relies upon the use of both routes (lexical and non-lexical) in order to partially retrieve the known representation and then use the phonetic information to decode the remainder of the word. These mixed strategies also had fairly low accuracy in reading the word correctly. The Year One children demonstrated a later shift towards using lexical strategies than the Year Two children, as in Year One the increase in the use of lexical strategies is prominent between time four and time five. In Year Two however there was a steep increase between time two and time three. Overall, the pattern showed an increase in the use of lexical strategies and a decrease in the reliance on the non-lexical route. However, the Year One children still had a higher reliance on the non-lexical route than the Year Two children, even at the last testing session.

When examining the correct use of these strategies it became clear that lexical strategies were the most effective way to produce a correct response on the single word reading task. The Year One children were increasing in correct use of lexical strategies from time three onwards and the Year Two children were showing high success rates from time two. Therefore the results suggest that the children were shifting away from strategies which were not producing correct responses in order to attempt to produce an accurate response using the most efficient strategy. These findings show a similar pattern to the results found by Rittle-Johnson and Siegler (1999) and Kwong and Varnhagen (2005) in spelling and Farrington-Flint et al. (2008a) in reading.

Examining the variations in accuracy and strategy use across the three different types of words (consistent, exception and unique), showed that consistent words were read most accurately and retrieval was used predominantly to read them. However whilst consistent words had the highest accuracy across all testing sessions, it was the exception words (which have low grapheme to phoneme correspondence) which showed the greatest increase in accuracy from 45% to 65% across the five testing sessions. When this is examined with the data on strategy use it shows that exception words showed a large increase in the use of lexical strategies and away from non-lexical strategies from time three onwards. This suggests that the children were using their metacognitive knowledge and realising that these exception words do not follow the standard GPC mappings and therefore they were simply trying to learn them as a sight-word. The unique words had the longest solution times overall and had a higher application of non-lexical strategies than the consistent or exception words, but the lowest accuracy when using non-lexical strategies. This could be because although they had regular mappings they also had low rime unit frequencies and therefore it took longer to read them using a non-lexical strategy. These findings are very similar to Farrington-Flint et al. (2008b) who looked at manipulated word types in children's spelling. They found that the unique words were spelt with a larger reliance on phonological approaches and that retrieval was used most frequently for consistent and exception word items. The current study showed the same pattern for the three word types and suggested that it is the words with few phonological neighbours (unique words) that are causing the problems in reading as they showed the lowest accuracy compared with the other word types. The low accuracy found in the unique words could be related to less reliance on the lexical strategies and therefore the children are trying to sound them out, but are struggling with the low rime unit frequency.

The analysis of the reading errors also showed an interesting pattern across both year groups and in terms of the strategies that were employed to read the words when the errors were made. Scaffolding errors (errors preserving the initial and final phonemes) have been found to be accurate predictors of children's later reading performance (c.f., Savage & Stuart 2001; Savage, Stuart & Hill, 2001). Therefore, the prediction was that in emergent reading there would be a shift towards making greater proportion of scaffolding errors on words that the children are still reading incorrectly by time five of testing. The other prediction was that scaffolding errors would be more like to be associated with the greater use of lexical strategies as the boundary letters in a word can aid word recognition (c.f., Pitchford et al., 2008). The children in Year One followed the predictions. At time one the children were making more initial errors than scaffolding errors and these were predominantly associated with the use of non-lexical (phonological) strategies. However by time five there had been a shift in errors made and the Year One children were making significantly more scaffolding errors than at time one. These scaffolding errors were also found to be predominately associated with the use of lexical strategies, which also matches the data showing that overall there was a shift towards lexical strategies. This suggests that the children in Year One are making scaffolding errors by retrieving the word from memory, but the word is being read incorrectly, for example reading the word 'hood' as 'head'. By making errors of this type it could suggest that they have encoded faulty orthographic representations for these words, or they are simply using the boundary letters for recognition and not checking the letters in the middle of the word. They were striving to be able to read the words by sight, but are not getting this correct on all occasions.

The pattern of strategy use overall shows a shift towards using lexical (retrieval) strategies. When looking specifically at the strategies used when errors were made, there was a slightly different pattern. This could suggest that children are adaptive in their use of strategies and are able to gauge their confidence in a certain strategy before applying it. In Year One there was a high use of lexical strategies associated with the scaffolding errors made, however in Year Two although there was still a positive correlation between the scaffolding errors and lexical strategies this was not as strong. The word list itself could explain some of this variation as the Year One word list contained all consistent CVC words and the Year Two children had the word list with the manipulated word types. However, due to the low number of errors made in Year Two (especially by time five) there was insufficient data to examine this by word type.

All of the findings presented here show support for more flexible models of reading development, suggesting that strategy use can be fluid (Ehri, 1995, 1999, 2002; Siegler, 2002). Overall the results are suggesting that in order to read different words children need to have a number of strategies available to them as some will have more success on certain types of words. Rittle-Johnson, Saylor and Swygert (2008) suggested that by asking for self-reports of strategy use it allows children to gain an understanding of how they are reading the words and therefore enables them to store a bank of available strategies.

The findings from the present study tracked the emergent reading of Year One and Year Two children in a longitudinal design spanning one academic term. Overall there was an increase in accuracy and a decrease in solution time and there was also variability in the pattern of strategy use that was found. An analysis of the errors made at the start of the testing sessions and during the final session revealed an increase in the number of scaffolding errors being made by the children in Year One and Year Two, with a significant change in Year One. An examination of the strategy use with the error data revealed that Year One children were more likely to make a scaffolding error when applying a lexical strategy, suggesting that they had an incorrect orthographic representation of the word, or they simply mistook the word. Overall the findings show that in order for children to progress with their emergent reading they need to have a range of strategies to be able to apply the appropriate strategy for the word presented. Rittle-Johnson (2006) highlighted that the use of self-reports of strategy use (self-explanation) can provide a scaffolding effect on the strategies available to the children and allow them to take ownership of their range of strategies. The educational implications of these findings will be discussed in the general discussion.

Chapter Nine

General Discussion

9. Introduction

The central purpose of this thesis was to probe the role of children's strategy use in emergent reading. There were four main research objectives. Firstly, the validity of self-reported strategy use was examined in order to find out if the children are able to provide accurate verbal protocols. The evidence confirmed that verbal self-reports of strategy use were a valid means of capturing the processing and that they produced comparable findings to that captured through observation of the children across Studies One and Two. Evidence from the rapid naming task confirmed that children were able to accurately verbalise this cognitive process. Secondly, word specific changes in strategy use were examined by manipulating the rime unit frequencies of words to see if it has an influence on how children were applying different strategies. Study Two found that there were distinct differences in the strategies that were applied to read the different types of words and that certain strategies had a much higher accuracy. Showing how word specific orthographic representations can influence children's reliance on particular lexical or non-lexical word reading strategies. Different reading profiles were also identified through the use of hierarchical cluster analysis. This found that the readers were showing differing levels of accuracy and solution times related to strategy use. This finding gave further support for the dual route model of reading as both pathways for reading were identified (Coltheart et al, 2001). Thirdly, the reading errors were examined in order to build up a clearer and more detailed picture of how children's emergent reading develops. The error types found were then used in order to further subdivide the non-lexical strategies to gain a greater insight into how children were applying phonological recoding strategies. Finally, the change over time in strategy use and reading errors were investigated using a repeated measures study set over one academic term. Study Four examined the change in word reading strategies (alongside reading errors) over time and found that there was a general increase in word reading accuracy and an expected decrease in solution times. This corresponded with the increased application of lexical word reading strategies over time.

This chapter discusses the overall findings across all four experimental studies. Initially the confirmation of the validity of verbal self-reports as a method of capturing strategy use is considered using data from Studies One and Two. The next section identifies the strategies used in learning to read and how they adapt over time drawing on data from Studies One and Four. The word specific implications of reading words with manipulated rime unit frequencies and the different types of reader profiles are also examined. The reading error data were discussed and compared to previous findings using the findings from Studies Three and Four. Finally, educational recommendations and implications for future research are drawn out.

9.1 The validity of verbal self-reports of strategy use

Verbal self-reports of strategy use have been used across many domains to gain an insight into the cognitive processing that is occurring (Rittle-Johnson & Siegler, 1999; Kwong & Varnhagen, 2005; Farrington-Flint et al., 2008a). As discussed in Chapter Four, questions have been raised concerning the validity of verbal self-reports of strategy use, particularly when used with young children (Russo et al., 1989; Robinson, 2001). The present research was examining emergent reading skills and therefore the children needed to be in Year One and Year Two of school in order to capture reading as it developed via formal reading instruction. Therefore it was important that the self-reports of strategy use that the children were giving were valid; providing a reliable source of data.

Previous studies have examined the validity of verbal protocols as a method of capturing strategy use by using different reporting conditions; concurrent condition, retrospective condition and a control condition (Russo et al., 1989; Robinson, 2001). However, there have been inconclusive findings about the overall veridicality of the verbal self-reports and it is this conflict in the literature that the first study here addresses.

Study One specifically examined the reactivity and veridicality of using verbal self-reports of strategy use in children's emergent reading. The data showed that there were no differences in accuracy across the three different conditions (concurrent self-reports, retrospective self-reports and a control condition). This suggested that being asked to give a verbal self-report of strategy use was not changing the accuracy of the response on the task. Similarly there were no differences in the solution times across the three conditions. This differs from the time latency data found by Russo et al. (1989) and Robinson (2001) where longer latencies in the concurrent reporting condition were found. However, these data were based on strategy performance in a mathematics task and not the context of word reading. The lack of any significant difference in the present data could be explained by the nature of the single word reading task. As it was a short task to complete and therefore it was hard to verbalise during cognition, meaning that retrospective self-reports were more natural to give. Overall the data showed that asking the children to provide a verbal self-report of strategy use had no reactive impact on the response given.

The veridicality of the verbal self-reports was examined via a correlational design used to compare the self-reports of strategy use with any overt observable behaviour. Certain strategies have expected associated behaviours that can be used as another method of assessing strategy use. For example pointing and saying each phoneme aloud and then blending to form the word could be an indication that the child is applying an explicit phonological-based strategy. The correlations between the expected observable behaviour and the self-reported strategy use were strong, suggesting that the children were able to accurately verbalise their processing. Positive correlations were found between the expected behaviour for sounding-out (pointing and saying each phoneme separately) with the self-report of applying sounding-out. Retrieval was correlated with no overt behaviour, but a short reaction time. These findings are in line with reports from Rittle-Johnson and Siegler (1999) who found a 70% correspondence of overt behaviour and the self-reported strategy in a spelling task. However, as there is little observable behaviour associated with using a lexical strategy (retrieval from memory) there was the need for an additional measure to test the veridicality of these reports. The rapid naming task was introduced to provide further validity for the use of verbal self-reports of using the strategy retrieval, as the time limit to read the words should remove the ability to apply the GPC mappings. This used the same words from the main experimental word list, but they were only displayed for 500 milliseconds. The results from Study One found that, if the children were self-reporting the use of a retrieval strategy, then they were able to read it during the rapid naming task on over 94% of the trials. This provided confirmation that the children were able to accurately provide a verbal self-report of retrieval. The validity check on the data was also carried out for Study Two using the word list with the manipulated word types. This also found that the verbal self-reports were valid (see Appendix F).

Examining the results of the rapid naming task and the trials where phonological strategies were used on the main task shows much less correspondence (around 20%) for both Study One and Study Two. The use of a phonological strategy and then a successful response on the rapid naming task could be explained by priming effects as the children have seen the word previously and therefore have learnt the word (or secured the sight word to memory). Share (2004) stated that just one exposure to a word could create an orthographic representation therefore the main experimental task could be priming the rapid naming task. Another plausible explanation revolves around conscious or unconscious processing. Previous research has found evidence that it is possible that strategies first develop as an unconscious process and that when children use them, they are not fully aware of how they are completing the task. Siegler and Stern (1998) examined the use of unconscious strategies and found that there was evidence from solution times that children were using retrieval before they were able to verbalise the process. Siegler and Stern linked this phenomenon to the gesture-speech concordance which suggests that knowledge can be portrayed through gestures before it can be verbalised (Alibali & Goldin-Meadow, 1993). It is unclear whether this effect is created by learning on the task or an unconscious use of strategies, however as the effect is relatively small compared to the correlations with observed behaviour and the use of retrieval and the rapid naming task results, verbal self-reports were still considered to be valid.

Overall the data shows that the children in Year One and Year Two were able to provide accurate self-reports of strategy use which did not impact on their performance of the word reading task and were valid representations of their cognitive processing when compared to behavioural observations and under controlled conditions (rapid naming task). The findings support the conclusions drawn by Robinson (2001) that verbal self-reports were a valid measure of capturing strategy use (in mathematical tasks), even in younger children. The present data shows that the validity is also found in reading tasks.

9.2 Strategy use in emergent reading

The validity data established in Study One and Study Two (Appendix F) of this thesis confirmed that retrospective verbal self-reports of cognitive processing were a reliable source of information for capturing strategy use. Predominantly Studies One, Two and Four found that there were two main strategies being applied to read the experimental word list. These were retrieval from memory (lexical strategies) or pure phonological strategies (non-lexical strategies). Across all three studies the children showed a reliance on these two strategies which reflect the processing pathways as identified by the dual route model of word recognition (Coltheart et al. 2001). The data gave further support for the serial processing of the dual route model as the children are predominantly only relying on one pathway at a time to correctly identify word items.

The children had such a high reliance on the lexical (retrieval) and non-lexical (phonological) strategies that the use of other reading strategies such as analogy was very limited. While some researchers argue that young children in the very early stages of learning to read are able to apply analogy strategies (Farrington-Flint & Wood, 2007; Goswami, 1988, 1990a, 1990b, 1993) others have documented how children need a well-developed sight vocabulary as a basis for making analogies between familiar and unfamiliar words (Ehri, 1998; Ehri & Robbins, 1992).

This questions the extent to which analogies are used in the consolidated alphabetic phase of reading (as outlined by Ehri). It is important to note that such claims are often based on experimental studies (or clue word studies) that specifically train children to recognise words based on similar rime units using clue-word prompts. Given that these findings are task dependent then it is likely that these studies often over-estimate the extent to which analogies are used spontaneously in the context of children's early word reading (Brown & Deavers, 1999; Roberts & McDougall, 2003; Savage, 1997). The present thesis and other studies using a single word reading task have found very low occurrence of analogy as a reading strategy (Farrington-Flint et al. 2008a). Therefore perhaps when there are no task demands on strategy use, the incidence of the use of analogy is lower in emergent readers.

One explanation of this finding is that the children do not have a sufficient vocabulary to make such analogies but an alternative explanation, outlined in Chapter Two concerns the application of small versus large phonological units in learning to read. Applying an analogy strategy is an example of applying the large phonological unit (onset-rime). The current recommendations for teaching phonics within UK schools using synthetic phonics encourages the manipulation of small phonological units and not the large units required if analogies are to be generated.

9.2.1 Redefining the coding framework

A further contribution of the thesis relates to the development of a new refined coding framework for classifying word-reading strategies. The previous studies (Study One and Study Two) did not break down the phonological recoding strategies and therefore the use of a 'mixed' strategy could only tell us that the children had used both retrieval of part of the word and sounding-out to read the rest. This meant that valuable information about the parts of the word that were particularly important for word reading were being lost. Study Three refined the strategy coding framework used to classify the verbal self-reports of strategy use. This was done through an analysis of the errors that the children were making in reading and looking at phonological similarities in the target word and the error (see section 9.3 for a review of the errors found). The new coding framework was applied in Study Four to refine the phonological recoding strategies using a mixed approach (retrieving part of the word and sounding-out the rest). This found that the Year One children were using more final mixed strategies (retrieving common endings), but the Year Two children were more likely to retrieve the initial phoneme and then apply a non-lexical strategy to the rest of the word. However, the use of these strategies overall is very low and is almost at floor level, particularly by time five.

Overall there was a reliance on the lexical and non-lexical strategies for reading, reflecting the dual route model (Coltheart et al., 2001). There is substantial evidence stating that the serial processing in the dual route model provides an accurate fit to human data, including studies looking at the effect of phoneme positioning in irregular words (Rastle & Coltheart, 2006) and lexical decision making (Coltheart et al., 2001). Jackson and Coltheart (2001) argued that children also learn to read via these dual routes and that they can use the lexical route if the word is familiar to them, but otherwise they will rely on decoding via the non-lexical route. The data from the current thesis support these claims and show that the use of these pathways can vary dependent on the target word presented.

9.2.2 Variability in strategy use over time

The repeated measures, cross-sectional study (Study Four) traced strategy use and reading development over one academic term to see if the strategies used by the children changed during the term. The data generally showed an expected trend of increased word reading accuracy over the academic term and a decrease in solution times taken to read the words.

As for previous research (Rittle-Johnson & Siegler, 1999; Kwong & Varnhagen, 2005; Farrington-Flint et al., 2008a; Farrington-Flint et al, 2010), this study found individual variability in the strategies chosen to read the words. This suggested that the children were able to select the strategy that they had the most confidence in using for the word item. The shift from the reliance on non-lexical to lexical strategies is also found in these previous studies such as Siegler's (2002; 2005) overlapping waves model, which projects that some of the strategies decline in use and others become more significant. The Year One children demonstrated a later shift towards using lexical strategies than the Year Two children, as in Year One the increase in the use of lexical strategies is prominent between time four and time five. In Year Two however there was a steep increase between time two and time three. Overall, the pattern showed an increase in the use of lexical strategies and a decrease in the reliance on the non-lexical route. However, the Year One children still had a higher reliance on the non-lexical route than the Year Two children, even at the last testing session. This supports Ehri's account of increased sight word reading through exposure as the children are shifting towards a higher use of lexical strategies. Also the fact that Year One children were using lexical strategies in the first few testing session also supports Ehri's claim that sight word reading can occur at any phase of reading development and is not just used by skilled readers (Ehri, 1995; 1999; 2002).

Evidence of the application of any strategy does not necessarily imply accurate usage of that strategy. When examining the accurate use of these strategies it became clear that lexical strategies were the most effective way to produce a correct response on the single word reading task. It has been well documented that applying a lexical strategy is the most efficient strategy for 'skilled' reading, producing both high accuracy and short solution times (Ehri, 1995; Ehri & Wilce, 1983; Coltheart et al, 2001). The Year One children were increasing in their accuracy when using lexical strategies from time three onwards and the Year Two children were showing high success rates from time two. Therefore the results suggest that the children were shifting away from strategies which were not producing correct responses in order to attempt to produce an accurate response using the most efficient strategy. These findings show a similar pattern to the results found by Rittle-Johnson and Siegler (1999) and Kwong and Varnhagen (2005) in spelling and Farrington-Flint et al (2008a) in reading.

Overall, the findings from the repeated measures, cross-sectional study show support for more flexible accounts of reading development and do not reflect the assumptions reflected in more traditional stage model accounts. Traditional models such as the cognitive-developmental model (Marsh et al., 1981) and Seymour's reading acquisition model (Seymour & MacGregor, 1984; Seymour 1990; 1997; 1999) stated that children would read using one strategy according to the stage of their development and once they had mastered that strategy they could progress in reading. Ehri's (1995; 1999; 2002) mediated phase model showed that accounts of children's reading need to be more flexible to take into account individual differences and to account for the development of sight-word reading. Sight-word reading can develop during any phase in Ehri's model for familiar words. This means that if a child has decoded the word a few times, they will learn that word as a complete orthographic representation and will in future retrieve the entire word, rather than relying on back-up decoding strategies. The present data clearly shows this shift towards using the sight-word reading, but having to rely on a decoding strategy for unfamiliar words. The reliance on these non-lexical (phonological) strategies could be more frequent in more difficult or low frequency words where the child may not have the confidence to apply the lexical strategies without more practice. The impact of word specific characteristics on strategy use will be discussed in the following section.

9.2.3 Word specific changes in strategy use

The baseline data presented in Study One highlighted that even basic word characteristics can have an impact on the accuracy of reading the word. The word frequency for example had an effect with the higher frequency words being read more accurately than the low frequency words. Word frequency effects have been long established in the literature and therefore this was an expected finding. A lot of the research looking at these effects has been examined though the use of a lexical decision task. This is where words and non-words are displayed at random and the participant has to decide if the letters displayed form a word. The lexical decision tasks however have been found to over exaggerate word frequency effects (Balota & Chumbley, 1984). Another way that these have been examined which still show word frequency effects (albeit slightly smaller) are via naming experiment (Forster & Chambers, 1973). The findings from these studies are similar to the current study. However, when combining this information with strategy use there is no significant effect of word frequency when only the trials using retrieval are examined. This suggests that the children are able to retrieve the word from memory (sight-word read) the low frequency words as well as the high frequency words. As discussed in Chapter Two, word-specific representations can be created at any phase of learning and the children are then able to read that word by sight (Share, 1995; 1999; 2004). In order to further examine the impact of word specific characteristics on strategy use the word types were manipulated to include words with a high or low rime unit frequency.

The word list used with the Year Two children in this thesis contained three different types of words with manipulated rime unit frequencies and GPC regularity. The consistent words all had regular GPC mappings and lots of phonological neighbours and therefore a high rime unit frequency. The unique words also had regular GPC mappings, but a low rime unit frequency. The exception words had irregular mappings and were therefore not able to be accurately decoding by applying the standard grapheme to phoneme rules in English. Differences in the strategies used in spelling these words have been highlighted in previous studies. Nation (1997) found that children were able to spell words with high rime unit frequencies more accurately than words with a low rime unit frequency. A similar finding was also shown in non-words that contained a high rime unit frequency. Farrington-Flint et al (2008b) found a similar pattern and highlighted that children were applying lexical strategies more often to the consistent and exception words.

As well as differences in the strategies that are used to read/spell such words there have been studies highlighting differences in accuracy and latencies in words with regular/irregular GPC mappings. Glushko (1979) found that regular words were read more easily than exception words. The latencies in this study were not only longer for exception words, but also for words with regular GPC mappings, but inconsistent pronunciations (known as unique words in this thesis). Glushko (1979) found that the unique words were read more similarly to the exception words, rather than the regular words. These consistency effects have also been shown by Seidenberg, Waters and Barnes (1984) where they found that the regularity of the GPC mappings and the consistency of the pronunciation impacted on the accuracy of the reading. Seidenberg et al. (1984) also showed that word frequency was an additive effect in the findings. Similarly Laxon, Masterson and Moran (1994) found that low frequency words which differed in the regularity of the word endings (many or few orthographic neighbours) impacted on the accuracy of reading. The words with many neighbours were easier to read for all children and those classified as 'better readers' had more issues overcoming the inconsistencies (the unique and exception words).

The findings here show that the characteristics of a word do have an impact on the accuracy and also the strategy that is used to read the word. The data from Study Two and Study Four found that overall consistent words were read the most accurately. In Study Four this was traced over five testing sessions spanning one academic term in which consistent words were read with greater accuracy than the exception or unique words across all of the testing periods. The exception words had the lowest accuracy in Study Two, however in Study Four the exception and unique words were showing a similar profile of accuracy at time one, two and three. By time four and into time five, it was the unique words that showed a lower number of correct responses. When examining the solution times taken to read the words the consistent words were read the fastest across both Studies Two and Four, suggesting that consistent words are read most accurately and quickly. The unique words show the longest solution times across both Studies Two and Four. The findings from the current studies lend extra support to the body of literature examining regularity and consistency effects. The disruption of the frequency of the rime unit (the consistency of the word) in reading mirrors the previous findings (Glushko, 1979; Seidenberg et al., 1984; Laxon et al., 1994).

The data shows that unique words in Study Four have the lowest accuracy and they show the longest solution times across Studies Two and Four. It could be hypothesised that the exception words would show the lowest accuracy and the longest solution times as they have irregular GPC mappings as well as a low rime unit frequency. Therefore an additive effect could be expected. However, this was not the case and the unique words appeared to be causing more problems for the readers than the exception words. In terms of strategy use this could be explained by the earlier shift towards the use of lexical strategies for the exception words. As the unique words have regular mappings they can in theory be read successfully through the use of non-lexical strategies and therefore they are not prioritised for the use of sight word reading. This could explain the longer solution times for unique words as the non-lexical strategies take longer to compute and the low rime unit frequency could be impacting on the success of reading. This finding is supported by Share's self-teaching hypothesis (1995; 1999) as the children are creating orthographic representations of the words that have irregular mappings as it is a necessity for accurate reading and therefore the words with regular mappings (particularly those with a low rime unit frequency) will be 'learnt' later in reading development.

To further examine the impact of rime unit frequency and regularity of GPC mappings the self-reported strategy use was compared to the word type. This showed distinct patterns of strategy use being related to the type of the word. It is important to note that due to the irregularity of the GPC mappings in the exception words, non-lexical strategies should not produce a correct response. The findings showed that in Study Two there was a higher application of non-lexical strategies used across all word types and interestingly they were applied most frequently to exception words. However the data from Study Four is showing that lexical strategies are applied more frequently across all testing sessions and across all word types. This variation could be explained by individual differences in the abilities of the children in the two studies.

When only the strategy use on correct responses is examined the same pattern of use across Study Two and Study Four was found, that is the lexical strategies induce the highest accuracy. In Study Four this was also tracked over time and this showed that overall there was a shift over time from non-lexical to lexical strategies as the children learnt the words (discussed above in 8.3.2). There was a distinction however in the size of this shift with the exception words showing the greatest shift towards lexical strategies over time. This suggests that children are applying metacognitive knowledge and automatically reading the exception words via a lexical strategy. This reduces strategy choice for these word types; however the words with regular GPC mappings can still be read using either strategy.

These findings show support for more flexible accounts of reading development such as Ehri's mediated phase model (1995; 1999; 2002) as the findings show variation in strategy use, indicated by the application of sight-word reading to the words that are already stored as an orthographic representation and applying a phonological strategy for unfamiliar words. Theoretically these findings also support Share's self-teaching hypothesis (1999) stating that creating word specific orthographic representations are based on an item-by-item approach.

Overall, the research examining strategy use shows that the children are using both lexical and non-lexical strategies to read the words. The repeated measures study showed that this strategy use can be variable over time dependent on whether the child is familiar with the word. The children generally showed a shift from the use of non-lexical to lexical strategies. The further exploration of the effect of the word specific characteristics showed that the rime unit frequency and regularity of GPC mappings also had an effect on how the child read the word. All of these findings show further support for flexible models of reading development.

9.2.4 Identification of reading profiles

The distinct reading profiles in the children's strategy performance were also examined in Study Two. This found that some readers were showing a reliance on one specific route and that this was impacting on their accuracy and overall word reading ability. The cluster analyses found that one group of readers were showing high accuracy and short solution times across all word types and were predominantly using the lexical route to read the words. This reflects an unbalanced reading profile (Bowey, 2008) with a reliance on using a 'Chinese' reading system. This is supporting Ehri's sight-word reading as being the most efficient and accurate strategy for reading familiar words showing that these readers are 'skilled' in their approach. The intermediate group of readers were showing a balanced profile using both pathways equally for reading, but showed a higher accuracy for consistent words. This is showing an ability to switch strategies dependent on the word presented. There was also a low ability group with lower scores on the baseline measures who had an over-reliance on the non-lexical route reflecting 'Phoenician' readers (Bowey, 2008). This is however not showing that the non-lexical route is failing these readers, as it is important to note that the word list included exception words for which the non-lexical route should not provide a correct response. Therefore this is simply showing that these students were not familiar with the words in order to use the lexical route and therefore showing a reliance on using the non-lexical route in their attempt to decode the words.

The variability in the selection of strategies used by the different profiles (particularly the equal reliance on both pathways in the intermediate group) show that children's reading development is not reliant on any one individual strategy at a certain stage of reading development. Ehri's mediated phase model suggested that children were able to achieve sight-word reading for familiar words at any phase and then rely on decoding strategies if the word was unknown. The data from Study Two showed support for this model. There is also support for the idea that sight-word reading is a 'skilled' reading ability as the group showing a reliance on this pathway had high baseline scores and short solution times for reading.

9.3 Reading errors

Reading errors were also analysed as an additional method of analysing children's early word reading. Greenberg et al. (2002) stated that reading errors were another method of examining the strategies that children were using in reading. The type of reading errors made during the experimental single word reading task were examined in Studies Three and Four. The errors identified included initial errors (where the first phoneme is preserved), final errors (where the final phoneme is preserved) and scaffolding errors (where both the initial and final phonemes are preserved). These scaffolding errors have been found to be predictive of later reading success (Stuart & Coltheart, 1988; Savage & Stuart, 2001; 2006, Savage et al., 2001).

A great importance has been placed in the literature on scaffolding errors as they have been found to be the most commonly occurring error in children's reading and there are links with later success in reading (Savage & Stuart, 2001;2001; Savage et al., 2001). Scaffolding errors have been linked to Ehri's phonetic cue stage as the children are able to make only partial representations of words (Savage et al., 2001; Ehri, 1995; 1999; 2002).

The findings from the present study show a slightly different pattern of errors to previous research which found a higher number of scaffolding errors made and that these scaffolding errors were predictive of later reading ability (c.f., Savage & Stuart, 2001;2001; Savage et al., 2001). Study Three identified that children most frequently made initial errors in both Year One and Year Two. This was an unexpected finding as the previous studies have highlighted a predominant number of scaffolding errors. One possible explanation for this finding is the method of teaching, employing the synthetic phonics method. Savage et al. (2001) stated that the children in their study were taught with an 'eclectic' approach to reading with phonics taught amongst text. Another possible explanation could relate to how the child is given feedback during reading. Studies examining feedback have found that parents/teachers who simply say the word correctly rather than looking at the phonological information may influence strategy use and errors (c.f. Chinn, Waggoner & Anderson, 1993; Meyer, 1982; Evans, Barraball & Erberle, 1998; Spaai & Ellermann, 1991). However, when looking at the number of scaffolding errors made, these types of errors were made more often by Year Two children, suggesting that there could be a developmental shift in reading errors.

Study Four also examined reading errors and looked at how the type of reading error made changed over time. From the previous studies linking scaffolding errors to reading success (and the developmental trend found cross-sectionally in Study Three) the prediction was that over time the children were more likely to make a scaffolding error when they read a word item incorrectly. The other prediction was that scaffolding errors would be more likely to be associated with the greater use of lexical word reading strategies as the boundary letters in a word can often aid word recognition (c.f., Pitchford et al, 2008). The analysis of the reading errors showed an interesting pattern across both year groups and in terms of the strategies that were employed to read the words when the errors were made.

At time one the Year One children were making more initial errors than scaffolding errors and these were correlated with the use of non-lexical strategies. However by time five there had been a shift in the type of errors made and the Year One children were making significantly more scaffolding errors than at time one. These scaffolding errors were also found to be positively correlated with the use of lexical strategies. This provides a clue about how the children are reading these words when they make the errors. If they are reporting the use of a lexical strategy this could mean that they are making an incorrect recognition and replacing the target word with a similar word (for example reading the word 'hood' as 'head'). This shows the relative importance of the boundary letters of a word for correct recognition. The Year Two children also showed an increase in the number of scaffolding errors made over time. However, even at time one the Year Two children were making more scaffolding errors than other error classifications.

An understanding of the association between the type of errors and the strategy could also assist in allowing an understanding of how children are learning to read. Greenberg et al (2002) stated that the use of error analysis could assist in examining the strategies that were used in reading. Combining the information about the type of error made and the self-reported strategy used should provide information about how the error is being made and which parts of the word are important for word reading. In Year One there was a high use of lexical strategies associated with the scaffolding errors made, however in Year Two although there was still a positive correlation between the scaffolding errors and lexical strategies this was not as strong. One possible explanation could be the word list used with the Year Two children which contained the manipulated word types. The data from Study Three and Study Four found that scaffolding errors were made most frequently on the exception words (with irregular GPC mappings and low rime unit frequency). In Study Two it was found that the children were most frequently applying a non-lexical strategy when attempting to read exception words. Therefore it could suggest that it is the exception words creating the lower correlation in Year Two between the scaffolding errors and the use of lexical strategies. This would mean that the use of lexical strategies correlating with scaffolding errors is prevalent in consistent words and not the words with irregular GPC mappings. However, due to the relatively low number of errors made in Year Two (especially by time five) there was insufficient data to examine this by word type in the present study. This would require further examination using a larger sample in future research.

Overall, the pattern of reading errors shows that although in Study Three there were a larger number of scaffolding errors made, the data from Study Four showed that over time the children were more likely to make a scaffolding error when they read a word incorrectly. This gives further support for the idea that scaffolding errors are important in reading development and that they are intrinsically linked with future reading success. In terms of examining the self-reported strategies applied when the words were being read there were positive correlations found between the use of lexical strategies and scaffolding errors and the use of non-lexical strategies and initial errors.

9.4 Implications for education

Most typically developing readers build up a range of strategies and are therefore able to adaptively choose between them in order to suit the task (Siegler, 2002). This means that skilled readers who would ordinarily read via a lexical strategy can switch to using the non-lexical pathway for unfamiliar or non-words. However there are a range of different factors that can impact on strategy development within formal reading instruction.

Reading instruction itself could have an impact on the range of strategies that the children are able to use. Currently in the UK literacy is taught via the synthetic phonics method and this encourages the use of small phonological units and teaches children to manipulate individual sounds. Studies One, Two and Four have identified a low use of strategies involving the use of large phonological units (analogy) and this could be linked to the type of reading instruction received in school. The use of these large phonological units (using onset and rime) could allow easy access to words with a high rime unit frequency. Therefore teaching children how to work with both large and small phonological units could assist in the development of children's decoding skills. Previous research has found that the use of onset and rime can have positive impacts on reading ability. For example, Bowey (1995) found that the application of onset and rime could account for around 25% of the variance in predicting reading success. Goswami et al. (2003) also found that the English readers showed slower reaction times when a list of non-words contained targets that relied on either large or small phonological units. This suggested that children were assessing the type of word as a whole and making a decision about the type of phonological unit to use to read the word. These studies provide further support for the view that onset and rime (analogy) should be taught as an additional strategy for successful emergent reading. If the readers in the present studies had received this additional training it would be expected that there would have been higher use of analogy as a reading strategy.

The NLS states that phonics teaching can be used for children to build up a lexicon of words that can therefore be read by sight (Department for Education and Employment, 1998). This is inducing that children will learn to read these words by sight without specific instruction after being exposed to the words enough times for the formation of an orthographic representation. This assumption is supported by the self-teaching hypothesis stating that exposure to words can create sight-word reading (Share, 1999; 2004). Sight-word reading was also encouraged to be used for high frequency words under the NLS and children were introduced to a list of 100 high frequency words (alongside their phonics training). However, this list also included GPC regular words that were high frequency (e.g. 'up') and this was argued to be detracting from the phonics based teaching (Department for Education and Skills, 2003). Solity (2003) also presented the case that GPC regular words should not be taught as sight words as they can be learnt via the phonics approach. However, when learning irregular words it is important that children are taught these words using the look-and-say approach to create the orthographic representation for sight-word reading. The Rose review (2006) mentions that irregular words will require extra support in reading and different strategies, but there is little guidance in how to teach these words. In order to allow children to gain the use of both lexical and non-lexical strategies it is important that both phonics teaching is undertaken, but also the use of look-and-say to create a sight word lexicon. Whilst the findings from Study Four have found that children are able to switch to using a lexical strategy over time (particularly on these exception words) with specific instruction in look-and-say the children could be more confident in the use of this strategy.

Whilst phonics instruction forms a core basis for reading and provides access to all words following consistent GPC rules, it does not assist children in reading all types of words. The deep orthography of English means that children cannot simply rely upon the use of decoding alone. In order to allow the children to progress in reading all types of words it is important to teach them to develop a range of strategies for reading and to teach an understanding about how these can be applied.

One possible interpretation from the current findings is that children's understanding of strategies and how to apply them could be further scaffolded and supported by the use of self-reported strategy use within the classroom. One of the impacts of using self-reports is that they allow the child to understand the cognitive processes and take hold of their own learning. As illustrated in the current thesis, retrospective forms of self-reports are valid measures of capturing shifts in children's reading performance and this could be extended into the classroom setting in more structured manner. Teasley (1995) stated that explaining your processing could allow further learning to take place. Similarly, Rittle-Johnson (2006) found that asking children to produce a self-explanation of the concept that they were using in a mathematical equivalence task could improve their transfer of knowledge onto other tasks. More recently Rittle-Johnson, Saylor and Swygert (2008) found that explaining the process to another person (a parent in their study) provided a better transfer of skills than explaining it to themselves, or not using self-explanation. By asking children to provide a self-report and therefore a self-explanation of the process that they are using could allow them to become more aware of the strategies that are being used and therefore allow transfer to novel words. Being able to apply strategies to novel words is a very important process in learning to read.

Applying this self-explanation approach to children's reading does not need to simply focus on emergent reading. Plucker (2010) assessed a school using an intervention approach to encourage enthusiasm in reading in Ninth graders (14 – 15 years old). The approach taken by the school was to use a reflective approach to advanced reading strategies, rather than specifically teaching them. The school encouraged verbalisation of strategy use through the using of thinking aloud. The results of the intervention showed an increase of 10 points, compared to an average increase of four points of grade-level peers on a standardised reading measure. Whilst this study has described different levels of reading strategies (based on accessing information from descriptive text) it still showed support for this technique being used successfully at later stages of reading development.

9.5 Implications for future research

9.5.1 Methodological limitations and implications for future research

The cross-sectional approach was introduced into this thesis in order to provide a sample of how reading strategies are applied across both Year One and Year Two readers. However, in order to further this finding it would be useful to follow the same cohort of children through Year One and Year Two in order to see how individual children are continuing their strategy development. This would also allow a greater degree of the examination of individual differences and how this can impact on emergent reading.

One of the established issues with the use of repeated measures designs, particularly within educational research, is that there are often a number of participants that are unable to take part in all testing sessions. Study Four used this approach and across the five testing sessions there were six children who were absent from school and therefore missed one or more testing sessions. However there was still sufficient data to capture changes in reading trends over time. In future research a larger sample size would strengthen these findings.

Within the current research, strategy use was only considered using word recognition via a single word reading task. In order to further examine the impact that semantics and context can have on word reading it would be important to include a task with the words embedded into text. This would allow a comparison of the strategies found in the present study on a single word task with the range of strategies that could be identified from in-text reading, such as using the context to assist in reading the word. Oakhill and Garnham (1988) found that children's ability to change reading strategy was linked to the comprehension of the text.

Further examination is also needed to examine orthographic learning and see how children are learning to create full orthographic representations of words. Shahar-Yames and Share (2008) found that spelling had an impact on learning to create orthographic representations as it made the children pay attention to the GPC mappings. Similarly Farrington-Flint et al. 2009 found that strategy use in arithmetic or spelling could be linked to reading strategies. Further examination of this link with spelling strategies could be explored over time to see how these variables effect each other.

The implications for further research found from these methodological issues are that in order to provide a further investigation of strategy use over time a large scale study should be carried out. This study would use a large sample and follow the children individually throughout their emergent reading development applying both single word reading and in-text reading. This study could also consider pre-school (foundation) literacy skills and the impact that they have on early strategy development.

9.5.2 Application of present research to children with reading disorders

Another area of future research is the analysis of strategy use in children with reading disorders. The current thesis considered typically developing readers and therefore did not use any children currently receiving any intervention or children with a statement of reading disorder. However, screening for possible reading disorders was not carried out and this may have highlighted children that have not been identified as having a reading disorder. Study Two looked at different reading profiles through the use of a cluster analysis. This found a group of low ability, slow readers who were showing very low use of lexical strategies and fairly low success rates when applying the non-lexical route. This suggests that some of these children could be experiencing decoding issues typically associated with reading disorders, such as dyslexia. This pattern of findings could be better considered looking at the range of strategies displayed by children with a reading disorder compared with a reading age matched control and a chronological age matched control. It is widely established that children with dyslexia will use compensatory strategies in order to further their own reading development (Stanovich, 1980). Context is one compensatory strategy that can be applied in order to assist with reading development. Snowling (1990) also stated that if the child has a good visual memory then this affords an opportunity to learn via the sight word approach, however semantics can help if the visual memory skills are not strong enough. The use of compensatory strategies could be an interesting follow up to the examination of strategy use over time.

9.6 Chapter summary

This chapter has highlighted the key contributions of this research to our understanding of early reading. Firstly the validation of verbal self-reports as a measure of capturing strategy use in young children. The veridicality and reactivity measures showed that the children are able to accurately verbalise their cognitive processing. Secondly, the studies have highlighted that there was variability in strategy use and that the children were able to choose a strategy that is suitable for the task. This variability was shown over time in the cross-sectional longitudinal study and the effect of word specific characteristics of the words on strategy use were also examined. Finally, the reading error analysis looked at the change in types of reading errors over time, showing a shift towards making more scaffolding errors in the longitudinal study. The data provides additional support for more flexible accounts of reading development, such as Ehri's mediated phase model (1995; 1999; 2002) which suggest that children are able to flexibly move between phases in order to read the word presented in the most efficient and accurate manner. The educational implications from this research suggest that children need to be taught via a range of methods in order to assist in the development of a range of strategies. Teaching via the phonics approach is vital; however it cannot afford success across all word types. Children's reading strategies could be scaffolded through the use of self-reports (self explanation) in order to allow children to have conscious understanding of how these strategies work and when to apply them. The limitations of the current research and the implications for further research highlighted that in order to fully examine strategy use a much larger scale longitudinal study is required to track children's individual strategy change over time. Another interesting avenue of research would be to consider how the strategies applied by children with reading disorders differ from typically developing readers and whether there are additional compensatory strategies that can be identified.

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Appendix A

Glossary

Analogy – Analogy allows children to use similar spelling patterns in order to read novel words.

Analytic phonics – Refers to a type of phonological teaching where the child is taught how to use the onset and rime and therefore how to generalise to read other words.

Algorithmic domain – By definition, the algorithmic domain is a domain whereby employing a strategy correctly will guarantee the correct response on every occasion.

Concurrent self-report – Asking children to provide a self-report (explanation) of how they are reading the word during the task.

Connectionist Model – Parallel computerised models used to simulate the processes involved in reading.

Decoding – Refers to the process of breaking down a word into its constituent parts in order to attempt to read it.

Deep orthography – A writing system that does not have full correspondence between graphemes and phonemes. A shallow orthography on the other hand is a one-to-one relationship between graphemes and phonemes.

Dual Route Cascaded (DRC) model – A reading model which has two separate routes to go from print to speech. The lexical route uses pre-stored orthographic representations and the non-lexical route relies on using the phonological characteristics.

Emergent reading – The idea that as reading emerges the child is using their existing knowledge about language.

Grapheme-phoneme correspondences (GPC) – The relationship between the written grapheme and the spoken phoneme.

Irregular words (exception words) – Words with irregular grapheme to phoneme correspondences, i.e. pint.

Microgenetic – A microgenetic study uses a repeated measures design with short periods of time between each testing session. This is to attempt to capture developmental change.

National Literacy Strategy – The National Literacy Strategy (NLS) was launched in 1998 and gave a prescriptive lesson on literacy to be taught for an hour every day. This involved a 30 minutes whole class activity, followed by ability appropriate group work and ending with a plenary.

Non-lexical – Using the phonological units to read the word.

Non-words – Made-up words which can be used to identify how children are decoding unfamiliar words. Pseudo-words are also made-up words, but they follow the same orthographic rules of the appropriate language.

Orthography – Is a standardised way of using a specific writing system.

Phonics – A method of teaching children to read using phonological units. This can take on the form of analytic phonics (using the onset and rime) or synthetic phonics (using individual phonemes).

Phonological awareness – Refers to an awareness of the phonological structure of spoken words. There has been a lot of research interested in the link between early phonological awareness and later reading ability.

Psycholinguistic grain size – States that the consistency of the language being taught can inform whether children are able to best apply a small or large phonological unit. Therefore, when learning to read English the smaller grain size is less useful because of the inconsistency in grapheme to phoneme correspondences.

Phoneme – The smallest unit of sound in language.

Reactivity – Reactivity is looking at whether asking children to give a self-report of strategy use has an impact on the response given, such as the accuracy.

Receptive vocabulary – Words which are known well enough to be understood. The British Picture Vocabulary Scales (BPVS) which measure receptive vocabulary asks the children to show the picture that matches the word said by the researcher.

Retrieval – This is the process of retrieving the word directly from memory. Ehri term's this process 'sight-word reading.' In terms of the dual route model this refers to using the lexical route.

Retrospective self-report – Asking the children to give an explanation of how they read the word after each word has been read.

Rhyme – A word which sounds similar to another due to sharing identical or at similar medial and final phonemes in the final syllable. Due to the deep orthography in English words can rhyme without sharing a similar orthography (e.g. Suite and Meat).

Rime - A rime is the part of a syllable which consists of its vowel and any consonant sounds that come after it. An example of the rime in the word 'Cat' is 'at' and therefore the onset is the consonant 'C'.

Scaffolding errors – An error made in reading where the initial and final phonemes of the target word are retained.

Sight word reading – The term used by Ehri to describe reading via retrieval from memory. Other terminology may include retrieval, lexical access or word recognition.

Synthetic phonics – Is a method of teaching children to read using the individual sounds in the words and blending them together. In this method children are first taught all of the phonemes in the language.

Unique words – Words which have consistent grapheme – phoneme correspondences, but have fewer phonological neighbours and therefore more unique rime units.

Veridicality - Veridicality looks at how truthful the self-report is and how accurately it is reflecting the strategy use.

Word recognition – This is another term explaining how words are read 'by sight'. This is how adults and skilled readers will read a known word.

Appendix B

List of Word Items Used in the Experimental Single-Word Reading Task (frequency per million) taken from Children's Printed Word Database (Masterson et al. 2003).

Four Letter words		**Five Letter words**	
Word	**Frequency**	**Word**	**Frequency**
pram	20	groom	20
ring	76	chart	28
join	80	flash	44
glow	123	phone	56
hood	183	storm	151
bath	367	brick	303
dark	542	still	721
long	1167	round	825
make	1817	these	972
came	1932	where	1498

Six Letter words		**Seven Letter words**	
Word	**Frequency**	**Word**	**Frequency**
manage	20	forever	20
carpet	40	between	64
stolen	56	million	76
rescue	88	reading	92
notice	96	quickly	163
picked	311	kitchen	307
garden	677	morning	490
wanted	1243	because	566
school	1597	laughed	625
people	1988	shouted	888

Appendix C

Word list containing words with manipulated rime unit frequency (taken from Nation, 1997)

Consistent		Exception		Unique	
Word	**Frequency**	**Word**	**Frequency**	**Word**	**Frequency**
white	441	watch	300	waist	3
grab	30	glove	3	gulf	N/A
blade	22	broad	5	burnt	19
truck	59	tough	27	tenth	N/A
sock	57	swan	111	size	89
dice	14	dove	3	desk	22
fast	660	flood	14	film	32
skate	14	swamp	16	scalp	N/A
gift	41	goal	57	gulp	38
hate	41	have	3746	hawk	N/A
nail	8	none	62	next	828
thank	408	thief	41	tribe	22
file	3	foot	135	fern	5
belt	19	bowl	54	bulb	11
clock	68	coach	8	curve	8

N.B Although there are variations in the Frequency per million taken from the Children's Printed Word Database this word list has been used in previous studies in spelling (c.f. Nation, 1997; Farrington-Flint et al., 2008b) and the teachers in the schools thought that the children would be aware of the words due to using 'real books' as well as reading schemes.

Appendix D

Item analysis based on word list and data from Study One.

Four Letter words		**Five Letter words**	
Word	**% Accurate**	**Word**	**% Accurate**
pram	73.33	groom	81.67
ring	90.00	chart	70.00
join	65.00	flash	83.33
glow	85.00	phone	61.67
hood	63.33	storm	86.67
bath	86.67	brick	81.67
dark	71.67	still	88.33
long	86.67	round	63.33
make	80.00	these	65.00
came	80.00	where	78.33
Mean	78.17	**Mean**	76.00

Six Letter words		**Seven Letter words**	
Word	**% Accurate**	**Word**	**% Accurate**
manage	40.00	forever	46.67
carpet	70.00	between	70.00
stolen	58.33	million	48.33
rescue	51.67	reading	75.00
notice	53.33	quickly	70.00
picked	71.67	kitchen	76.67
garden	71.67	morning	66.67
wanted	75.00	because	83.33
school	86.67	laughed	53.33
people	78.33	shouted	61.67
Mean	65.67	**Mean**	65.17

Appendix E

Item analysis based on word list and data from Study Two.

Consistent		Exception		Unique	
Word	**% Accurate**	**Word**	**% Accurate**	**Word**	**% Accurate**
white	45.90	watch	44.26	waist	40.98
grab	62.30	glove	37.70	gulf	42.62
blade	37.70	broad	21.31	burnt	45.90
truck	63.93	tough	19.67	tenth	59.02
sock	67.21	swan	26.23	size	29.51
dice	32.79	dove	47.54	desk	60.66
fast	78.69	flood	31.15	film	63.93
skate	31.15	swamp	36.07	scalp	36.07
gift	68.85	goal	42.62	gulp	45.90
hate	36.07	have	72.13	hawk	31.15
nail	49.18	none	40.98	next	77.05
thank	70.49	thief	21.31	tribe	22.95
file	34.43	foot	50.82	fern	55.74
belt	65.57	bowl	32.79	bulb	26.23
clock	67.21	coach	40.98	curve	31.15
Mean	54.10	**Mean**	37.16	**Mean**	45.03

Appendix F

Validation of verbal self-reports of strategy use on word list used in Study Two

There was a further validation of strategy use in Study Two (using the word list with manipulated rime unit frequencies.

Table F.1 Correlations among Reported Strategy Use and Observed Behaviour for Study Two

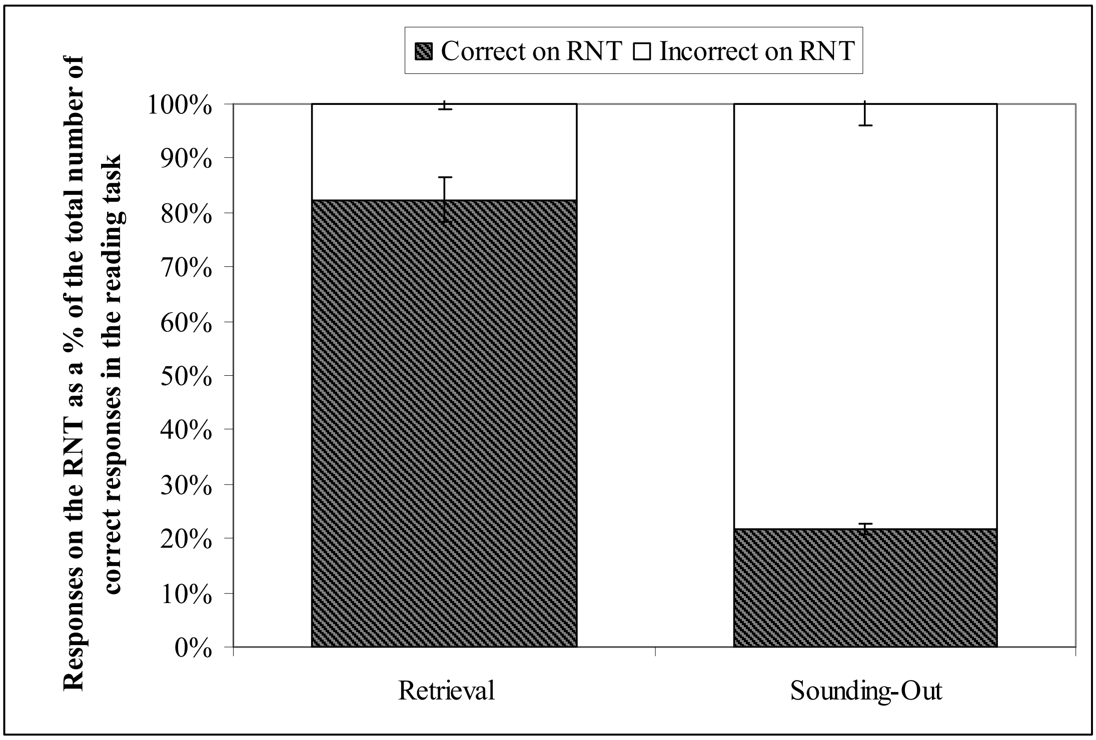
Self-Reported Strategy Use	Observed Overt Behaviour			
	Short solution time, no behaviour	Sounding-out behaviour	Mixed behaviour	No overt Behaviour
Retrieval	**.723****	-.701**	-.186**	**.230****
Sounding out	-.567**	**.967****	-.242**	-.438**
Mixed	-.186**	-.241**	**.977****	-.146**

Note: Short response time based on a median spilt at 2000 ms.
** = p<.05; ** = p<.01*

Correlations showed that there was a strong positive correlation between self-reported use of sounding-out and overt behaviour (.967, p <0.01). More importantly, trials in which children reported using lexical retrieval strategy were significantly correlated with no observable signs of behaviour on task and a short reaction time (.723, p < 0.01).

To further validate the use of retrieval the data from the rapid naming task was analysed. In the rapid naming task the same words as in the experimental task were displayed on the screen for 500 ms. Under these conditions the use of any explicit non-lexical-based strategies (e.g., phonological decoding or making analogies) should be prohibited given that the short time frame should result in providing an incorrect pronunciation. When comparing the results we found that if a child reported the use of retrieval to gain a correct answer on the main task then 82.25% also correctly identified the word on the rapid naming task, implying that the children's reports of using lexical (retrieval-based) strategies in the main experimental task remained accurate.

Figure F.1
Correct and incorrect responses on the rapid naming task (RNT) as a percentage of correct responses on the main experimental task



These data find that the retrospective verbal self-reports of strategy use were an accurate representation of how the children were reading the words on the word list used in Study Two (appendix C). This finding supports the data in Study One.