Can Poor Readers Visually Recognize Words They Are Unable to Read?

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Abstract

The ability to learn new reading vocabulary was assessed in 30 grade 3 poor readers reading approximately one to two years below grade level; the results of the assessment were compared to the performance abilities of 33 normal readers in grade 3 as obtained from an earlier study that employed the same approach and stimuli. The purpose of the study was to examine the strategies employed by poor readers in the acquisition of new reading vocabulary. Students were randomly assigned to either a treatment group (Mixed Phonics Explicit), or to a control group (Phonics Implicit). Subjects in the Mixed Phonics Explicit groups received explicit letter/sound correspondence training. Subjects in the Phonics Implicit group were asked to re-read the presented pseudo-words, receiving corrective feedback when necessary. The stimuli on which the subjects were trained involved a list of six pseudo-words presented in sentences as surnames. The training involved a teaching and test format on each trial for a total of six trials or until criterion had been reached. The results suggested that both normal and poor readers engage in visual learning and verbal coding when acquiring new reading vocabulary. However, poor readers appear to engage in less verbal coding than normal readers. Between group comparisons showed no difference between poor and normal readers in trials and errors to criterion in the visual recognition memory measure. However, normal readers performed significantly better in reading their visual recognition choices.
Acknowledgements

I have discovered that the field of reading research is varied and extends into a variety of other academic disciplines. I see art as one of these disciplines.

Like art, reading research is far more complex and intellectual a language than is often realized. The language of artistic expression is accessed through knowledge extracted from print. Similarly, to become literate in a specific field requires far more than the mere ability to decode these abstract symbols. Word recognition alone is no simple construct and involves many cognitive processes at work. It is a field deserving of much attention.

In this respect, my thanks in the first instance are directed to Brock University, in St. Catharines Ontario, Canada. It was here as an undergraduate honours student that my interest in art was cultivated. It was also here that my supervisor, Dr. James Wagner, of the Faculty of Education introduced me to the field of reading research. His professional collaboration and enthusiasm for my work has been appreciated.

Thanks are also appropriately due to Special Services Education at the Lincoln County Board, and foremosly to the young participants without whom this study could not have been carried out. In this respect, I dedicate the work to them, along with the best of wishes for their future success.

On a lighter note, a number of individuals contributed in a less formal, and less academic way. There are far too many to name here, but they know who they are. Thank you very much.

Finally, noted thanks and appreciation go to my immediate family, mostly my parents, Dr. John and Mrs. Ellen McNeil, for their ongoing encouragement and support, without which this work may not have been completed.

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CHAPTER ONE: THE PROBLEM

Introduction to the Study

Word recognition is an area of great difficulty for almost all problem readers. It is a weakness that emerges early in learning disabled individuals and continues on into adulthood (Vellutino, 1979; Allington, 1984; Gough & Tunmer, 1986). Consequently, in recent years attention to the processes involved in word identification has predominated in many areas within the domain of cognitive psychology. It has been suggested that reading development is connected to proficiency in language related tasks (Vellutino, 1979; Swanson, 1983, 1984; Stanovich, 1986; Vellutino and Scanlon, 1987). Yet, although significant gains have been made in the area of reading and language relationships, there has been a substantial lack of focus regarding which elements of language are most associated with encountered difficulties or failure in reading (Stanovich, 1986). Moreover, although the investigation of this relationship has led to the discovery of many factors that contribute to early reading ability, few have been truly instrumental in explaining the gap that exists between inefficiency in language processing tasks and the difficulty which many of these same children encounter in learning to read (Ball & Blachman, 1991). Rather, in many instances noted deficiencies in the poor reader are exploited for the purpose of reporting what is most predictive of early reading success, and do not address the poor reader and treatment-oriented aims.

There are, however, some occasions in which poor readers are shown not to be deficient in a particular processing skill. The finding that poor readers have a verbal coding deficit and that the visual processing ability of these readers is normal (Vellutino, 1979) is one such instance.
Earlier investigations most often cited visual deficiencies as the specific cause of reading disability, as manifested in the perception of written symbols as reversed (Orton, 1925, 1937), in deficiencies in visual-motor integration (Bender, 1956; Drew, 1956), and in the reader's experiencing of after-images (Stanley & Hall, 1973). Although earlier explanations of reading disability differ in subtle degrees, they are similar in the respect that impairments in visual processes were posited as causes of such disability (Orton, 1937; Bender, 1957, 1975). The above studies are cited in Vellutino, (1979).

More recent findings view deficiencies in visual-verbal learning as the proximal cause of reading disability, a view that contrasts with what had formerly been perceived (Vellutino, 1979; Swanson, 1983, 1984; Stanovich, 1986; Vellutino & Scanlon, 1987). Thus, the poor reader's difficulty in developing efficiency in skilled word identification has come to be regarded as consequential to difficulties encountered in acquiring and accessing the verbal correlates of visual stimuli (Vellutino, 1979).

Such findings provided the impetus to consider the possibility that the poor reader may favour visual code formation when learning new reading words and that this might result in the development of normal or better visual recognition memories for these words relative to normal readers. Thus, a primary interest of this study was to look at poor and normal readers' visual coding operations independent of their verbal coding operations, yet on the same stimuli. In this, the measure of visual coding adopted the form of a forced choice visual recognition memory task, and the verbal coding was measured by asking subjects to read this recognition memory choice. This study further aimed to assist educational practice by investigating whether there would be effects on both visual and verbal coding of the new reading words as a result of the employment of word family
null
group stimuli and an explicit phonics training condition. The primary aim here was to consider how this explicit training may affect the reader's employment of different strategies, and his/her rate of visual and verbal acquisition for new reading words.

The purpose of this research, therefore, was to examine the types of strategies employed by poor and normal readers in the acquisition of new reading vocabulary with an aim to evaluate the hypothesis that poor readers have a verbal coding deficit and that their visual processing ability is normal. Although numerous factors have been noted to contribute to the overall act of reading, the particular focus of this study was on word acquisition and the processing strategies employed by these readers as new words are learned. Beyond what is required for the beginning reader's movement into reading (Gough & Hillinger, 1980; Ehri, 1987; Ehri & Wilce, 1985), the aim of this study was to explore differences in the extent to which visual and verbal processes are employed by poor and normal readers and, moreover, to investigate whether learning in the initial stages of acquisition is predominately visual or verbal, and at what stage in the acquisition process these processes might mutually assist word identification. Thus, a fundamental methodological aim was to investigate word learning performance over a number of trials in order to map this development. In addition, the types of errors made by children with learning disabilities was intended to account for word recognition processes that are both common and different among normal and poor readers.

Rationale

In spite of the fact that numerous variables have been found to contribute to the overall process in skilled reading (Perfetti, 1985), studies continue to be dominated by
approaches in which a laboratory task or psychometric measure that is believed to be central to skilled reading performance is the basis from which correlational accounts of failure in reading are sought. Consequently, the literature is informative in the respect that we learn a great deal about differences in the levels of attainment for these readers, but much less about the differences in their acquisition strategies. Given the lack of studies of children in various stages of progress in word recognition acquisition (Perfetti, 1992), there is need for investigations that aim to understand the acquisition process as a set of theoretically distinct, empirically separable processes (Hoover & Tunmer, 1993). This, of course, does not imply that the processes are distinct in the mind of the learner or that they should lead to separated or isolated constituent skill-based instruction, however. Further, although it has been suggested that statistically large and reliable group differences can be observed in tasks which involve the repetition of stimulus items or repeated exposures, these studies have largely been confined to the investigation of memory processes (Feustal, Salasoo & Shiffrin, 1983, 1985; Peynircioglu, 1990).

Closely connected is the ensuing lack of certain critical details from which a theory of acquisition can be postulated. For example, studies in which the attempt has been made to account for processes employed by the reader make claims about how these processes differ at various stages of acquisition and development (Frith, 1985; Seymour & Macgregor, 1984), without considering the differences in the teaching methods to which these subjects have been exposed (Thompson & Johnston, 1993). Investigations as such do not separate the processes involved in acquisition, nor those required in the reading of words, but only confirm that differences in the levels of attainment have been observed. Thus, existing models of word acquisition are limited in their description of
which processes are applied, to what degree, and how the employment of these processes may be influenced by different types of instruction.

Finally, although a substantial number of investigations have evaluated the differences between the performances of poor and normal readers on visual and verbal processing tasks, none has included a word identification task from which a measure for both visual and verbal responses derive from the same stimulus. Moreover, these measures have involved phonological coding and phonemic segmentation tasks aimed at demonstrating differences in the verbal coding abilities of normal and poor readers (Vellutino & Scanlon, 1987), labelled and non-labelled abstract shaped stimuli (Swanson, 1987), and digits (Vellutino, 1979), as a means of assessing the degree to which these stimuli were verbally coded by these ability groups: other measures have included simplified phonetic spellings whose letters corresponded to sounds (e.g., JRF for giraffe), and visual spellings (e.g., XGST for balloon) in which letters bore no correspondence to sounds but were more distinctive visually as a means of assessing whether the initial movement into reading is visual or phonetic (Ehri & Wilce, 1985). Furthermore, as these ‘words’ appeared in isolation they lacked context through which a reasonable likeness to the reading process could be modelled. In sum, although insightful, unfortunately there has not been an application of tasks in which readers are evaluated on their ability to visually identify a target word that has been presented in the context of a meaningful sentence, and then provide a verbal (reading) response for that same word. Although there is ample evidence to support the contention that visual and verbal systems are unique processes involved in word identification, there is little in the way of suggesting which process predominates in the earliest stages of acquisition, and for which type of reader.
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Yet, above all, perhaps the most important question that can be asked of sequentially and/or descriptively-based acquisition models is which teaching method can best foster the development of skilled word recognition. Then and only then can one begin to answer the types of questions that researchers continue to ask. Is phonics or whole word teaching the better approach in reading instruction? Should letter names be taught? What are the prerequisite skills for learning how to read? Clearly, these questions are of critical importance, but the research on them seems to have had little contact with acquisition models and hence has had limited impact on fundamental theoretical issues (Perfetti, 1992).

Thus, overall it was felt that an approach which focused on the learning and the cumulative phases through which the reader progresses toward skilled word recognition would be of value. Put another way, a move beyond the more traditional correlational designs towards a detailed study of word acquisition processes might better enable the postulation of an account for failure to acquire new reading vocabulary. Thus, are reading disabled children simply slower to acquire new reading words or are they reading words differently (i.e., by which processes does a word come to be learned, stored, and accessed by the poor reader)? To examine these phenomena it was decided that a replication study of a previously employed word acquisition learning task for normal readers would yield comparative insights regarding differences in the reading response patterns of poor readers.

Problem Statement

The purpose of this research was to examine the strategies employed by poor readers in the recognition and acquisition of new reading vocabulary. The locus of the
investigation stems from the finding that poor readers lack facility in verbally coding visual stimuli (Perfetti, 1992; Vellutino & Scanlon, 1982, 1987). Thus, it was reasoned that poor readers would consequently develop only partial or weak associations between the verbal (auditory) and visual attributes of new words. Moreover, these difficulties could prove detrimental to the process of forming sufficiently accurate phonological representations for new reading words. In sum, the demands resulting from the cognitive load associated with forming auditory-visual associations may preclude the poor reader’s ability to either intentionally or automatically code words in this manner. Consequently, the comparative ease of constructing a visual code might become an unconscious default strategy choice for the poor reader (Hulme & Mackenzie, 1992).

This reasoning led to the hypothesis that the poor reader might exhibit better visual recognition memory performance for new reading words relative to normal readers, especially in the formative stages of the acquisition process. However, the employment of a purely visual approach to the learning of words would preclude the poor reader’s development and subsequent availability of a verbal (reading) response for visual stimuli. As the normal reader was expected to concentrate on establishing a verbal or phonological representation for visual stimuli in the initial stages of acquisition, then this might be at the expense of developing a visual code for these stimuli. Thus, in the initial stages of the acquisition process the normal reader would be more prone to making visual recognition memory errors. Overall, the type of available response, visual or verbal, becomes contingent upon the nature of the coding operations that are initially employed to form a representation of the to-be-read word. Put another way, retrieval of a representation, whether visual or verbal, can only be accomplished if there is an
established visual or verbal code for the presented item being reviewed. Consequently, if normal and poor readers differ in the types of coding strategies they employ to represent visual stimuli, then these differences should influence item availability in visual and verbal recognition tasks. Taken together these possibilities suggested a number of general hypotheses. These are as follows:

1. It seemed likely that the difficulties poor readers have verbally coding visual stimuli might be due to a general verbal deficit, and that part of this general verbal deficit might consist of poorly established auditory representations for words (Perfetti, 1985, 1991). This suggested that poor readers might take longer to establish lexical entries in auditory memory when learning new words. In other words, if poor readers had to learn to read a new name of a person, they might take longer than normal readers to learn the name as an auditory representation, independent of learning to read it. Thus, if asked to recall the name on a free recall test, the poor readers would be expected to do less well than their normal counterparts. This would be important as it would point to the possibility that lexicalization may not always be complete when the poor reader is attempting to learn a new word.

2. As learning to read a word involves the learning of a word’s visual features and the association of these with a corresponding auditory representation, it seemed likely that a verbal coding deficit would not only reflect in the poor reader’s difficulty in recalling the words’ names, but also in the reading of them. In other words, a verbal coding deficit should result in difficulties in verbal code retrieval when a visual stimulus is presented. This type of problem would show itself in inaccurate and/or slow name retrieval in whole-word reading and possibly in the use of indirect retrieval strategies such as
phonics. Thus, the word recognition difficulties of poor readers should reflect in longer times (more trials to criterion) in learning to associate the verbal code of a word with its spelling relative to normal readers.

3. Further, the proposed verbal deficit of poor readers suggests that these readers might favour visual coding over verbal code mapping during word learning. In other words, although the poor reader would attempt to engage in both verbal code mapping and visual processing when learning a new word, his/her relatively intact visual processing abilities would result in more visual learning than verbal mapping. Thus, the poor reader's visual recognition memory of new reading words may initially exceed his/her ability to read them. The normal reader, on the other hand, may give equal attention to both of these processes or may favour verbal mapping. The latter possibility suggests that the normal reader would be able to read words he/she could not visually recognize.

4. In spite of the poor reader's difficulty in verbally coding visual stimuli, it would nevertheless be expected that a phonics training condition and the employment of word family stimuli would assist performance in visual and verbal coding for both the poor and normal reader alike. The additional attention given to the interior components of word family stimuli in a phonics training condition should result in the formation of more accurate or complete visual and verbal representations. In addition, the repetition of the spelling patterns common to a word family would be expected to facilitate learning regardless of whether or not explicit phonics training was employed. This might be manifested in fewer trials and errors to criterion in both normal and poor readers on both reading and visual recognition measures.
CHAPTER TWO: REVIEW OF RELATED LITERATURE

Introduction

In the cognitive view, reading is shown not to be a simple, effortless endeavour, but rather a complex series of interrelated component processes (Perfetti, 1985). These processes include the recognition of words and the connection of these to stored concepts; the development of meaning from grammatical constructs (phrases, clauses, sentences); connecting text; relating what has been learned or what is already known; etc. Thus, for comprehension to occur, these mental operations must take place, and many simultaneously. However, it has become evident that human information-processing capacity is limited and that working memory is taxed in the attempt to concurrently process these many elements. Thus, in order to facilitate comprehension many of these underlying processes have to be developed and exercised to the point of automaticity or profound efficiency (Perfetti, 1985). Word recognition is only one of the lower-level processes that must be mastered to this level of efficiency; otherwise, attention is drawn from the higher-level comprehension processes.

However, without denying the existence of these higher level processes and their contributions to the overall act of reading, in the simplest of views reading is said to comprise only two component processes: one that permits language to be identified by means of a graphic representation, and another which permits language to be comprehended (Hoover & Tunmer, 1993). Although the former view is critical to research's understanding of such a complex organization of processes, at the most basic level the latter view is critical to enabling the understanding of reading as a hierarchical system of isolable, yet mutually interdependent component processes. Thus, there is much
to be gained if we treat decoding as the proximal cause of reading failure (Stanovich, 1992). Even more recently the additive nature of the underlying processes of reading as proposed by Perfetti (1985) has come full circle to again include these rudimentary components in a definition of reading.

Without implying that literacy as a whole is solely connected to facility in word recognition, Gough, Juel, & Griffith (1992) purport that the acquisition of literacy is primarily the acquisition of the ability to recognize words. From here a whole number of integrative processes at various levels occur in order for the reader to derive meaning from what has been read. The point to be made is that as readers must also go through a similar set of processes when listening, for all intents and purposes literacy is the product of understanding and decoding (Gough, Juel, & Griffith, 1992). Thus, in this view reading can be understood as the product of decoding and comprehension where each variable ranges from '0' as an absolute value, to '1' (mastery), (i.e., \( R = D \times C \)) (Gough & Tunmer, 1986; Hoover & Gough, 1990; Tunmer & Hoover, 1992). Here, of course, comprehension does not refer to reading comprehension, but rather linguistic comprehension.

The view that reading largely derives from spoken language and listening in general is firmly established (Vellutino, 1979; Vellutino & Scanlon, 1987; Stanovich, 1986; Tunmer & Hoover, 1992). Likewise, there is compelling evidence to suggest that decoding and linguistic comprehension are positively correlated (Hoover & Gough, 1990; Juel, Griffith, & Gough, 1986; Stanovich, 1986). Thus, in the final analysis the two component view of reading is of great benefit to a discussion concerning cognitive elements that are directly connected to efficiency in reading and reading comprehension.
Simply said, notwithstanding the given intricacies of such an act, reading is divisible into two distinct parts; one being word recognition, and the other linguistic comprehension.

In these regards the point must be made that reading comprehension cannot occur, or at least will be constrained by limitations in either of these two domains. For example, the reading comprehension potential in a grade 2 student who demonstrates facility in oral discourse comprehension at a grade 4 level will be restricted by inadequacies to recognize printed words from a grade 1 passage. Similarly, one's reading will not benefit from the ability to read text at a grade 4 level, should one only be capable of understanding spoken language at a grade two level. And although the witnessing of the latter is comparatively rare, the point to be made is that difficulties in reading do not exist in a vacuum, and can therefore exist in the absence of difficulties in other aspects of cognitive functioning (Vellutino, 1979).

The above examples and considerations are meant to serve three purposes. First, while maintaining that decoding and reading comprehension cannot exist in the absence of linguistic comprehension, and likewise that reading comprehension cannot proceed without efficiency in decoding, one can begin to appreciate not only the complexity of the overall act of reading, but also how the contribution made by each of these two processes is critical to this act. Second, for the purpose of understanding the contributions made by each process, methodology (as will be addressed in the section which follows) is a vital determinant of how these processes can be viewed both independent of one another, and of the reading process as a whole. Third, the example is intended to establish a framework for understanding that decoding or word recognition can further be divided into the two respective components of visual and verbal processing. Thus, as reading
comprehension cannot occur in the absence of efficiency in decoding, decoding and reading comprehension cannot proceed without efficiency in both the visual and verbal domains, which above all precedes decoding itself. Not unlike the staged example, this relationship is also extremely fine-grained. To this end, despite gains being made in one component, no or little improvement in reading will occur if skill in the other component is nil or impaired (Gough & Tunmer, 1986).

The ability to separate a set of mental operations or cognitive functions is critical to a review of distinct processing systems. Referred to by some as decomposition (Gough & Tunmer, 1986), and as independent process analysis by others (Calfee & Spector, 1981), such dissociation is crucial to the understanding of the components of reading as theoretically distinct and empirically isolable constituents (Hoover & Tunmer, 1993).

In such analyses there are a number of hierarchical aims which have been proposed (Calfee & Spector, 1981; Gough & Tunmer, 1986; Carr, Brown, Vavrus & Evans, 1990). First, the cognitive processes involved in the performance of the task must be identified. Second, the relationship and the involvement of information between these processes are to be understood. Third, how these systems are governed in relation to stimulus input, strategies, and capability with the demands of task proficiency must be identified. Fourth, the system’s parameters, (i.e., individual processes, its structure, and its control) are to be fully realized, as variation between two components is the source of individual differences (Carr et al., 1990). With these aims in mind, decomposition begins with the identification of the systems involved.

Therefore, as any effort to ascertain whether performance in a task involves the application of different cognitive processes, the approach must derive from a
methodology through which these proposed differences can truly be said to belong to separate systems. Thus, if there are differences between the poor and normal reader's word acquisition strategies, and if the learning processes which underlie acquisition in these readers differ, some form of dissociation between the relevant processes must be made.

In this regard, more than one system of representation, such as visual and verbal codes, is employed in learning a word, thus a subsequent requirement to recognize, identify, or confirm this information should involve the retrieval of both representational forms (Kirsner, 1994). A printed word can trigger the associated auditory response for that word, and the same word when spoken may produce a visual memory of its printed form. This would suggest that two distinct processes or stages are involved in naming, word identification, or lexical decision. Although the prior reading of a word assists its subsequent visual recognition, as the hearing of a word enhances the probability of auditory recognition, the finding that cross-modal occurrences are minimal led to the conclusion that the input lexicon comprises independent auditory and visual input systems (Morton, 1979; Murrell & Morton, 1974), as cited by Ellis (1994). Further, the conceptualization of visual and verbal coding systems as separate processes is strongly supported by the suggestion that these two systems are functionally independent in poor readers (Nelson & Brooks, 1973; Swanson, 1984).

In relation to this research, there is an aim to substantiate this claim through the employment of a forced-choice visual recognition memory identification task, for which the reader will be asked to provide a reading response. Thus, at the requirement of providing both a visual and verbal response to the same stimulus under separate response
conditions, the poor reader's difficulty in the provision of a verbal response to the visual
stimulus will not only support the verbal coding deficit hypothesis, but will also assist to
substantiate findings that regard visual and verbal coding systems as independent in the
poor reader.

In short, if the visual processes of the poor reader are intact, and therein show no
differences in the comparison to normal readers, difficulty in name retrieval for visual
stimuli as manifested in incorrect reading responses to a visual recognition memory
choice should point to non-integrative or poorly coordinated visual and verbal coding
systems. Clearly, the poor reader's verbal deficiencies will adversely affect the probability
of recall when the available code is only partially intact. In contrast, should a mutually
interdependent coding system for normal readers be intact, the probability of name-
retrieval for visual recognition memory choices based on visual-verbal associations
should be greater. Thus, given the assumption that reading processes hinge upon the
transference of visual information into a verbal or symbolic system (Swanson, 1987),
deficiencies in the language domain could result in an over-reliance on the other.
Consequently, central to the notion that poor readers might develop better visual
recognition memories for new reading words relative to normal readers is the suggestion
that poor readers have functionally independent visual and verbal coding systems, or at
best fail to employ multiple codes in additive fashion (Swanson, 1984, 1987).
Acquisition

Although theories of reading development differ on the issue of whether the beginning reader's movement into reading is characterized by the establishment of connections that are visual or phonetic, semantic or phonological, arbitrary or systematic (Gough & Hillinger, 1980; Ehri & Wilce, 1985; Vellutino & Scanlon, 1987; Gough & Hillinger, 1980), they nonetheless appear to agree on the basic requirements of skilled reading, and moreover, on the general sequence or progression of learning towards this proficiency.

On these general grounds, it has been proposed that the initial stages of word acquisition involve code learning (Gough & Hillinger, 1980), cue learning (Ehri, 1987), or paired-associate learning during which the recognition of words is largely characterized by the reader's selection of a distinctive visual feature of the stimulus which may arbitrarily (Gough & Hillinger, 1980), or systematically (Ehri & Wilce, 1985) correspond with the item's name. That the learning of a word's name and the ability to retain this in memory is seen as critical to word learning is a view which is consistent with a number of acquisition theories (Swanson, 1984; Paivio, 1978; Jorm & Share, 1983; Vellutino & Scanlon, 1982). This paired-associate learning begins with an individual's first experience with a word's visual form and accompanying pronunciation provided by a teacher, parent, or other. Some structural attribute or visual feature is then associated with the word and subsequently stored in memory. When this word, or another word that is visually similar, is next encountered the stored association serves as a memory source for subsequent recognition. However, it should also be noted that this knowledge or memory source comprises information from the print stimulus and the
association between this information and the lexical, phonological, and semantic representations (Thompson & Fletcher-Flinn, 1993; Share, 1995). Moreover, errors in reading that are corrected by an external agent are more than just provided responses, as the learner is made aware of both the sound and meaning of the word in relation to its printed form (Share, 1995).

An example of the reader’s association of a word to a selected visual attribute would be the recognition of the word flower based on the reader’s perception that the [f] is somewhat stem-like, or that the [flow] component of the word is much like the head of a flower. However, when presented with the word ‘flown’ or ‘tower’ the relative similarities to the word ‘flower’ may result in an incorrect response, and another perhaps more distinguishing visual characteristic will be assigned to the new reading word.

The claim has also been made, however, that initially the reader may unconsciously choose to base such recognition on the visual coding of the first letter of the word only (Gough & Hillinger, 1980; Frith, 1985). Thus, when a new word which shares the same first letter is encountered, further discrimination may be sought by adding the word’s second letter to the visual memory form (Wagner, 1985). Consequently, it may be that during the retention of a word’s name in working memory, the attachment of additional visual information to the auditory representation is more attentionally demanding than simply coding the word visually (Wagner, 1985). This view is also consistent with others regarding the possibility of increased processing demand in acquisition tasks when the visual features of a word are differentially connected to the corresponding pronunciation (La Berge & Samuels, 1974).
Nevertheless, there does not seem to be disagreement over the premise that the initial stages in acquisition are characterized by a type of learning in which association at some level is visually-based. Additionally, researchers seem to agree that this system of recognition (which is by some considered to be sight word reading) can assist the development of a reading vocabulary. However, beyond the earliest stages of acquisition, further development is largely precluded by this system’s limitations in enabling finer and more subtle discriminations to be made between words that are visually similar (Gough & Hillinger, 1980; Ehri & Wilce, 1985; Share, 1995). Moreover, (as cited in Share, 1995) it is estimated that the average fifth grade reader encounters approximately 10,000 new words per year (Nagy & Herman, 1987), and thus, the claim is made that acquisition enabled by direct instruction at the whole word level will eventually fail to support the increased demands of the growing number of words to be recognized. According to Gough & Hillinger (1980) the next stage, cipher learning, begins when the reader’s knowledge of letter-sound correspondences is fairly accomplished, and it is this knowledge that the reader applies to read words.

In contrast to this two-staged model, the theory espoused by Ehri & Wilce (1985) differs not on the issue of seeing a phonetic analytic system as underlying effective printed word learning, but on when the system begins to operate and the amount of information that is required by the reader. In this, it is suggested that the overall process can begin with only partial knowledge, as incomplete deciphering skills will be supported by memories for spelling-pronunciation associations. Thus, in this theory it is letter-sound processing which characterizes what beginning readers do at the outset of learning to read. Accordingly, print-sound associations need only to be recognized and not generated
by the learner (Ehri & Wilce, 1985). As a result, recognition in the initial stages of acquisition may derive from knowing only partial letter-sound correspondences acquired through exposure to letter names. For example, seeing and hearing the word ‘jail’ may result in the association of the sounds of the word’s boundary letters j and l, with the word’s pronunciation (Ehri & Wilce, 1985). As a complete knowledge of letter-sound correspondences has not yet been formed, this stage mainly comprises associations being made by virtue of consonant letters and their constituent sounds to remember spellings (Ehri & Wilce, 1985), and not the more complex and variable vowel-letter sound associations (Venezky, 1970).

The entire process of making associations between consonant letters and their constituent sounds to remember spellings is viewed as reciprocal in nature, thus as children’s knowledge of letter-sound connections increases, so too does their analysis of spellings as symbols for pronunciations, consequently enabling more letter-sound associations in spellings to be processed and remembered. In this regard, the claim is made that this type of phonetic processing not only differs from a more advanced stage of recoding where spellings are sounded out and blended, but further characterizes what children do in the initial stages of learning to read words reliably (Ehri & Wilce, 1985). Moreover, it is premised that phonetic processing which entails the recognition and retention of the contained associations between letters in spellings and sounds in pronunciations marks the initial grounding in acquisition as opposed to visually-based sight word learning or sounding-out and blending. These conclusions were based on paired-associate learning tasks which suggested that beginning readers learn visual spellings more readily than they do phonetic spellings. Visual spelling stimuli comprised
letter strings which bore no correspondence to sounds but were more distinctive visually (e.g., XGST for balloon), whereas the simplified phonetic spellings contained letters which corresponded to sounds (e.g., JRF for giraffe). Accordingly, the reverse pattern in learning was noted for both novice and veteran readers (Ehri & Wilce, 1985).

There are limitations to each of the theories advanced by Gough and Hillinger (1980) and Ehri and Wilce (1985). First, neither advances the process of acquisition beyond the rudimentary connections being made via an alphabetic mapping system. Thus, it is unclear how children progress toward whole word reading. Second, the claim that early acquisition is necessarily based on the identity of a word’s spelling and corresponding sounds may not be true for all readers, as evidenced in the early reader’s preference in the learning of words which were more visually descript (Ehri & Wilce, 1985), and in the observation that the poor reader may establish a visual code independent of learning its name (Wagner, 1985). It is therefore possible that the reader’s attempt at the identification of a word may stem from an association that is more visual in nature, with limited letter-sound correspondences. Similarly, rehearsal of the word’s name may occur as a whole, independent of its internal phonological structure being associated with its corresponding graphemic counterparts. Thus, the reader may choose to strengthen the word’s name as a whole, while forming a visual code for the stimulus independent of mapping letter-sound associations (Wagner, 1985). Therefore, theories of acquisition which are restricted to distinct or successive phases of development may be misleading, insofar that all readers do not necessarily fit neatly into the descriptive stages in acquisition as defined by developmental models such as those proposed by Frith (1985) and Seymour & MacGregor (1985). Moreover, since methods of instruction have been...
shown to influence both rates of learning and the types of processes employed in reading. Consideration must be given to the likelihood that the situation through which words come to be known may vary across readers and reader groups (Thompson & Fletcher-Flinn, 1993). Thus, an important consideration that should be given to a theory of acquisition is how a printed word’s form is acquired, stored, and accessed, and how the identity of each of these processes may qualitatively differ as a function of learning.

In this regard, how a word comes to be acquired in the first instance must clearly bear some relationship to how it is both represented and retrieved. This logic is rooted in the acceptance of learning as a process in which its very elements are shaped by experience. This is why it is extremely difficult to propose a theory of reading acquisition that is truly generalizable. Thus, beyond the mere processes involved in the acquisition and subsequent retrieval of the pronunciation for printed words, consideration of the sources of knowledge and the experiential history that comprise these sources (Thompson & Fletcher-Flinn, 1993), is especially critical to the evaluation of influences, specifically where treatments employed as a means of producing observable differences as a function of learning are to be evaluated.

This relates to how, as educators, a knowledge of the proposed stages of acquisition may indirectly influence instruction. Thus, knowledge of developmental stages through which the learner is said to progress from learning the visual features of a word to applying letter-sound correspondence rules to access a word’s pronunciation (Gough & Hillinger, 1980; Ehri & Wilce, 1985) may contribute to the development of an instructional attitude that will be mirrored in the encouragement given to the learner to sound words out. In this regard, however, what is not taken into account, is the possibility
that the learner’s acquired reading vocabulary may not have been formed in this manner. Therefore, in keeping with the observation that no standard formulation of a theory of acquisition has been developed, one can only heed the various observations that have been proposed, while considering how one’s own methods of instruction may shape the student’s learning. Similarly, whether these stages of development accurately capture the phases through which readers progress toward skilled word recognition or not, for those who encounter difficulties in the integration of visual and verbal codes, and beyond into a semantic network (Paivio, 1978; Perfetti, 1979; Snodgrass, 1984; Swanson, 1984, 1986; Vellutino & Scanlon, 1987), these stages are clearly not as well known or defined. Additionally, there is no real account of the default mechanisms or compensatory strategies (Stanovich, 1986) employed as a result of a reader’s encountered difficulties in forming connections between visual stimuli and their corresponding names.

In short, models of word acquisition are limited not only in their description of which processes are applied, to what degree, and how the employment of these processes may be influenced by different types of instruction, but also in their restriction to the observed stages of acquisition largely characterized by the normal reader. However, despite subtle differences regarding opinions of when the involvement of sounding-out and blending strategies may begin (Gough & Hillinger, 1980; Ehri & Wilce, 1985), or whether access to a new word occurs via letter-sound knowledge, or the integration of stored components from several print words (Thompson & Fletcher-Flinn, 1993), researchers are in general agreement that an alphabetically-based mapping system is seen as both necessary and central to skilled word acquisition. Further, it would appear that the acquisition process begins with the learning of a word’s name and, moreover, that this
process is episodic in nature, involving visual, auditory, and semantic systems. What is not addressed in many current theories, however, is the organization of the visual code in regards to both auditory and semantic codes during acquisition.

Wagner (1985) suggests that the acquisition process involves both within code elaboration and between code association, the former being confined to the visual domain, with the formation of auditory-visual codes between the word’s name and its visual features relating to the latter. The cross-modal integration of these independent coding mechanisms is seen to strengthen the memory trace for words while at the same time contributing to a more efficient system of word recognition and impending comprehension. This view is consistent with other theories in which associations that are made between a verbal code and the visual stimulus produce a semantic processing of input as a result of the activation of both verbal and visual associations (Swanson, 1987). A code, which is seen by and large as a mechanism through which stimulus features can be assigned to memory, makes an independent contribution to the reading process as a whole, yet the efficiency of this process is largely determined by the integration of numerous codes. It is thus assumed that the manner in which multiple codes combine in memory may be related to the difficulties encountered by poor readers in reading (Swanson, 1987). The other theories of acquisition discussed in the above often fail to mention such integration, and at best offer cursory appraisals of the processes involved in translating visual information into a verbal or symbolic system. Nonetheless, common to most developmental models is the view that the learning of either a word’s name, or its constituent sounds is an important precursor to word recognition acquisition (Gough & Hillinger, 1980; Ehri & Wilce, 1985; Wagner, 1985; Vellutino & Scanlon, 1987).
However, this does not imply that the learning of a word’s internal structure must be complete in order for whole-word reading to occur. (Ehri & Wilce, 1985; Vellutino & Scanlon, 1987). This is given consideration in the following section on whole-word and phonological processes in word recognition.

Word Recognition

Perhaps due in part to its broad application in the research literature and in education in general, what is meant by the term decoding is often not well understood. Rather than being applied consistently to make reference to word recognition proper, or the simple ability to retrieve a word’s pronunciation, in its many guises the term decoding has amongst other elements, described both the application of phonics skills for the purpose of deriving a word’s pronunciation (Chall, 1967), and the transformation of letter strings into phonetic codes (Perfetti, 1985). Thus, for clarity’s sake, the term word recognition will be used to refer to the reader’s successful arrival at a word’s pronunciation. However, it is important to note that this is not meant to preclude the role of semantic and contextual processing in word recognition. It is granted that both of these forms of processing play a role in word recognition. However, it is less clear that they are involved in acquisition. Put another way, although semantic and contextual factors clearly prime word recognition, there is little evidence that any facilitative effects from such priming have any long-term affect on learning (changes in word recognition over long periods of time). Contrary to the speculations of Whole Language theorists, semantic and contextual priming appears to be a temporary post-lexical effect, specific to single processing episodes (Taft, 1991). The only model that even hints at possible acquisition
effects is that of Seidenberg, Petersen, MacDonald, and Plaut (1996) and this model has not been fully developed. Such long-term effects might exist, but to date the data does not support this hypothesis. In order for it to do so, researchers will have to distinguish between on-line priming effects (which do facilitate word recognition) and long-term changes in word recognition accuracy and/or speed. This was not the purpose of this study. Moreover, although there are a variety of word recognition models, for the purpose of keeping component processes in reading also at a minimum, the notion that there are two principal ways in which the pronunciation for a given word can be retrieved shall form the basis of this discussion on word recognition processes.

Referred to in some models as direct access and phonetic recoding, or as orthographic or phonological processing respectively, whole word and phonetic reading are both seen to make contributions to the acquisition of word recognition. However, it should be noted that in the initial stages of acquisition the ability to recognize words by means of phonetic reading has been shown to account for much of the variance in skilled reading (Liberman & Shankweiler, 1989; Stanovich, 1986; Ball & Blachman, 1991).

In consequence of repeated exposure and experience with a given word, recall, sight word reading, or direct access involves the immediate recognition of a word by virtue of its visual image being mapped onto the same representation held in memory (Baron, 1977; Coltheart, 1978). The point has been made, however, that this access cannot be purely visual, especially where phonological processes were initially applied in acquisition (Ehri, 1992). Counter to this argument, however, is the consideration of older poor readers who possess limited skill at reading words phonetically, yet demonstrate an accomplished repertoire of sight vocabulary.
In contrast, phonological recoding is a means by which a word’s pronunciation derives from the reader’s translation of letters into their respective sounds (or a phonological representation) from which an auditory match is either found or not found. Whereas the visual-orthographic or direct access route is thought to occur for familiar words, the phonological access route is believed to be applied to unfamiliar words or when a direct match is not found. These conclusions are based primarily in the review of latency times for the reading of familiar and unfamiliar words (Seidenberg, 1985; Patterson & Coltheart, 1987). Faster identification of familiar words is to be interpreted as indication that familiar words are identified as a whole. This type of direct access is contrasted by longer response times for unfamiliar words which are believed to involve the mediation of the stimulus input via the application of phonological codes.

However, recent inquiry into the application of phonological codes has resulted in some differences of opinion. Consistent with these former theories, the system of print-to-sound translation is viewed as having the potential to function as a self-teaching mechanism, which can enable the reader to acquire detailed orthographic representations requisite for efficient and automatic visual word recognition (Gough & Hillinger, 1980; Ehri & Wilce, 1985; Share, 1995). However, that a word not recognized automatically by sight is subsequently accessed by letter-sound correspondence mapping alone, has been questioned. Rather, this mechanism as a knowledge source is seen to be acquired through past experiences which may be retained as stored knowledge and recalled in procedures the same as those used for provided associations (Thompson & Fletcher-Flinn, 1993). If a correct response that is generated through the reader’s knowledge of letter-sound correspondences is retained in memory, subsequent encounters with the same word
should be sufficient for recognition to occur directly, without having to again apply a letter-sound mapping strategy (Ehri & Wilce, 1985; Thompson & Fletcher-Flinn, 1993; Share, 1995).

Yet, in this recent view, generation and recall procedures are considered to be contemporaneous (Thompson & Fletcher-Flinn, 1993), and thus are not seen as belonging to distinct phases or developmental stages of acquisition as proposed by other acquisition theories previously reviewed (Gough & Hillinger, 1980; Ehri & Wilce, 1985; Frith, 1985; Seymour & MacGregor, 1984). Moreover, both of these procedures can function at any time during acquisition, and also for mature readers (Thompson & Fletcher-Flinn, 1993). This theory further differs from the dual route model in which phonological mediation and direct access are believed to be functionally independent (Baron, 1977; Coltheart, 1978). In this regard, the generation and recall theory of acquisition stands in stark contrast to these other models, as generation procedures are said to include sublexical relations induced by the learner from stored experience of print words, and thus may involve the integration of phonological and orthographic components common to several print words experienced by the learner (Thompson & Fletcher-Flinn, 1993). Consequently, these relations are a source of knowledge for generation, and thus represent an existing link between both phonological mediation and information based on specific print word experience. In short, recognition of a word can be generated from partial information stemming from specific orthographic information shared with other words, in combination with access to segments of phonology as small as the phoneme. (For a full review see Thompson & Fletcher-Flinn, 1993; Thompson, Cottrell, & Fletcher-
Flinn, 1996). Generation is, therefore, not restricted to print-sound association alone (Baron, 1977; Coltheart, 1978; Gough & Hillinger, 1980; Ehri & Wilce, 1985).

The finding that self-generated responses to new reading words are not solely based on principles of alphabetic mapping seems to be an important one for two reasons. First, this finding has strong implications for a possible need to re-evaluate instruction in which traditional systematic, rule-based teaching is seen to underlie effective word learning. Second, it strongly supports the contention that the qualitative differences which may underlie the reader's application of knowledge and strategies are largely connected to experience as a function of overall learning and instruction.

Nonetheless, the principle that describes the use of phonological codes in word identification is based on the beginning reader's need for an understanding of the alphabetic principle and the importance of this awareness to reading the alphabetic system. In order to access print the reader must develop an awareness that words comprise syllables and phonemes, and that each phoneme corresponds to distinct sounds that are represented by the visual symbol in the alphabet (i.e., speech sound is discernible to a specific object). Thus, the alphabetic code in the mapping of words involves the ability to translate and map component letters of words to sound (Vellutino & Scanlon, 1987).

In a series of studies by Vellutino and Scanlon (1982, 1987), a battery of tasks measuring a variety of reading subskills, basic processes, and knowledge sources supporting those subskills, above all revealed that the majority of poor readers were found to be most deficient in alphabetic mapping as indexed by recognizing words out of context, which in this study was found to be the best predictor of reading comprehension.
Although phoneme awareness and the relationship to reading is a relatively new phenomenon (the work of L.Y. Zhurova, 1963; and D.B. Elkonin, 1963; 1973 as cited by Ball and Blachman, 1991, suggested that early success in reading was enhanced by phoneme segmentation abilities), subsequent studies have further indicated that language tasks which measure phoneme awareness are largely predictive of success in early reading and spelling, irrespective of the task used to measure such awareness (Bradley & Bryant, 1985; Juel, Griffith, & Gough, 1986; Lundburg, Frost, & Petersen, 1988; Mann & Liberman, 1984). Recent evidence (Ball & Blachman, 1991) has further demonstrated that tasks measuring phonological awareness in kindergarten are powerful predictors of early reading achievement. However, as all children do not necessarily possess equal ability to access these phonemic constructs, it can be inferred that the word recognition strategies of these readers must somehow differ, and similarly, their development of codes and acquisition in general.

How Word Recognition Processes May Differ

Some investigations which suggest that children’s word recognition strategies differ in various stages of early reading (Ehri, 1991; Ehri & Wilce, 1985), are contrasted with indications that there are no differences between readers’ word recognition strategies inasmuch as lexical access occurs either directly with identification at the whole word level, or indirectly through phonetic recoding (Baron, 1977; Coltheart, 1978). However, the evidence which suggests that the learning processes of poor and normal readers may be qualitatively different appears strong enough to warrant further investigation.
McNeil and Wagner (1997) suggest that there are differences in poor and normal readers' employment of strategies in the learning of new reading vocabulary. In this, it has been suggested that over a number of repeated trials the poor reader tends to favour or give more emphasis to the construction of a visual code of a new reading word than to the development of verbal or auditory-visual associations. This suggests that children with a reading disability may employ auditory to visual associative mapping strategies less frequently than normal achieving children in word identification. This bias could be a default outcome of the difficulties the poor reader has in constructing a phonological representation of new words and in maintaining this representation in working memory while attempting to map it onto a new visual stimulus (Hulme & Mackenzie, 1992). In other words, it may simply be easier for the poor reader to construct a visual code than to attempt to engage in the more cognitively demanding task of forming auditory-visual associations (Wagner, 1985). Furthermore, the poor reader may believe that given a new visual stimulus, he/she should give precedence to learning what it looks like before learning to name it. It is equally likely, however, that this is not a conscious strategy choice, but rather one that is automatically retrieved by the relative fluency of the poor reader's visual coding operations. This view finds strong accordance in theories of word learning concerning the verbal processing inefficiencies of poor readers (Vellutino 1979; Vellutino & Scanlon, 1987; Swanson, 1987; Stanovich 1986). The theory that describes this phenomenon is primarily based on the finding that poor readers have a verbal coding deficit and that the visual processing ability of these readers is normal (Vellutino, 1979), a review of which is outlined in the section which follows.
The number of investigations which support the hypothesis that the visual coding processes for the poor reader appear to be intact (Swanson, 1983; Vellutino & Scanlon, 1982), are grossly undermined by accounts which demonstrate that the poor reader’s processes in verbal coding are not (Swanson, 1978; Vellutino, 1979; Vellutino & Scanlon, 1982; Stanovich, 1986). A primary interest in elements that are predictive of early reading success, in concert with a tendency to focus on children who find reading difficult, has by and large resulted in the poor reader’s deficiencies being the object of attention in reading research. Consequently, fields of inquiry have been inundated with investigations of group differences on measures of phonological awareness, phonological processing, phonemic segmentation, and phonetic recoding (Ehri & Wilce, 1985; Bradley & Bryant, 1985; Juel, Griffith, & Gough, 1986; Lundburg, Frost, & Petersen, 1988; Mann & Liberman, 1984; Ball & Blachman, 1991), in all of which the discovered differences are intrinsically related to visual-verbal learning. Thus, as a causal link between such awareness and reading achievement is essentially firm, examination of the poor reader’s relegation of verbal code formation in word acquisition can better inform theories of acquisition. Thus, although not as widespread, there is strong evidence which regards the visual processing ability of poor readers as normal (Vellutino, 1979; Vellutino & Scanlon, 1987; Swanson, 1987), despite evidence which suggests that the verbal processing of visual stimuli for these readers is weak (Vellutino, 1979; Vellutino & Scanlon, 1987; Swanson, 1987) and, moreover, that the visual and verbal coding systems for these readers are poorly co-ordinated in identification tasks (Swanson, 1986). Each of these findings is discussed in turn.
The Poor Reader's Visual Processing Abilities as Normal

Although the visual processing of a stimulus input is a rudimentary element in the initial stages of word identification and acquisition, the fluent review of the graphic features of printed words as mediated by reciprocal interaction between the visual and verbal systems is nonetheless viewed as being largely dependent on access to the verbal correlates of these stimuli (Vellutino, 1979). This, of course, stems from our knowledge that reading at the most basic level involves the recognition that language is represented by graphic symbols. Thus, as reading is not primarily a visual function but a linguistic one, inefficiency in the linguistic processing of words can be considered an outcome of impairment in either the domain of language processing or in the integration of the visual and verbal properties of words (Vellutino, 1979).

These types of considerations led Vellutino and his colleagues (1975, 1987) to a series of investigations which aimed to evaluate the contention that the perceived visual deficiencies of the poor reader are in fact secondary outcomes of encountered difficulties in visual-verbal associative learning. In order to examine this possibility, verbal and nonverbal learning tasks were used to evaluate the hypotheses that poor and normal readers would not differ on nonverbal learning tasks, but would perform less well on tasks which contained both a verbal and a visual component. The tasks in this study comprised geometric designs, English words, and randomized letter and number strings that were shown for brief exposures.

In the nonverbal measure poor and normal readers were asked to copy geometric designs from memory following their presentation. For words, letter, and number string stimuli, subjects were asked to provide a verbal response. Words were to first be
pronounced and then spelled orally letter by letter. Number and letter strings were to be listed verbally, character by character in their order of appearance.

As predicted no between group differences were noted for the immediate recall of geometric designs. Further, the poor readers performed better on the graphic reproduction of stimuli than on the naming of these. Overall, the performance of poor readers was comparable to normal readers on the reproduction of presented stimuli, yet clear differences occurred when subjects were required to provide a verbal response for these items. Additionally noteworthy was the finding that the grade 6 poor readers in this study were more accurate at spelling word stimuli than the normal grade 2 subjects, even though the poor readers' pronunciation of these stimuli was comparatively, in many instances, much poorer. Thus, it would appear that although the poor readers were familiar with the orthographic structure, and consequently could spell the words letter by letter, they nonetheless encountered difficulty in pronouncing them. This suggests facility in the poor readers' ability to form visual memories for words, yet deficiency in correlating this information with verbal counterparts. Above all, the results of this study point to the poor reader's ability to verbally code visual stimuli, but not to inefficiencies that are related to the visual coding and discrimination of visual stimuli.

Stronger indications of poor and normal readers' equal abilities in visual processing emerge from a study in which the visual recall of Hebrew letters and words served to measure poor and normal readers' visual coding systems and how these may differ (Vellutino et al. 1973; 1975). Noteworthy in this study is the selection of the stimuli. Thus, not unlike the employment of pseudo-words in an acquisition task, these Hebrew letters and words appropriately model the learning of new reading vocabulary
since subjects will have had no prior exposure to the stimulus words. Moreover, any emerging differences in performance can consequently be viewed as an outcome of actual learning, and not connected to previous experience.

Thus, poor and normal readers with no prior exposure to Hebrew, and normal readers who were learning to read, speak, and write the language, were exposed to three, four, and five letter Hebrew words that were to be reproduced after their presentation. As anticipated, no differences emerged for the poor and normal readers’ replication of the presented stimuli. Similarly, with the exception of the three letter stimuli, neither group performed as well as the normal readers studying Hebrew. Furthermore, the normal readers with no prior exposure to Hebrew made more orientation errors than the poor readers. These errors were largely confined to Hebrew letters that resembled an altered orientation of those from our Roman alphabet. This finding suggests that the types of orientation errors observed in the reading and writing of dyslexic readers may arise in consequence of inefficiencies in verbal mediation, and therefore, not as a result of visual-spatial confusion. Consequently, the fact that the normal readers in this study made more orientation errors than the poor readers may indicate that the normal readers’ ability to code the new information was in effect being constrained by the relative strength of existing phonological codes for visually similar items.

These results point to the possibility that the poor reader’s difficulties in reading are not connected to perceptual deficiencies, and subsequently lend further merit to the supposition that reading problems are in fact bound by a deficiency and/or disorder in verbal coding (Vellutino, 1979). Such findings are critical to any examination of the processes involved in word acquisition tasks. Further, the inclusion of a forced-choice
visual recognition memory measure in a word acquisition task should demonstrate the degree to which visual code formation is employed by poor and normal readers in the learning of new reading vocabulary, while substantiating previous findings in support of both the intact visual processing and verbal processing deficit hypotheses for poor readers.

Verbal Processing Abilities in the Poor Reader

As aspects of deficiencies in verbal processing have been identified in the poor reader’s encountered difficulties in accessing a name (Vellutino & Scanlon, 1987), in the verbal rehearsal of names (Torgesen & Goldman, 1977), and in the conversion of printed stimuli into the respective phonological equivalents (Shankweiler, Liberman, Mark, Fowler, & Fischer, 1979), it has become increasingly apparent that difficulties in reading are the result of inefficiency in the linguistic or verbal coding of visual stimuli, and not connected to visual perception problems. Conversely, modality or independence between these two coding systems has been shown to be more prevalent in skilled readers, moreover, that the effect of a verbal code is weakest for poor readers when the visual information to be remembered is unfamiliar (Vellutino, Steger, De Setto, & Philips, 1975), when it is complicated (Vellutino, Pruzek, Steger, & Meshoulam, 1973; Vellutino, Steger, Karman, & DeSetto, 1975), and when the verbal label for a real word or pseudo-word is associated with the visual stimulus (Vellutino, Harding, Philips, & Steger, 1975). (Studies by Vellutino et al., as cited in Vellutino, 1979.) These observations led to the conclusion that poor readers are less adept at forming representations of the linguistic properties of words in both written and spoken forms (Vellutino, Scanlon, DeSetto & Pruzek, 1981). Moreover, it has been proposed that
differences between poor and normal readers’ linguistic coding abilities are manifested in ability group differences on measures of encoding and word retrieval (Vellutino & Scanlon, 1982).

To examine this hypothesis, a series of studies (Vellutino & Scanlon, 1982) involving spoken and printed word, language processing tasks were conducted. This evaluation of linguistic coding differences in the first instance involved the comparison of poor and normal readers’ sensitivity to orthographic versus phonologic features of words, and was formed on the premise that if poor readers are more attuned to the visual than to the phonologic properties of words, then they should be more inclined to select words based on orthographic similarity.

This proposition was tested using sets of words which could be categorized on the basis of either orthographic or phonologic similarity, (e.g., paid, said, made). Results showed that poor readers categorized a much larger proportion of words on the basis of orthographic similarities than did the normal readers, even though further analysis of the data revealed that the poor readers were able to pronounce these words. Moreover, the normal readers made use of both orthographic and phonologic similarities in approximately equal measure. These results not only support the linguistic coding deficit hypothesis, but also suggest that the failure to develop a phonologically-mediated mindset or approach towards the recognition of words, may result in a developed tendency to rely on a whole word approach to identification, even when the pronunciation for the words is known.

A second study by Vellutino & Scanlon (1987) examined the linguistic coding explanation of reading disability in the processing of spoken words. This approach is an
important one given that the poor reader's inability to provide verbal (phonological) responses for visual stimuli could be a result of difficulties associated with the integration of visual and verbal information. Thus, the requirement of providing only a verbal response should reduce the cognitive load associated with cross-modal integration processing, while providing support either for or against the verbal processing deficit hypothesis. In this respect, a free recall measure in which the development of an auditory/phonological memory code can be evaluated on the basis of the subject's ability to recall words that have been aurally presented is important, as the ability to code the name of a word in memory is an indicator of auditory code learning, which is recognized as being separate from the alphabetic mapping of a word's visual features (Vellutino & Scanlon, 1987). Therefore, deficiencies in linguistic processing or verbal code formation should also become apparent in ability group differences on a free recall measure through which the ability to encode and integrate the phonologic components of aural information can be judged independent of the ability to encode this same information in a visual-verbal learning task. In sum, the ability to learn and recall aurally presented words is a process that is considered to be highly related to the ability to store and retrieve phonetic representations (Vellutino, 1979). In the case of pseudo-words, this process has been also related to the ability of the individual to codify and lexicalize (form a whole-word lexical entry in long-term memory) the to-be-remembered item. In this regard, after approximately five prior occurrences, words and pseudo-words were identified with equal accuracy (Feustal, Salasoo, & Shiffrin, 1985). Moreover, after one year, performance was likewise shown to be equal for old pseudo-words, and new and old words alike, all of
which were identified more readily than new pseudo-words. These results suggest that the learned codes for pseudo-words are as strong and permanent as the codes for words.

In the investigation by Vellutino and Scanlon, (1987), the performance of poor and normal readers’ memory for spoken words was evaluated using words which varied in levels of abstraction. The employment of such words was important for two reasons. First, it has been shown that abstract words are more difficult to recall than concrete words simply because it is more difficult to form referential images that can be used to assist recall (Paivio, 1971). Second, abstract words are more difficult to recall simply because they are more linguistically complex (Paivio, 1971, 1978; Vellutino & Scanlon, 1982). Thus, although it was predicted that poor and normal readers would differ in their ability to recall words of an abstract nature, it was expected that the recall of concrete words would be similar for these two groups, in part due to the poor readers’ similar facility in the use of imagery to assist both storage and retrieval (Vellutino, 1979). Results indicated that, although poor and normal grade 2 readers were essentially matched on their recall performance for concrete words, the poor readers were significantly less adept at remembering abstract word types. The comparison of grade 6 poor and normal readers, however, showed that there were significant differences favouring normal readers on both types of words. Although this result was not anticipated, it supports the linguistic deficit coding hypothesis.

Other studies in support of the verbal processing deficit hypothesis demonstrate equally compelling results. To this end, two separate investigations carried out by Vellutino, Steger, De Setto, & Phillips (1975) centred on the creation of associative-based learning tasks which were felt to closely approximate the type of visual-verbal learning
involved in the initial stages of word identification. The first of these two studies assigned poor and normal readers to either a visual-auditory, nonverbal learning condition, or to a visual-verbal learning condition involving two subtests (Vellutino et al., 1975). The first subtest required readers to make associations between nonsense syllables and novel cartoons. The second subtest required that associations be made between the same nonsense syllables and novel script. As predicted, there were no between group differences on the nonverbal learning task, however, significant differences in performance were noted for both the picture-naming and script-naming subtest measures. These results suggest that poor readers either have difficulty on verbal learning tasks, in visual-verbal learning, or both.

Of further interest in this particular study was the observation that poor readers made proportionately more errors in naming the visual stimuli. In this, the poor readers were shown to provide real word reading responses for the nonsense syllable words, (e.g., fog for mog), whereas normal readers' error types often involved the intermixing of individual phonemes contained in the stimulus words, (e.g., mag and yog for mog and yag). This suggested that the normal readers were more inclined to code the nonsense syllables phonetically, a suggestion that is also consistent with other views (Liberman & Shankweiler, 1977; Perfetti & Lesgold, 1979) which concern the poor readers' encountered difficulties in the phonetic coding of both visual and aural linguistic information.
Independent Visual and Verbal Coding Systems

Finally, additional support for the relationship between verbal learning and reading disability comes from other investigations (Swanson, 1986, 1987) in which paired associate learning was examined for named and unnamed training conditions. In this, the comparison of poor and normal readers’ serial recall performance for visual stimuli that differed in terms of their level of verbal codability was investigated in order to assess the hypothesis that poor and normal readers differ in the links that are made between visual and verbal coding systems.

The items were presented serially since it has been shown that verbal coding appears to be the most appropriate aid for processing sequential information (Paivio, 1971; Snodgrass, 1984), moreover, the requirement of coding stimuli sequentially should encourage verbal processing or naming of serial stimuli (Swanson, 1984, 1986). It was predicted that recall for unnamed shapes and named shapes whose titles bore no relationship to the shapes’ contours would be equal for these two ability groups, whereas differences would be observed for a name-training condition which included name-associated items with names that were similar to the shape’s contours. The principal focus of these investigations aimed to evaluate the degree to which the development of codes reflect combined visual-verbal (modality-independent) or separate visual-verbal (modality-dependent) representations (Kolers & Gonzalez, 1980; Scarbrough et al., 1984, as cited in Swanson, 1986, 1987). In this regard, it was assumed that if the poor readers’ coding operations are independent, then differences would be noted in their recall of name-associated items versus name-nonassociated items, the former stimuli considered to encourage interdependent coding because of the closer association between
the item's shape and given name. It was further believed that the poor readers' serial recall of named items that are conceptually similar to their visual representations would be disrupted since it is assumed that visual codes better assist the poor readers' access to information than verbal codes. Thus, the consideration was whether verbal response deficits in the poor reader are reflective of inadequacy in the coordination of representations that are connected to the visual and verbal memory sources.

In the unnamed condition random shapes whose distinctive visual features were pointed out by the experimenter were presented for two seconds each in fifteen second intervals. These cards were then placed face down and a single shape which corresponded to one of the overturned cards was shown. Subjects then had to point to the match amongst the over-turned cards. In the named condition subjects were presented with a series of shapes that contained distinctive features on which the name for the shape had been based. Name-nonassociated items had names that were arbitrarily assigned to the shapes, and bore no meaningful relationship to the shape's contours. In each of these conditions the same two second exposure with fifteen second intervals between each exposure was employed. Controls for nonverbal items included a reminder to subjects that they were only to look at the shape; and for named items subjects were required to overtly name each shape as it was presented for the two second interval in order to minimize active verbal rehearsal for previously shown items, before being tested with the test shape. As expected, the normal and poor readers did not differ in the recall of items in the unnamed and name-nonassociated conditions. However, significant differences favouring the normal readers were found for the recall of name-associated stimuli.

Further, for normal readers the recall of items was higher in named conditions, whereas
the opposite pattern emerged for poor readers. Thus, it was suggested that overall the similar performance of poor and normal readers on unnamed and name-nonassociated items indicate that the visual coding operations of poor readers are intact, and that the results of the name-associated item task point to deficiencies in the poor readers' ability to verbally code visual stimuli. Moreover, that there were no differences in the normal readers' recall of name-associated and name-nonassociated items, would suggest that the normal reader is able to generate names for stimuli which have no obvious verbal associations. Likewise, that the normal readers' recall for named items was better than for unnamed items, further suggests that these readers can make transitions between the visual and verbal coding systems. Conversely, the higher recall of name-nonassociated over name-associated shapes for poor readers would suggest that interference occurs in the retrieval of visually-represented information where training involves an emphasis on the semantic properties (name-associated) of visual stimuli. Thus, such processing is representative of a modality-specific or independent coding system.

Instruction

With respect to research undertaken to investigate word and reading acquisition, traditional approaches have typically focused on how the rate of progress in learning is effected by different types of instruction (Adams, 1990). These investigations have focused on the influences of whole-word and phonics-based instructional approaches in reading. More recently, however, there has been a shift towards the consideration of how different types of instruction influence the way that a child attempts to learn (Thompson & Johnston, 1993; McNeil & Wagner, 1997). Thus, rate of learning becomes a separate
enterprise in the respect that two children of equal attainment in reading may approach the identification of words in different ways. Thus, when viewed in this light, the line of enquiry is the extent to which different types of instruction influence not the rate of learning, but the nature of the process that will be employed in the learning.

By and large, studies which advocate the necessity for the explicit and systematic teaching of phonics (Adams, 1990) base such claims on the ensuing differences observed in levels of attainment for students who did and did not receive such training. What many of these studies fail to consider is the extent to which learning processes differ under these varying modes of instruction. Furthermore, it has been suggested that such investigations fail to consider that attainment levels which are presumed to be an outcome of the application of different processes as influenced by the instruction, may be connected to differences in the intensity of such programs, not to mention the time and resources devoted to such instruction (Thompson & Johnston, 1993). Although a matter of contention, that the processes would differ under these types of instruction is expected, but how they actually differ remains the subject of speculation. What is known is that different levels of reading attainment were noted for the two different instructional approaches. Thus, the results of such investigations of reading instruction which consider the differences in attainment levels of children who receive explicit phonics instruction and those who do not cannot be disputed (Chall, 1967; Adams, 1990). The degree to which these forms of instruction influenced the children’s application of different processes however, can.

Nonetheless, there are some studies in which the effects of different types of training on reading have been closely examined, specifically the effects of metalinguistic
training on verbal response learning and code acquisition (Vellutino & Scanlon, 1987; Ball & Blachman, 1991). In the former study, reader groups were compared on verbal code learning and code acquisition tasks with or without phonemic segmentation training. Although poor readers performed more poorly than the normal readers performed, the results clearly indicated that, under different treatments, poor readers benefitted from training that drew their attention towards grapheme-phoneme correspondences in words, which in turn assisted the identification of these. Furthermore, it was observed that the type of training received can influence either the use of holistic or analytic processing strategies.

Thus, it is these types of investigation through which claims regarding improvements which arise in consequence of training can legitimately be made. With these aims in mind, this research set out to investigate the degree to which explicit instruction in the sounds made by a medial vowel digraph contained in word family word stimuli would assist both the visual and verbal identification of these stimuli, as well as how this instruction may influence the use of different strategies. In this regard, as it has been noted that poor readers have a tendency not to fully analyze the interior components of words (Stanovich, 1993), it was felt that by directing the reader's attention to the details of the vowel digraph's letter-sound association, some indication would be given as to the influence of this training on the facilitation of the development of more distinctive or elaborated representations when compared to those readers not receiving this instruction. Several investigators believe that phonics instruction will in fact assist such development, yet perhaps not in terms of traditional word attack skills. Rather, it has been proposed that the effectiveness of phonics instruction is perhaps more closely related to
influencing the reader's attunement to the interior detail of words (Adams, 1990; Venezky & Massaro, 1979), as opposed to inducing sounding out and blending strategies.

This model suggests that training poor readers to pay attention to a particular letter-sound correspondence within a word may have a number of effects. First, it may elaborate the visual representation of the word making it more distinctive and retrievable on a visual recognition memory test. Poor readers in particular, might show improved visual recognition memory performance in such cases. Second, as has been suggested, it may improve the entire word schema by increasing the number of specific visual-auditory links between the whole word name and its spelling. In this case an improvement in whole word reading for both normal and poor readers would be expected. However, forcing attention to a specific letter-sound relationship that the poor reader may not otherwise process may result in more improvement for this type of reader than for the normal reader. Third, this type of training could result in more numerous and more accurate sounding out reading attempts as a decoding strategy. Again, it would be expected that both the normal and poor reader would exhibit this type of improvement, with perhaps the more dramatic improvement occurring with the poor reader.

The addition of the word family as an instructional component should facilitate learning in both phonics explicit training and in whole-word training as well. This is predicted because word families by definition and structure involve the repetition of a rhyming unit and its corresponding orthography in each word exemplar. Thus, training in terms of a specific letter-sound correspondence common to a word family will be repeated. In addition, even in a whole word reading condition in which specific letter-sound correspondences are not made explicit, the repetition of the rhyming unit and its
corresponding orthography is expected to facilitate learning. It follows that both normal and poor readers should benefit from learning to read words presented in word family groupings regardless of whether their attention is drawn to specific letter-sound correspondences. However, the poor reader in particular might show enhanced learning when words are grouped in word families in a whole-word reading condition. This is expected because repetition at the whole word level may serve learning in a manner similar to verbal rehearsal or mastery learning.

However, above all, as poor readers are noted for their particular weaknesses in the phonological processing of words, there is an interest in examining the degree to which explicit training on the letter-sound components of words that are both visually and phonologically similar (word family words) may influence visual and verbal learning. Thus, in brief, where it is generally accepted that printed words are accessed either by grapheme-to-phoneme correspondence principles, or by direct access vis a vis orthographic recognition which derives from the letter string (Coltheart, Patterson, & Marshall, 1980), educational practice can be informed by the types of instructional devices that may or may not influence learning processes, which can then in turn be evaluated for their effectiveness in acquisition or learning models.

Summary of Research Aims

This study arises in no small consequence from Vellutino’s theory that poor readers have a verbal coding deficit, and that the visual processing characteristics of these readers can be regarded as normal. This provided the impetus to consider the possibility that poor readers may be better at visual coding than normal readers. Thus, the research
aimed to look at visual coding independent of verbal coding on the same word. There was a further interest in whether there would be effects for word family words and phonics training on visual and verbal code formation. Visual code formation was measured by a forced-choice visual recognition memory task in which subjects were asked to select the stimulus word set amongst four visual and phonetic distractors. Verbal code mapping was measured by asking subjects to read the selected word. A free recall measure was employed as an index of verbal code formation as a means of assessing the degree to which words had been verbally/phonologically coded.

Thus, given the need to understand decoding problems as the proximal cause of reading disability, methodological considerations warranted that the component processes which underlie word acquisition be separated. Further, that reading acquisition is regarded as episodic, and involving visual, auditory, and to a degree semantic processes, the study adopted a training and test format for six trials, in which the visual recognition memory task, the reading response to this task, and the free recall measure served to evaluate visual code formation and verbal code mapping in the acquisition of new reading vocabulary presented in meaningful sentence contexts. In order to evaluate the degree to which different types of instruction may influence the rate of acquisition, as well as the types of processes that are engaged in such acquisition, subjects in a Phonics condition received explicit letter-sound correspondence training for a medial vowel digraph contained in word family words.

At the requirement of providing both a visual and verbal response to the same stimulus under separate response conditions, the poor readers’ difficulty in the provision of a verbal response to the visual stimulus not only should lend merit to the verbal coding
deficit hypothesis, but will also substantiate findings that regard visual and verbal coding systems as poorly coordinated in the poor reader. Furthermore, as it has been shown that the ability to form a verbal code for reading words is an important determinant of being able to provide a reading response for a visual stimulus, and of acquisition in general, the free recall measure in which the subject is asked whether or not he/she can recall any of the words is employed to this end. In short, overall, the free recall measure, the visual recognition memory choice measure (VRM), and the reading response to this memory choice (VRM-R) shall form the dependent variables and the basis upon which verbal code formation, visual code formation/visual memory, and verbal code mapping respectively, shall be examined.

Hypotheses

H1a) It was hypothesized that the normal readers would engage in more verbal code processing and thus faster code formation than the poor readers, therefore a main effect for ability would be noted on a free recall measure in that normal readers would be expected to do better on a free recall measure of words they are learning to read.

H1b) It was hypothesized that the normal readers would engage in more verbal code mapping than the poor readers, and thus a main effect for ability would be noted in the trials and errors to criterion data for reading responses (VRM-R) to the visual recognition memory choices (VRM) in that normal readers would be expected to do significantly better than poor readers in learning to read words.
H 2) It was hypothesized that the poor readers would initially engage in more visual
learning per trial than the normal readers, and their performance in a visual recognition
task in which they were required to recognize words they were learning to read would be
significantly better than that of the normal readers. Therefore, it was predicted that a main
effect would be noted for ability in the trials and errors to criterion data for visual
recognition memory choices (VRM) with poor reader performance being significantly
better than that of the normal reader.

H 3) As a supplement to the main hypotheses, it was predicted that both normal and poor
readers receiving Mixed Phonics Explicit training would show fewer trials and errors to
criterion than subjects receiving whole word training in the Phonics Implicit group, and
thus, apart from the prediction that a main effect would be noted for ability, a main effect
would also be noted for training (i.e., conditions).

H 4) As a second supplementary hypothesis, it was predicted that word family stimulus
words would be learned better than unique non-word family words. Thus, a main effect
was predicted for the type of words learned (wordtype).
CHAPTER THREE: METHODOLOGY AND PROCEDURES

This chapter serves to outline the method of this study. First however, consideration is given to the employment of pseudo-words as stimulus items as well as to the study's sequential framework, as considered in relation to employed methodologies which concern the mapping of memory forms for novel and real word stimuli. Following this, the chapter continues with a description of the subjects, pre-test measures, materials and apparatus. A procedural summary is then presented as it was felt that a condensed synopsis of the study's method would assist understanding. What follows is the procedure proper, as presented in three sections which correspond with the natural divisions of the actual experiment; namely, introduction to the words, training, and testing.

A Methodological Consideration

Because memory contains both permanent, general knowledge and information regarding specific past events, or semantic and episodic memory (Tulving, as cited in Feustal, Salasoo, & Shiffrin, 1985), it follows that word recognition tasks also involve the application of long term memory processes for the purpose of recognizing letter strings (Feustal, et al., 1985). In this, the identification of words is believed to involve the activation of permanent codes in semantic memory (Tulving, 1972), lexical memory (Scarborough, Cortese, & Scarborough, 1977), or the mental lexicon (Forster, 1976; Morton, 1969, 1979). (The above studies by Tulving, Forster, and Morton are cited in Feustal, Salasoo, & Shiffrin, 1985.) Yet, to infer that accurate word identification results only from the activation of permanent memory codes is to ignore the role played by
episodic memory devices (episodic factors which assist in the identification and recall of recently presented items), in cumulatively establishing the formation of these permanent memory codes. Most important, it has been shown that recent encounters with printed words greatly enhance the level of probability in subsequent identification tasks (Feustal, Shiffrin, & Salasoo, 1983; Jacoby & Dallas, 1981; Scarborough et al., 1977). The phenomenon of a word being more quickly and accurately identified even after a single prior exposure in these studies has come to be known as the repetition effect.

Viewed as the threshold which separates episodic and semantic memory, the repetition effect is important to researchers for its positioning at the empirical and theoretical crossroad between these two memory forms. Moreover, the repetition effect has also been shown to apply to pseudo-words that share some similarities with the structural properties contained in words (Feustal et al., 1983; Jacoby & Witherspoon, 1982). The interest here is that in these studies the pseudo-words carried no semantic significance and likewise are presumed to have no coded representation in the mental lexicon. Despite this, after five subsequent exposures, pseudo-words and words were identified with equal accuracy, consequently suggesting that codification of pseudo-words had occurred. Thus, through the presentation of a novel word form it would appear that subsequent identification of the presented item is facilitated in part by the development of a memory trace that serves to respond as a single unit or memory code that can be triggered even by fragmented input information as in the identification of a set of letter features: codification (Salasoo & Shiffrin, 1985), unitization (Drewnowski & Healy, 1982; Feustal et al., 1983; Hayes-Roth, 1977; Healy, 1976), chunking (Miller, 1956), logogen formation (Morton, 1969, 1979), lexical entry (Forster, 1976), word integration
(Johnson, 1981), and generation of a semantic node or concept (Brooks, 1977, 1978; McClelland & Rumelhart, 1981). (The above named studies above are cited in Feustal et al., 1985.) Overall, it is noteworthy that successful recall of an item that is presented over a number of trials is in part facilitated by the development of episodic memory traces that at some point converge to establish a permanent memory code for the presented item.

In a similar respect the structure of this study’s methodology is modelled on the premise that over a repeated number of trials the mapping of both visual and verbal code formation in acquisition can be reviewed. Further, the use of pseudo-words is seen to be critical to such an endeavour for a number of reasons. First, and perhaps most important, is the fact that the acquisition of new reading vocabulary cannot be examined through the use of familiar words. Second, to find real words that the reader is not familiar with would involve having subjects read word lists from which the unknown words could then be used in an acquisition task. However, that all subjects in the study could be tested on the same words would be precluded by these subjects’ varying degree of familiarity for some words and not for others. Consequently, the need to utilize different real words for each subject would result in a loss of control over effects for some reading words. Put another way, some reading words are more easily acquired than are others. As a result, the stages of acquisition for a sample of readers could not be consistently inferred. Thus, pseudo-words permit the researcher to control for familiarity, yet, at the same time the use of pseudo-words can result in a loss of meaning. To control for this each word was treated as a surname and embedded in a meaningful sentence context. It should also be noted that the subjects in this study had no difficulty in accepting these words as the names of people. In addition, pseudo-words are often employed since substantial correlations have
been noted between a reader's ability to read pseudo-words and his/her ability to read real words (Baron, 1979; Gough, Juel & Griffith, 1992). Similarly, (as cited by Gough et al., 1992), Curtis (1980) found the ability to read pseudo-words to be the best predictor of reading ability she examined. However, it will be shown that the learning curves for both real and pseudo-words are similar and that approximately half way in the acquisition process the pseudo-words appear to become codified or lexicalized, and therein for all intents and purposes are treated by the learner as meaningful words.

**Subjects**

The subjects in this study, poor readers \([n=30 \text{ (Mean C.A. 8.23)})\] normal readers \([n=33 \text{ (Mean C.A. = 7.93)})\] were drawn from schools located throughout the Niagara Region. The initial pool of poor readers was drawn from a list of readers throughout the county that had been identified yet remained in a regular classroom, and received varying degrees of assistance with math and reading skills throughout the course of each school week.

Although the purpose of this investigation was to report on the strategies used by poor readers in the acquisition of new reading vocabulary, it is important to note that this design was initially tested on normal readers in an earlier study under the supervision of Dr. Wagner through the Reading Clinic at Brock University's Faculty of Education. Permission to use the normal reader data from this study, in addition to the acquisition test model, was granted by Dr. Wagner. Thus, only the poor reader groups were tested in this study. However, the data analysis included both the normal readers from the earlier study and the poor readers tested for this study.
Pre-test Measures

Word recognition was assessed using the Woodcock Reading Mastery Test, Revised Form A. The mean Word Identification grade equivalent scores for normal and poor readers were 4.8, (S. D. = 3.192) and 2.5, (S. D. = .613) respectively. Poor reader subjects were selected on the basis of a reading grade performance equivalent of one to two years below grade level. Those subjects awaiting assessment regarding speech and language difficulties were excluded from participating in this study. Subjects in the normal reader group achieved performance equivalent levels appropriate to their respective chronological ages, and none were identified as having difficulty in school, and none spoke English as a second language. One group of normal readers and one group of poor readers was randomly assigned to a Whole-word Training condition and to a Mixed Phonics Training condition respectively.

Materials and Apparatus

The stimuli used in this study consisted of six pseudo-words, treated as the surnames of people and embedded in meaningful sentences (see Appendix A). Three of the six pseudo-words formed a word family (e.g., Haboamit, Hapoamit, Hakoamit), and the remaining three were individually unique, (i.e., they did not share a common phonics rule), (e.g., Semouket, Fajoither, Dekaishep). There were four different stimulus sets in total. The sets were rotated for each subject in order to control for possible single word family effects, and thus, for the second subject the stimulus set in the above became Semouket, Sevouket, Serouket, Fanoither, Denaishep, Hakoamit; the third set comprised
Fajoither, Fanoither, Fapoither, Delaishep, Hapoamit, Serouket; and the fourth set comprised Dekaishep, Denaishep, Delaishep, Haboamit, Semouket, Fajoither.

Procedural Summary

Training consisted of an initial presentation in which the sentences containing the pseudo-words were introduced and read to the subject, followed by presentations in which the subject attempted to read the pseudo-words. Corrective feedback on his/her response was provided. One group of normal readers and one group of poor readers were randomly assigned to a Whole-word Training condition and to a Mixed Phonics Training condition respectively. Whole-word training consisted of having the subject read the whole pseudo-word twice on each trial with corrective feedback provided by the experimenter. In the Mixed Phonics Explicit training condition the subject read the whole pseudo-word once and then (for word family words only) read the contained medial vowel digraph which was pointed to by the experimenter. The Mixed Phonics Explicit condition received the same training as the Implicit condition for individually unique words, (i.e., non-word family words were read twice on each trial). A training trial consisted of reading all six pseudo-words this way, followed by a rest and then a test trial. In the test trial the subject was presented with one stimulus pseudo-word at a time in the context of four visual and phonetic distractors. The subject's task was to select the stimulus pseudo-word from among the distractors and then read his/her choice. No feedback was given on the test trials. Training and testing continued until the subject achieved criterion (two consecutively correct test trials) or for six trials.
Procedures of the Experiment

The overall training-testing procedure consisted of three stages. In the first stage each subject was introduced to the pseudo-words in sentences that were read by the experimenter. In order to ensure that each subject was capable of pronouncing the pseudo-words, subjects were asked to repeat each word immediately following its presentation. As an indication of verbal code formation the child was then asked if s/he could remember any of the words that had just been presented (free recall). The children in the Mixed Phonics Explicit Training groups were shown a phonics card for the word family being studied, and thus received explicit instruction on the phonic rule that defined the word family stimulus words (e.g., oa-o, ai-a, oi-oy, ou-oo). On the other hand, for children in the Phonics Implicit Training groups no attempt was made to draw attention to the underlying structure of studied words.

Stage Two (Training)

The purpose of the second stage was to give subjects practice at reading the to-be-learned pseudo-words. Here, subjects were asked to read each pseudo-word within the context of its sentence, “The pilot, Mrs. Haboamit, flew the plane”. The order of presentation of each stimulus sentence was randomized for each trial. Immediately following the presentation of each sentence subjects were asked to do one of two things. In the Mixed Phonics Explicit condition subjects were asked to read the vowel combination that defined the phonic rule in each of the word family word stimuli (e.g., ‘oa’ in Haboamit, Hapoamit, Hakoamit = ‘o’), and to re-read single word stimuli as whole words (e.g., Semouket, Fajoither, Dekaishep), with corrective feedback on vowel
and whole-word responses provided by the experimenter when necessary. In the Phonics Implicit condition subjects were asked to re-read both word family and single word stimuli with corrective feedback provided for each of these readings when necessary. In the Mixed Phonics Explicit Training condition, data from the child’s two reading responses consists of both vowel and whole-word readings. In the Phonics Implicit group the data comprises the child’s two reading responses to the whole word. In all conditions the child then rested for 3 minutes before going on to stage three. This was done in order to ensure that responses to the test stimuli in stage three would not be based on short term memory recall. Moreover, the child was engaged in conversation in order to control for the rehearsal of words in between the testing conditions.

Stage Three (Testing)

In stage three (forced-choice visual recognition memory test), the children in each Training condition were presented with the test stimuli, the order of which was randomized across trials. Each test pseudo-word set consisted of a stimulus word and a look-alike distractor, sound-alike distractor, and two random distractors respectively (see Appendix B). These words were printed on index cards and placed in front of the child in a random arrangement. The child was then asked to select the stimulus word by pointing to it and then reading it. In the testing condition the child’s ‘pointed to’ response was recorded as a visual recognition memory (VRM) response and his/her reading response to the selected word was also recorded (VRM-R). The dependent variable for each of these measures was trials to criterion in correctly selecting the stimulus word on the visual recognition memory test (VRM), and correctly reading it (VRM-R).
Each training trial (stage two) was followed by a test trial (stage three), and this sequence of training and test trials was repeated for a total of six trials or until criterion had been reached, (i.e., the child had correctly selected and read all six words for two successive trials). However, all responses in the trials to criterion data were also broken down into the following seven categories:

1. Recognition memory errors (independent of reading response)
2. Stimulus word selected and read correctly
3. Distractor selected and read as stimulus word
4. Distractor selected and read correctly
5. Distractor selected and read incorrectly
6. Stimulus word selected and read incorrectly
7. Stimulus word selected and read as a distractor

As well, all correct and incorrect readings for test words were further coded on the basis of whether the response was characterized by a sounding-out (indirect retrieval), or whole-word (direct retrieval) reading response. Examples of each of these categories are shown in Appendix C.
Data Scoring

The following section describes the dependent variables and their relevance to this investigation, as presented in a theoretical context and supporting rationale for the employed methodology.

As acquisition is viewed as episodic in nature, and involving visual, auditory, and semantic processes it became apparent that, in order to propose a theory of acquisition, the methodology itself must reflect this progression. Thus, as acquisition does not occur at least in most instances with a single exposure, numerous opportunities through which the learner could successively progress towards the learning of new reading words warranted that a series of learning trials be employed. In this regard, one trial involved the presentation of the entire task (i.e., training and testing). In this way, subsequent to the training, any improved performance from the previous trial could serve as an indication of further learning. Yet, in order to determine when learning was complete, criterion was set at two successive trials in which all words were correctly selected and read, or for six trials in total. Thus, given that subjects may complete all six trials for all six words simultaneously for two successive trials, comparisons would be based on the number of correct responses for individual words in trials to criterion.

Limitations

As with most basic research designs there are certain limitations in the degree to which findings can be said to be generalizable to a population, and most certainly where the poor reader is concerned. Thus, in addition to the many tasks faced by today’s
The text on this page is not legible due to the resolution and angle of the image. It appears to be a page from a book or a document, but the content is not discernible.
classroom teacher, attempts to develop word recognition efficiency in the poor reader would need to be as varied as the individual learners themselves. This study only examined two such approaches, however. With respect to the evaluation of the degree to which learning is enhanced by explicit phonics training, we do not know what amount of letter-sound knowledge the subjects in this study possessed. It is, therefore, difficult to comment on the amount of improvement made by subjects in the explicit training condition. Additionally, although transfer data for these Ability groups has been gathered, until this is analyzed by the Reading Clinic at Brock University, the question of which type of training effected transfer of learning most is not known. Moreover, such an analysis would have to some degree presented indications of differing strategy use in the acquisition of transfer words. Another important question that cannot be answered by this study is, if the poor reader takes longer to advance to the stage of whole word recognition, how much more learning time is required? Unfortunately, as acquisition cannot be fully measured over a few simple exposures to words, the nature of the task in this study precludes answering this question.

This study was also limited to examining word learning without strong semantic or context effects. Although the subjects in the study treated the pseudo-words as real surnames and although these surnames were embedded in meaningful sentences, it is doubtful that they carried as much meaning as concrete nouns or verbs. Furthermore, although the sentence contexts that were constructed added to the meanings of the stimulus words, it is unlikely that the contribution of this type of context to word recognition was anywhere near the effects achieved with common nouns in a story.
context. However, a comparison to real word learning data was used to at least partially address this limitation.
CHAPTER FOUR: RESULTS

The major findings that emerged from this study are presented in Figures 1, 2, and 3, and refer to the mean number of trials and errors to criterion for Ability, Training, and Wordtype respectively. Additional results pertaining to the central hypotheses of this investigation appear in the subsequent Figures and refer to the mean number of trials and errors to criterion for Ability groups and their respective Training conditions on Word Family and Single Word stimuli on the free recall, reading response to the visual recognition memory choice, and the visual recognition memory choice dependent measures respectively. The results are presented in sections which correspond to the stated hypotheses regarding these three measures, in addition to the predicted differences for Training and Word Family versus Single Word stimuli. Attention is then focused on the types of responses and strategies which are categorized and explained prior to this analyses. Following this, the proportion of strategy use in acquisition is examined, prior to a review of these patterns in relation to the learning acquisition curves for real words. First, however, the results of the pre-test word identification screening subtest are reported, followed by a description of how task responses for the dependent variables were converted to means, after which the type of statistical analyses employed is stated before turning to the results proper.
Pre-Treatment Measures

As stated in the Methods section of the previous chapter, the mean word identification scores for the normal readers and the poor readers were 4.84, (S.D. = 3.19) and 2.4, (S.D. = .613) respectively. T-tests showed that for the Word Identification scores $t(61) = 4.00, p = .000$, the normal readers performed significantly better than the poor readers.

Experimental Results

The proportion of correct responses in the mean number of trials and errors to criterion for the free recall, reading response to the visual recognition memory choice (VRM-R), and the visual recognition memory choice (VRM) dependent measures were calculated. For each pseudo-word criterion was reached when subjects achieved two successive correct responses. Similarly, loss of criterion was marked by two consecutive errors. Correct responses to the dependent measures for all six pseudo-words over two consecutive trials did not occur for any individual subject in either ability group, and thus, all six trials were completed by all subjects. A two between groups Ability (normal vs. poor readers) and Training (Mixed Phonics Explicit vs. Phonics Implicit training) and a one within group Wordtype (word family vs. single words) MANOVA was conducted for each dependent measure.
Figure 1. Mean number of trials (TC) and errors (EC) to criterion for Ability groups on the Free Recall (FR), Reading Response to the Visual Recognition Memory choice (VRM-R), and Visual Recognition Memory choice (VRM) dependent measures.
Figure 2. Mean number of trials (TC) and errors (EC) to criterion for Training on the Free Recall (FR), Reading Response to the Visual Recognition Memory choice (VRM-R), and Visual Recognition Memory choice (VRM) dependent measures.
Figure 3. Mean number of trials (TC) and errors (EC) to criterion for Wordtype on the Free Recall (FR), Reading Response to the Visual Recognition Memory choice (VRM-R), and Visual Recognition Memory (VRM) choice dependent measures.
Free Recall

The hypothesis that the normal reader subjects would engage in more verbal code formation than the poor reader predicted that a main effect for Ability would be noted on the Free Recall measure. As noted in Figure 4, in this regard the performance of poor readers' was significantly below the level of the normal readers on this measure. Thus, as indexed by the mean number of correct free recall responses for the stimulus items, a main effect for Ability on trials to criterion, F (1, 59) = 16.51, p = .000, and errors to criterion F (1, 59) = 40.11, p = .000 was shown. This, of course, replicates previous findings (Vellutino & Scanlon, 1987), and also suggests that poor reader subjects in this sample were significantly impaired in acquiring and codifying the stimulus pseudo-words as unitized auditory representations.

Visual Recognition Memory Choice Reading Response (VRM-R)

As anticipated, the examination of the reading responses to the visual recognition memory choice data revealed a significant main effect for Ability groups in both trials to criterion F (1, 59) = 15.61, p = .000, and errors to criterion F (1, 59) = 19.29, p = .000. Consistent with previous findings, this result lends further support to the verbal coding deficit hypothesis advanced for poor readers (see Figure 5.).

Additionally, other significant main effects for reading responses to the visual recognition memory choice were noted in trials to criterion for Training, F (1, 59) = 12.61, p = .001, and Wordtype, F (1, 59) = 12.94, p = .001, and in errors to criterion for
Figure 4. Mean number of trials (TC) and errors (EC) to criterion for normal and poor reader ability groups on the Free Recall (FR) dependent measure.
Figure 5. Mean number of trials (TC) and errors (EC) to criterion for normal and poor reader ability groups on the Reading Response to the Visual Recognition Memory (VRM-R) choice measure.
these two factors, $F(1, 59) = 10.79, p = .002, F(1, 59) = 17.84, p = .003$, respectively. These results are presented in Figures 6 and 7.

As can be seen in Figures 8 and 9 respectively, interactions were observed between Ability by Training by Wordtype, $F(1, 59) = 4.14, p = .046$, for the trials to criterion data, and between Ability by Training by Wordtype, $F(1, 59) = 6.09, p = .017$, for the error to criterion results for reading responses to the visual recognition memory choice measure.

Post hoc Scheffe tests ($p < .05$) confirmed that there was a significant difference between Phonics Implicit and the Mixed Phonics Explicit Training for Word Family stimuli in the normal reader group, but not for the poor reader group. There was also a significant difference within the Mixed Phonics Explicit Training between Word Family and Single Word stimuli for the normal readers, but not for the poor readers. These same differences were observed for the errors to criterion data as confirmed by Scheffe's post hoc tests ($p < .05$).

This three-way interaction clearly indicates that the normal readers were benefitting from the word family structure when the structure was made explicit, (i.e., normal reader subjects in the Mixed Phonics Explicit Training condition significantly outperformed normal reader subjects in the Phonics Implicit condition, on the reading of word family stimuli). The mean trials and errors to criterion for this measure indicate that Mixed Phonics Explicit Training subjects had proportionately fewer trials, $M = 5.88$ (6.45), and errors, $M = 5.06$ (5.41), to criterion in the reading of Word Family stimuli than the Phonics Implicit Training subjects respectively $M = 13.5$ (5.27), $M = 11.81$
Figure 6. Mean number of trials (TC) and errors (EC) to criterion for Training on the Reading Response to the Visual Recognition Memory (VRM-R) choice measure.
Figure 7. Mean number of trials (TC) and errors (EC) to criterion for Wordtype on the Reading Response to the Visual Recognition Memory (VRM-R) choice measure
Figure 8. Ability by Training by Wordtype interaction in the trials to criterion data for Reading Responses to the Visual Recognition Memory choice (MPE) Mixed Phonics Explicit, (PI) Phonics Implicit, (WF) Word Family, (SW) Single Word)
Figure 9. Ability by Training by Wordtype interaction in the errors to criterion data for Reading Responses to the Visual Recognition Memory choice (MPE) Mixed Phonics Explicit, (PI) Phonics Implicit, (WF) Word Family, (SW) Single Word
Similarly, the proportion of trials to criterion were significantly fewer for word family stimuli \( M = 5.88 \) (6.45) compared to single word types \( M = 10.53 \) (5.46) within the normal Mixed Phonics Explicit Training condition. This pattern was also observed in the errors to criterion data word family stimuli \( M = 5.06 \) (5.41) and single word types \( M = 9.41 \) (5.17).

**Visual Recognition Memory (VRM)**

There was no main effect noted for the difference between the poor and normal readers on the visual (code formation) recognition memory response measure, \( F(1, 59) = 1.87, \) ns. A second analysis on the visual recognition memory responses for the first three trials likewise showed no significant between group differences \( F(1, 59) = 2.21, \) \( p = .142, \) thus suggesting that poor readers are as equally adept as normal readers in establishing visual recognition memory codes. However, as presented in Figures 10 and 11, significant main effects for the visual (code formation) recognition memory measure were found in trials to criterion for Training, \( F(1, 59) = 11.58, \) \( p = .001, \) and Wordtype, \( F(1, 59) = 7.16, \) \( p = .012. \) Similarly, a significant main effect was found for errors to criterion for Training, \( F(1, 59) = 9.34, \) \( p = .003, \) and for Wordtype, \( F(1, 59) = 11.17, \) \( p = .001. \) An interaction was also observed between Training and Wordtype in the trials to criterion data, \( F(1, 59) = 4.48, \) \( p = .039 \) (see Figure 12.), but not in the errors to criterion measure, \( F(1, 59) = 1.07, \) ns. The two-way interaction indicates that that both normal and poor readers may have been benefitting from the word family structure when the structure was made explicit. This finding was confirmed with Scheffe's post hoc tests (\( p < .05 \)).
Figure 10. Mean number of trials (TC) and errors (EC) to criterion for Training on the Visual Recognition Memory (VRM) choice measure.
Figure 11. Mean number of trials (TC) and errors (EC) to criterion for Wordtype on the Visual Recognition Memory (VRM) choice measure.
Figure 12. Training by Wordtype Interaction in the trials to criterion data for the Visual Recognition Memory choice measure.
Data on Strategy Use

As the examination of the types of errors made by children with learning disabilities was intended to account for word recognition processes that are both common and different among normal and poor readers, a two between groups Ability (normal vs. poor readers) and Training (Mixed Phonics Explicit vs. Phonics Implicit training) and a one within group Wordtype (word family vs. single words) MANOVA was conducted for the following dependent response type measures: distractor choices read as stimulus words; correct and incorrect whole-word reading responses; correct and incorrect sounding-out reading responses, correct and incorrect whole-word reading of distractor choices; correct and incorrect sounding-out responses to distractor choices. Within these measures, Ability group differences for verbal code formation and verbal code mapping were expected to surface in the proportion of distractors being read as stimulus words, and whole-word reading responses to stimulus words respectively. Thus, as it has been suggested that poor readers may focus strictly on visual code formation, it was anticipated that they would be less likely to read a distractor as a stimulus word. Similarly, the poor readers would have significantly fewer whole-word reading responses as a result of their encountered difficulties in verbal code mapping. Overall, it was further expected that sounding-out approaches to identification for both stimulus and distractor items would be greatest for poor readers, and that the proportion of these strategies would be greater still in the Phonics Implicit condition. In this regard, it was felt that those readers who received explicit phonetic training would rely more on sounding-out approaches as more
...
detailed orthographic and phonological representations would arise in consequence of this training.

**Distractors Read as Stimulus Words**

Analysis of the proportion of responses wherein distractor stimuli were read as stimulus words (taken as a measure of verbal code formation) showed a significant main effect for Ability, $F(1, 57) = 53.70, p = .000$ (see Figure 13), and an interaction was observed between Training and Wordtype, $F(1, 59) = 4.07, p = .048$. However, post-hoc Scheffe tests ($p < .05$) showed that differences within this interaction were not significant.

**Whole-Word Reading Responses for Stimulus Words**

The examination of the types of reading responses to the visual recognition memory choice data also showed a significant main effect for Ability groups in the number of correct whole-word reading type responses to stimulus words, $F(1, 59) = 42.15, p = .000$ (see Figure 14). Other significant main effects for this measure were noted for Training, $F(1, 59) = 9.67, p = .003$ (see Figure 15), and Wordtype, $F(1, 59) = 1.42, p = .000$ (see Figure 16). As presented in Figure 17, an interaction was observed between Ability by Training by Wordtype, $F(1, 59) = 6.75, p = .012$.

Post-hoc Scheffe tests ($p < .05$) showed that there was a significant difference between Ability groups for Word Family stimuli in the Mixed Phonics Explicit Training condition, and between Ability groups for Single Word stimuli in Phonics Implicit Training. There was also a significant difference within the Mixed Phonics Explicit
Figure 13. Mean proportion of distractor choices read as stimulus words as defined by Ability
Figure 14. Mean proportion of correct whole word reading responses to stimulus words as defined by Ability.
Figure 15. Mean proportion of correct whole word reading responses to stimulus words as defined by Training.
Figure 16. Mean proportion of correct whole word reading responses to stimulus words as defined by Wordtype.
Figure 17. Mean proportion of correct whole word reading responses to correctly selected stimulus words on the Visual Recognition Memory choice measure (MPE) Mixed Phonics Explicit, (Pi) Phonics Implicit, (WF) Word Family, (SW) Single Word
Training between Word Family and Single Word stimuli for the normal readers, but not for the poor readers. Other significant differences occurred between Mixed Phonics Explicit Training and Phonics Implicit Training for Word Family stimuli in the Normal reader Ability group. Thus, it is clear that the normal readers in both the Mixed Phonics Explicit Training and the Phonics Implicit Training conditions were significantly better than the poor readers in these respective Training conditions at providing correct whole-word reading responses. Likewise, as was anticipated, the benefits arising from the repeated structure in word family stimuli was greatest in the explicit training condition.

The proportion of incorrect whole-word reading responses for stimulus words showed a main effect approaching significance for Ability groups, \( F(1, 59) = 3.79, p = .056 \), and an interaction was observed between Ability and Training, \( F(1, 59) = 7.28, p = .009 \). However, Post-hoc Scheffe tests \((p < .05)\) showed that within this interaction there were no significant differences.

**Sounding-Out Reading Responses for Stimulus Words**

An examination of the proportion of stimulus words read correctly by a sounding-out approach showed a significant main effect for Training only, \( F(1, 59) = 4.70, p = .034 \) (see Figure 18). However, the proportion of sounding-out attempts that resulted in incorrect reading responses to stimulus words yielded significant main effects for Ability, \( F(1, 59) = 51.37, p = .000 \) (see Figure 19), and Training, \( F(1, 59) = 17.47, p = .000 \) (see Figure 20). As presented in Figure 21, an interaction was also observed between Ability and Training, \( F(1, 59) = 10.77, p = .002 \).
Figure 18. Mean proportion of stimulus words read correctly by a sounding out approach as defined by Training.
Figure 19. Mean proportion of stimulus words read incorrectly by a sounding out approach as defined by Ability.
Figure 20. Mean proportion of stimulus words read incorrectly by a sounding out approach as defined by Training
Figure 21. Ability by Training interaction for the mean proportion of sounding out reading attempts that resulted in incorrect responses for stimulus items on the Visual Recognition Memory choice measure.
Post-hoc Scheffe tests ($p < .05$) showed that there was a significant difference between Ability groups in the Phonics Implicit Training, and between Mixed Phonics Explicit and Phonics Implicit Training in the poor reader Ability group. This finding suggests that poor readers in the Mixed Phonics Explicit Training were less likely than their poor reader counterparts in the Phonics Implicit Training condition to employ a sounding out strategy. This finding is interesting given that phonics instruction is usually found to influence analytical approaches to reading words. However, in this instance, the explicit training received by the poor reader subjects may have facilitated learning the whole stimulus which in turn precluded their having to apply a sounding out strategy.

**Whole-Word Reading Responses for Distractor Stimuli**

Analysis of correct whole-word reading responses for distractor-type stimuli showed a main effect only for Training, $F(1, 57) = 8.74, p = .005$ (see Figure 22). Incorrect whole-word reading responses for distractor stimuli however, showed a significant main effect for Wordtype, $F(1, 57) = 10.91, p = .002$ (see Figure 23), and an Ability by Training interaction was observed, $F(1, 57) = 5.17, p = .027$, however, Post-hoc Scheffe tests ($p < .05$) revealed that these differences were not significant.

Analysis of the proportion of sounding-out attempts that resulted in correct readings for distractor-type stimuli could not be performed as the variables did not have any variance. This arose as a consequence of sounding-out attempts for distractor stimuli being made only by the Mixed Phonics Explicit and the Phonics Implicit Training conditions in the poor reader Ability group. On the other hand, sounding-out attempts
Figure 22. Mean proportion of correct whole word reading responses for distractor choices as defined by Training.
Figure 23. Mean proportion of incorrect whole word reading responses for distractor choices as defined by Wordtype
which resulted in incorrect reading responses to distractor stimuli yielded significant main effects for Ability, $F(1, 57) = 40.26, p = .000$, Training, $F(1, 57) = 13.33, p = .001$, and Wordtype, $F(1, 57) = 11.03, p = .002$. These main effects are presented respectively in Figures 24, 25, and 26. A two-way interaction, as presented in Figure 27, was observed between Ability by Training, $F(1, 57) = 8.58, p = .005$, and between Training by Wordtype, $F(1, 57) = 7.13, p = .010$ (see Figure 28). Post-hoc Scheffe tests ($p < .05$) showed that for the Ability by Training interaction there was a significant difference between Ability groups in the Phonics Implicit Training condition, and between Mixed Explicit Training and Phonics Implicit Training in the poor reader Ability group. Post-hoc analysis of the Ability by Wordtype interaction showed that there was a significant difference between Ability groups for Single Word stimuli.
Figure 24. Mean proportion of incorrect sounding out reading responses for distractor choices as defined by Ability
Figure 25. Mean proportion of incorrect sounding out reading responses for distractor choices as defined by Training.
Figure 26. Mean proportion of incorrect sounding out reading responses to distractor choices as defined by Wordtype.
**Figure 27.** Ability by Training interaction for the mean proportion of incorrect sounding out reading responses to distractor choices
Figure 28. Training by Wordtype interaction for the mean proportion of incorrect sounding out reading responses to distractor choices.
Verbal Acquisition Patterns

First, as presented in Table 1, the total number of correct and incorrect responses showed that for poor readers 43.1% of the indirect retrieval responses occurred in the first half of the trials to criterion, compared with 19.9% in the second half of these trials. For normal readers the figures were 3.4% and 3.1% respectively. These percentages are contrasted with 56.9% of direct retrieval responses for poor readers in the first half of trials to criterion, and 80.1% in the second half of acquisition. Percentages of direct retrieval responses for the normal readers in the first and second half of acquisition were 96.6% and 96.9% respectively.

Thus, although it is evident that sounding out strategies are gradually replaced by whole word strategies during learning, in the initial stages of acquisition the poor readers clearly have a substantially larger proportion of sounding out attempts. For the normal readers, the use of whole word strategies clearly predominate in both the first and second halves of the acquisition process. Thus, it could be inferred from this data that the normal readers’ early reliance on whole word strategies is indication that a whole word verbal code representation was already largely established. This should not, however, be taken to mean that this whole word representation was necessarily correctly linked to the visual stimulus, as can be seen from the proportion of sounding out and whole word reading attempts that resulted in both correct and incorrect reading responses, as presented in Tables 2 and 3 respectively.
Table 1

Total proportion of whole word and sounding out strategy use for both Word Family and Single Word stimuli as defined by Ability

<table>
<thead>
<tr>
<th></th>
<th>Sounding out</th>
<th>Whole word</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Half</td>
<td>Second Half</td>
</tr>
<tr>
<td>Normal</td>
<td>3.4%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Poor</td>
<td>43.1%</td>
<td>19.9%</td>
</tr>
</tbody>
</table>
Table 2

Total proportion of correct whole word and sounding out strategy use for combined Word Family and Single Word stimuli as defined by Ability and Training

<table>
<thead>
<tr>
<th></th>
<th>Sounding out</th>
<th>Whole word</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Half</td>
<td>Second Half</td>
</tr>
<tr>
<td>MPE Normal</td>
<td>0</td>
<td>.35%</td>
</tr>
<tr>
<td>MPE Poor</td>
<td>0</td>
<td>1.4%</td>
</tr>
<tr>
<td>PI Normal</td>
<td>.6%</td>
<td>2.6%</td>
</tr>
<tr>
<td>PI Poor</td>
<td>1.8%</td>
<td>1.7%</td>
</tr>
</tbody>
</table>

(MPE) Mixed Phonics Explicit, (PI) Phonics Implicit
Table 3

Total proportion of incorrect whole word and sounding out strategy use for combined Word Family and Single Word stimuli as defined by Ability and Training

<table>
<thead>
<tr>
<th></th>
<th>Sounding out</th>
<th>Whole word</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Half</td>
<td>Second Half</td>
</tr>
<tr>
<td>MPE Normal</td>
<td>2.8%</td>
<td>0%</td>
</tr>
<tr>
<td>MPE Poor</td>
<td>26.1%</td>
<td>8.0%</td>
</tr>
<tr>
<td>PI Normal</td>
<td>3.4%</td>
<td>3.3%</td>
</tr>
<tr>
<td>PI Poor</td>
<td>58.3%</td>
<td>28.8%</td>
</tr>
</tbody>
</table>

(MPE) Mixed Phonics Explicit, (PI) Phonics Implicit
Thus overall, an evaluation of strategy use yields interesting comparative insights into the acquisition processes of poor readers. Clearly, although there is a general shift in these readers’ application of sounding out to whole word strategies, their reliance on indirect retrieval strategies in both the first and second halves of acquisition suggests that poor readers take much longer than normal readers to advance to the application of whole word strategies. Similarly, given the high incidence of reading errors at this stage, it would appear that learning is still incomplete when the shift to whole word strategies has occurred (see Table 4).

In this regard, 56.9% of direct retrieval attempts in the first half of the trials to criterion resulted in 15.5% of responses being correct, and 41.4% of responses being incorrect. The proportion of correct and incorrect whole word responses in the second half of acquisition were 30.1% and 49.5% respectively, based on 80.1% of whole word reading attempts. In contrast, normal readers had 53.5% correct and 43.1% incorrect responses in the first half of acquisition with a total of 96.6% of whole word attempts. The second half of these acquisition trials showed 76.6% of correct responses and 20.3% incorrect responses based on 96.9% of whole word attempts. Thus, it is apparent that readers do not necessarily move to whole word attempts when the correct pronunciation of the whole word’s name is achieved. Similarly, the proportion of differences as defined by Training conditions and performance on Word Family versus Single Word types further showed that the highest incidence of error occurred for the Phonics Implicit Training condition on single words, which again attests to how differing forms of instruction may influence the types of strategies employed.
Table 4

Proportion of whole word attempts in the first and second half of acquisition trials that resulted in correct and incorrect proportions

<table>
<thead>
<tr>
<th></th>
<th>First Half</th>
<th></th>
<th></th>
<th></th>
<th>Second Half</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Attempts</td>
<td>Correct</td>
<td>Incorrect</td>
<td></td>
<td>Attempts</td>
<td>Correct</td>
<td>Incorrect</td>
<td></td>
</tr>
<tr>
<td>Poor Readers</td>
<td>56.9%</td>
<td>15.5%</td>
<td>41.4%</td>
<td></td>
<td>80.1%</td>
<td>30.1%</td>
<td>49.5%</td>
<td></td>
</tr>
<tr>
<td>Normal Readers</td>
<td>96.6%</td>
<td>53.5%</td>
<td>43.1%</td>
<td></td>
<td>96.9%</td>
<td>76.6%</td>
<td>20.3%</td>
<td></td>
</tr>
</tbody>
</table>
Visual Acquisition Patterns

The examination of visual recognition memory choice errors likewise reveals some interesting patterns and differences for both Ability and Training in visual code formation for new reading words. Here, although no significant differences between Ability groups emerged, there are observable differences that can be noted in the proportion of stimulus and distractor words selected. (These means are reported in Table 5.)

First, from a possible mean score of $M = 18.00 (0.00)$, poor reader subjects in the Mixed Phonics Explicit Training and Phonics Implicit Training conditions averaged $M = 15.00 (5.00)$ and $M = 12.13 (4.17)$ respectively on the correct selection of Word Family stimuli. These means in the normal reader Ability group were $M = 14.77 (3.99)$ and $M = 10.00 (5.18)$ for the respective Training conditions. Thus, to some degree, although not substantially different for readers in the Mixed Phonics Explicit condition, it would appear that the poor readers in the Phonics Implicit Training were performing slightly better on this measure of visual code formation than their normal reader counterparts. Overall, as can be seen in Table 6, performance on the correct selection of Single Word stimuli would appear to favour both Training conditions in the poor reader Ability group.

Again, from a possible mean score of $M = 18.00 (0.00)$, poor readers in the Mixed Phonics Explicit and Phonics Implicit Training conditions averaged $M = 13.87 (4.78)$ and $M = 11.33 (4.75)$ respectively, compared to mean scores of $M = 11.94 (3.68)$ and $M = 9.25 (4.01)$ for these respective Training conditions in the normal reader Ability group.
Table 5

Mean proportion of stimulus and distractor selections for Word Family stimuli on the Visual Recognition Memory choice measure, (MPE) Mixed Phonics Explicit, (PI) Phonics Implicit

<table>
<thead>
<tr>
<th>Word Family</th>
<th>Stimulus $M$ ($SD$)</th>
<th>Distractor $M$ ($SD$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPE Normal</td>
<td>14.765 (3.993)</td>
<td>3.235 (3.993)</td>
</tr>
<tr>
<td>MPE Poor</td>
<td>15.00 (5.00)</td>
<td>3.00 (5.00)</td>
</tr>
<tr>
<td>PI Normal</td>
<td>10.00 (5.177)</td>
<td>8.00 (5.177)</td>
</tr>
<tr>
<td>PI Poor</td>
<td>12.133 (4.172)</td>
<td>5.867 (4.172)</td>
</tr>
</tbody>
</table>

(MPE) Mixed Phonics Explicit, (PI) Phonics Implicit
Table 6


<table>
<thead>
<tr>
<th>Single Word</th>
<th>Stimulus $M$ ($SD$)</th>
<th>Distractor $M$ ($SD$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPE Normal</td>
<td>11.941 (3.682)</td>
<td>6.059 (3.682)</td>
</tr>
<tr>
<td>MPE Poor</td>
<td>13.867 (4.779)</td>
<td>4.133 (4.779)</td>
</tr>
<tr>
<td>PI Normal</td>
<td>9.250 (4.008)</td>
<td>8.750 (4.008)</td>
</tr>
<tr>
<td>PI Poor</td>
<td>11.333 (4.746)</td>
<td>6.667 (4.746)</td>
</tr>
</tbody>
</table>

(MPE) Mixed Phonics Explicit, (PI) Phonics Implicit
However, taken in the form of a percentage for the first and second halves of the acquisition process, it can clearly be seen that the proportion of stimulus and distractor choices on the visual recognition memory choice measure are greatest in the Phonics Implicit Training conditions, as can be seen from Table 7.

Here, in the first three trials, the proportion of correctly and incorrectly selected stimulus words for poor reader subjects in the Phonics Implicit Training condition was 64.4% and 35.5% respectively, as compared with 56.9% and 43.1% for the normal reader subjects in the same Training condition. The figures for the second half of the acquisition trials were 70.4% stimulus choices and 29.6% distractor for the poor reader subjects in the Phonics Implicit Training condition, and 54.2% stimulus, and 45.8% distractor for normal reader subjects in the same Training condition. Thus, as can be seen the percentage of correctly selected stimulus words was larger in the poor reader Ability group in the second half of acquisition. Similarly, the percentage of distractor words selected was much lower for these poor readers in the Implicit Training condition.

Visual and Verbal Code Acquisition Patterns

The differences in acquisition for these Ability groups and Training conditions are best reviewed in a comparison of the learning curves for both the visual and verbal task measures as presented in Figures 29 and 30. In this regard, the pattern of visual recognition and verbal identification in acquisition provides insight into the degree to which the formation of visual and verbal codes are apparently separate or mutually assistive in identification.
Table 7

Proportion of stimulus and distractor choices made by normal and poor reader subjects in the Phonics Implicit (PI) Training condition on Visual Recognition Memory choice measure in the first and second half of acquisition trials

<table>
<thead>
<tr>
<th>First Half</th>
<th>Stimulus</th>
<th>Distractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI Normal</td>
<td>56.9%</td>
<td>43.1%</td>
</tr>
<tr>
<td>PI Poor</td>
<td>64.4%</td>
<td>35.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second Half</th>
<th>Stimulus</th>
<th>Distractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI Normal</td>
<td>54.2%</td>
<td>45.8%</td>
</tr>
<tr>
<td>PI Poor</td>
<td>70.4%</td>
<td>29.6%</td>
</tr>
</tbody>
</table>
Overall, as presented in Figures 29 and 30, as the visual recognition memory performance of normal reader subjects in the Phonics Implicit Training condition decreased in the latter half of acquisition, substantial gains were made in the proportion of correct reading responses. This would suggest that at this stage of acquisition these subjects began to focus more on establishing a verbal response code for the visual stimulus, than on completing the visual learning. Similarly, in the first half of the acquisition trials, the normal reader subjects in this Implicit condition appear to have made relatively similar gains with respect to providing both correct visual recognition memory choices and reading responses to these. However, the gains made in the visual selection of these stimuli were not quite as steep as those for the reading of these, which would again suggest that the coding processes involved in this acquisition are more verbally than visually driven. Similarly, the normal reader subjects in the Mixed Phonics Explicit Training condition appear to have given greater precedence to forming a verbal code in the initial stages of acquisition as the proportion of correct reading responses to the visual recognition memory choices steadily increased in rather sharp contrast to the choices themselves. However, it would appear that performance on both measures in the latter half of the acquisition trials is relatively matched, thus suggesting that both orthographic and phonologic information may have been mutually facilitative in assisting both recognition and identification. Thus, taken as a whole, a comparison between normal readers in the two respective training conditions suggests that explicit training assists recognition, identification, and overall rate of acquisition most. Sharp contrasts in the integration of these two processes for normal reader subjects in the Phonics Implicit Training condition are especially noticeable in the latter half of the acquisition trials. In
Figure 29. Mean proportion of correctly selected stimuli on the Visual Recognition Memory choice measure over six trials (MPE) Mixed Phonics Explicit, (PI) Phonics Implicit
Figure 30. Mean proportion of correct Reading Responses to correctly selected stimuli on Visual Recognition Memory choice measure over six trials, (MPE) Mixed Phonics Explicit, (Pi) Phonics Implicit
this regard it appears as though there had been a shift in acquisition strategies for these readers approximately mid-way in the learning. In comparison, the performance of poor reader subjects in these respective Training conditions shows comparatively similar gains in both visual and verbal code formation in the initial stages of acquisition, however, that recognition and identification is not mutually assisted by the integration of these coding systems is clearly illustrated in the existing gaps between the correct selection of visual stimuli and the reading of these. However, it is nevertheless interesting to note that as gains in verbal code mapping are made by poor reader subjects in the Phonics Implicit Training condition between the third and fourth, and fourth and fifth trials respectively, no gain is made in the visual recognition of stimuli between the third and fourth trial, and likewise there is a sharp drop in performance on this measure between the fourth and fifth trial as the verbal identification of stimuli appears to peak for these readers before dropping off between the two final trials. Interestingly, as this decline in the reading of stimuli between the fifth and sixth trial occurs, there is a corresponding increase in visual recognition memory choice performance. Thus, although largely separated by differences in the proportion of correct visual recognition memory choices and the reading of these, gains in one process are contrasted by a decrease in performance on the other, suggest that these two processes are not coordinated during acquisition or at test. This opposite growth pattern in performance can likewise be noted for poor reader subjects in the Mixed Phonics Explicit Training condition in the latter half of acquisition.
Real Word Acquisition

In the interest of knowing how these patterns of acquisition for pseudo-words may differ qualitatively from the learning of real words, the learning curve for these latter stimuli is presented alongside of the acquisition trials for pseudo-words in Figures 30 and 31. As the normal reader subjects in this investigation \( n=19 \) (Mean C.A. = 7.8) did not receive explicit letter-sound correspondence training, it would seem most appropriate that the performance of these readers be compared with that of the normal reader subjects in the Phonics Implicit Training condition. Moreover, it should be noted that this investigation employed the same training and testing format, and conditions as the current one being reviewed. Additionally, it should be stated that the real word stimuli were selected as unknown, not previously read words on the basis of subjects’ inability to identify the words on a pre-test measure. This process involved having subjects read word lists from which six words unknown to them were selected to be used as stimulus items in a subsequent acquisition task. Thus, each set of words differed for each subject according to a prior demonstrated lack of familiarity. The data was collected under the supervision of Dr. Wagner and the Brock University Reading Clinic, and permission to use this data was granted by Dr. Wagner.

As can be seen from Figure 31, the visual code formation for real words demonstrates a steady increase in performance in the initial three trials of acquisition. Although the performance on this measure is comparatively lower for normal reader subjects in the Phonics Implicit condition, it is interesting to note that the proportion of correct visual recognition memory choices is nevertheless within a range that is
Figure 31. Mean proportion of correctly selected stimuli for real word data and pseudo-words on the Visual Recognition Memory choice measure over six trials (MPE) Mixed Phonics Explicit, (PI) Phonics Implicit
observed with normal reader subjects in the pseudo-words Mixed Phonics Explicit Training condition. This would suggest that despite the use of pseudo-words, the explicit training appeared to have the same effects as with real words. This aside, in spite of the differences in the proportion of correctly selected real and pseudo-words, similar gains in the visual recognition memory code formation appear to be occurring for both of these groups during the initial stages of acquisition. Similarly, as can be seen in Figure 32, this pattern of gains appears to be consistent with the reading of these recognition memory choices. However, what is most significant in this course of acquisition is that between the third and fourth trial the proportion of correct reading responses for real words is matched by the performance of normal readers in the Phonics Implicit Training condition, thus suggesting that both real and pseudo-word stimuli were being identified with equal accuracy. In this regard, by the end of the testing stage in the third trial of this acquisition task all subjects would have had 30 exposures to the words being learned. This suggests that with repeated exposure pseudo-words gain wordlike properties and are consequently treated as lexical items. This is consistent with investigations in which it has been suggested that over a number of trials identification is in part facilitated by the development of episodic memory traces that at some point converge to establish a permanent memory code for the presented item (Feustal et al., 1985). Further, it has been suggested that the identification of the presented item is facilitated in part by the development of a memory trace that serves to respond as a single unit or memory code that can be triggered even by fragmented input information as in the identification of a set of letter features (Feustal et al., 1985).
Figure 32. Mean proportion of correct Reading Responses to correctly selected real and pseudo-word stimuli on Visual Recognition Memory choice measure over six trials, (MPE) Mixed Phonics Explicit, (PI) Phonics Implicit
CHAPTER FIVE: DISCUSSION AND CONCLUSIONS

This chapter focuses on the discussion of findings and the relevance of these to previous research, namely that which involves the roles of establishing an auditory memory code, verbal code mapping, and visual code formation, within the context of multiple coding in poor and normal readers’ visual and verbal processing systems. Additional accounts of the cumulative pattern of acquisition for these Ability groups is discussed, as well as processing mechanisms that may be regarded as contributing to the poor readers’ encountered difficulties in forming accurate visual-verbal associations, with an overall view to illuminate some of the fundamental theoretical issues surrounding the poor readers’ inadequacies of reading, in the context of proposed educational aims.

The principal question addressed in this study was whether or not poor readers would develop visual recognition memories for new reading words at a faster rate than their normal counterparts. The hypothesis was connected to the finding that poor readers have a verbal processing deficit and that the visual processing ability of these readers can be regarded as normal. Thus, it was further suggested that poor readers may have visual and verbal coding systems that are poorly co-ordinated. Consequently, the employment of the forced choice visual recognition memory task, and the separate requirement of providing a reading response to the memory choice would demonstrate the degree to which these processes can be regarded as operating with limited co-ordination in the poor reader. In this regard, that subjects were asked to provide a reading response for the selected word would require the integration of these two codes. Consequently, where the development of one code is only partially intact, item availability would be hindered.
Thus, for poor readers a matched performance to normal readers on the visual recognition memory task, and significant differences emerging on the reading response measure would indicate possible Ability differences in each of the two coding systems. Thus, in order to assess the hypothesis that poor and normal readers would differ in the links that are made between visual and verbal coding systems, the inclusion of separate visual and verbal identification tasks was employed to this end.

In this regard, the forced-choice visual recognition memory task was presented separately since it has been shown that the isolation of component processes as induced by task requirements is critical in examining the degree to which these processes are operating independently (Hoover & Tunmer, 1993; Ellis, 1994). Thus, given previous indications that poor readers have a verbal coding deficit (Vellutino, 1979), it was predicted that visual code formation would be equal for these two ability groups, whereas differences would be observed for the reading or retrieval of the name associated with the visual stimulus. The principal focus of this investigation aimed to evaluate the degree to which the development of visual codes was equal for these Ability groups, and the degree to which the development of these codes reflect combined visual-verbal or separate visual-verbal representations. There was, of course, an additional curiosity in the influences of explicit phonetic training and word family stimuli on orthographic and phonologic code acquisition. With regard to this investigation’s principal aims, it was assumed that if the poor readers’ coding operations were poorly co-ordinated, then no differences would be noted in these readers’ performance on the visual recognition memory choice measure since this task did not require the integration of visual and verbal codes. However, procedures that require poor readers to combine the two codes,
especially when the one code is weak, should cost the subject in terms of poor between
code co-ordination (Swanson, 1987). It is this association between a word’s verbal code
and its visual form that is seen to contribute to the activation of a flexible coding network
of both verbal and nonverbal associations (Swanson, 1987). Likewise, it has been
suggested that the manner in which these codes combine in memory may account for
Ability group differences (Swanson, 1987). With respect to secondary interests, it was
reasoned that if poor readers exhibit a tendency to not fully analyze the interior
components of words, then a training condition in which the reader’s attention is drawn to
orthographic and phonologic similarities in word family stimuli may assist the
development of orthographic and phonologic codes.

Overall, with respect to the hypotheses advanced for this study, as anticipated
poor and normal readers significantly differed on measures of verbal code formation and
verbal code mapping as indexed by performance on the free recall and verbal response to
the visual recognition memory choice measures respectively. As further predicted, no
differences were found on the visual (code formation) recognition memory choice
measure. The expectation that performance in the Mixed Phonics Explicit Training
condition would be better than in the Phonics Implicit Training condition, and that Word
Family stimuli would be learned better than Single Word types emerged in the form of a
main effect for each of these factors in the visual recognition memory choice data, yet for
reading responses to the visual recognition memory choice these predicted differences
emerged only in the normal reader Ability group.

In this respect, the results suggest that both normal and poor readers appear to
engage in the same amount of visual learning when acquiring new reading vocabulary.
However, poor readers appear to engage in less verbal coding than normal readers. The between group comparisons showed no difference between the poor and normal readers in trials and errors to criterion in the visual recognition memory choice measure, thus suggesting that poor readers perform equally as well as normal readers in terms of establishing visual recognition memories for new reading words. However, as was predicted, significant Ability group differences were noted in these readers’ performance on whole word codification as indexed by the free recall measure. Moreover, the poor readers in this study required significantly more trials to attain criterion, and showed greater number of errors to criterion than the normal readers on the reading responses for visual recognition memory choices. The interaction between Training and Wordtype for the visual recognition memory trials to criterion data suggests that both normal and poor readers may have been benefiting from the word family structure when the structure was made explicit. This benefit was not found in the errors to criterion visual recognition memory data, however. Furthermore, it is interesting to note that, although the normal readers showed evidence of the benefits arising from explicit training on the word family stimuli in the reading response measures, the poor readers did not. This suggests that directing the attention of the poor reader to a common letter-sound correspondence in a group of words somehow facilitates visual coding (visual recognition memory), but not the verbal coding of the very same words. Thus, the poor reader may have been acquiring an orthographic pattern, but not the phonetic correlates of this pattern, even though this relationship had been pointed out to them. In short, an analysis of the errors these subjects were making suggests that the poor reader may develop a well learned visual code for a new reading word independently of associating a name or specific phonemes with it.
Conversely, the normal reader appears to focus on establishing a name-visual association, a finding which would suggest that these coding operations mutually assist word acquisition recognition and identification. In sum, irrespective of whether one claims that the poor reader has a verbal coding deficit at the whole-word level as indexed by performance on free recall tasks, or difficulty in phonologically coding the parts of words, evident in Ability group differences in assembling or providing a verbal response for visual stimuli, the poor reader can nonetheless be characterized as having normal visual (recognition) memories for new reading words. One outcome of this may be that s/he can visually recognize words s/he is unable to read.

A number of important conclusions can therefore be postulated on the basis of the advanced hypotheses and related findings for this study, namely that the visual processing ability of poor readers can be regarded as normal or intact; that the verbal processing ability of these readers is comparatively weak; and that visual and verbal processing systems for these readers can be viewed as being poorly co-ordinated.

With regard to verbal code formation, the observation that the poor readers in this study performed significantly below the level of the normal readers on the free recall measure suggests that poor reader subjects in this sample were significantly impaired in phonologic coding ability, which was the major cognitive skill addressed by this measure. This finding is consistent with other investigations (Vellutino & Scanlon, 1987) in which results suggested that whole-word identification is especially dependent on the ability to recall the word’s name. Moreover, that the poor readers were consistently shown to perform below the level of their normal reader counterparts in verbal code mapping, finds even stronger accord in the literature (Vellutino & Scanlon, 1987). That these Ability
groups were matched in their performance on visual code formation would likewise find support in previous investigations (Vellutino, 1979; Swanson, 1987). These findings carry a number of implications, each of which will now be discussed.

Verbal Code Formation and Verbal Code Mapping

The results on both the free recall and reading response to the visual recognition memory choice measures are strongly suggestive of deficiencies in the poor readers’ ability to phonologically process words. These difficulties are manifested in Ability group differences in the development of auditory/phonological memory codes for the presented stimuli, for which success is largely dependent on the learner’s ability to process, retain, and retrieve phonetic representations of auditorally and visually presented items (Vellutino & Scanlon, 1987). The noted deficiencies are further manifested in Ability group differences in the development of a verbal association to the visual stimulus, for which effective learning is dependent upon the ability to map the visual stimulus onto corresponding speech sounds. More to the point, however, subjects were provided with the pronunciation for stimulus words both in the introduction prior to training, and in the form of correction when reading errors were committed, thus, Ability group differences on the free recall measure are clearly indicative of the poor readers’ lack of facility in verbal code formation, regardless of whether this inefficiency is connected to either memory or phonological processing deficits. Thus, the noted differences between poor and normal readers in visual-verbal associative learning tasks, appears to be closely related to differences in these readers’ facility in acquiring the verbal responses for visual stimuli. Similarly, it can be inferred from the reading responses to the visual recognition
memory choice data, that the observed differences between the Mixed Phonics Explicit Training and the Phonics Implicit Training conditions in the normal reader Ability group, would support the contention that poor and normal readers differ in phonologic coding ability, especially since no differences were noted for poor readers in these respective Training conditions. It likewise appears reasonable to conclude that these overall Ability group differences in phonologic coding account for between group differences in code acquisition as a whole.

Visual Recognition Memory

The fact that significant main effects for the visual recognition memory measure were noted in both trials and errors to criterion for Training, suggests that the rate and development of orthographic representations may be enhanced by directing the learner’s attention to the component phonetic structures contained in words. Thus, despite difficulties in phonological processing, the poor reader’s ability to visually identify words may nonetheless be enhanced by training which directs attention to interior grapheme-phoneme correspondences. The main effect noted for Wordtype may also suggest that these readers may benefit from orthographic similarity, and repeated structural patterns such as those contained in word family groupings. Moreover, the poor reader subjects in the Mixed Phonics Explicit and the Phonics Implicit Training conditions were shown to differ in the proportion of sounding-out attempts, and this may indicate that this training had contributed to filling in the parts of a whole word schema (Perfetti, 1985) which permitted more direct retrieval reading response attempts to be made. However, this finding is not consistent with other investigations in which analytic training approaches
were employed. Typically, explicit grapheme-phoneme correspondence training has been shown to foster a greater proportion of analytic processing strategies (Lesgold et al., 1985; Vellutino & Scanlon, 1987). One obvious explanation for these differences is that the explicit training facilitated the formation of a stronger and more accurate orthographic representation, which in turn precluded these readers’ perceived need to employ an analytic processing strategy in their attempts to read the words.

Strategy Use

It is interesting to note variations in the degree to which whole-word reading (direct retrieval) and analytic processing (indirect retrieval) strategies were employed by each Ability group and its respective Training conditions.

The examination of strategy use and this relationship to the selection of stimulus and distractor words on the visual recognition memory choice measure was intended to lend further support to the hypothesis that poor readers are especially deficient in verbal processing tasks. There was, of course, an additional interest in the evaluation of the degree to which the different types of instruction received by subjects in the two Training conditions influenced processing strategies.

Within these measures, Ability group differences for verbal code formation and verbal code mapping were expected to surface in the proportion of distractors being read as stimulus words, and in the proportion of correct whole-word reading responses to stimulus words respectively. Thus, as it has been suggested that poor readers may give more emphasis to learning what a word looks like than to associating these features with corresponding sounds, it was anticipated that these readers would be less likely than their
normal reader counterparts to read a distractor choice as a stimulus word. Similarly, as
the poor readers were expected to focus on establishing a visual code for the new reading
words, and moreover, that they would encounter difficulty in the integration of visual and
verbal codes, then this would result in significantly fewer correct whole-word reading
responses. Additionally, it was felt that the proportion of indirect (sounding-out) retrieval
attempts would be greatest for poor readers in the Phonics Implicit Training condition.
This expectation was based on the assumption that subjects receiving explicit phonetic
training would rely less on sounding-out approaches as more detailed orthographic and
phonological representations developed as a consequence of this training.

First, the significant main effect that was noted for the proportion of distractor
words read as stimulus items suggests that subjects in the normal reader Ability group
were most likely to make reading errors of this nature. This finding suggests that they
were less attuned to the visual/orthographic structure of distractor words, and likewise
had developed stronger verbal representations for stimulus words than the poor reader
subjects, as evidenced in both the normal readers’ inattentiveness to the subtle visual
differences of distractor stimuli, and in their reading of these as stimulus words. This
finding strongly suggests that the normal reader gives priority to establishing connections
between the verbal response (be it a whole word or phonetic response) and the visual
stimulus over learning the visual features of the visual stimulus. This finding is further
reminiscent of the observed between Ability group differences in the study by Vellutino
(1979) in which poor readers made fewer orientation errors than normal readers in the
replication of visually presented unfamiliar alphabetic symbols. Thus, not unlike this
finding, the normal readers in this present study were more likely to read a distractor
word as a stimulus item, and this also suggests that the visual-verbal connections in the representation of stimulus words is established before the learning of the visual stimulus is complete. However, the opposite approach may be favoured by the poor reader.

Similar support for the verbal coding deficit hypothesis advanced for poor readers can be found in the examination of the proportion of correct whole-word reading responses to visual recognition memory choices. In this regard, the significant main effects and three-way interaction noted for Ability, Training, and Wordtype in the proportion of correct whole-word reading responses showed that poor readers in the Mixed Phonics Explicit Training condition were less adept than their normal reader Explicit Training counterparts in providing whole-word reading responses for Word Family stimuli. Subjects in the poor reader Phonics Implicit Training condition were likewise shown to perform significantly below normal readers in the Implicit condition on providing whole-word reading responses for Single Word stimuli. Thus, the greater proportion of correct whole word reading responses for normal readers again points to the poor readers’ encountered difficulties in verbal code mapping. However, performance differences on Word Family stimuli for normal readers in the two respective Training conditions suggest that the explicit training received on the structure of Word Family words resulted in a higher proportion of correct whole-word reading responses. This is further suggested by differences within the normal reader Explicit Training condition for Word Family and Single Word stimuli. Again, the logical conclusion that can be drawn from this finding is that the explicit training facilitated a more complete orthographic representation that precluded these readers’ need to employ an analytic processing strategy in the reading of the test words. Similar findings emerged in the examination of
the proportion of sounding-out attempts that resulted in incorrect responses, in which analysis of an Ability by Training interaction revealed significant differences between Ability groups in the Phonics Explicit Training condition, and between Training conditions in the poor reader Ability group. Thus, the proportion of sounding-out responses was again found to be highest in the Phonics Implicit conditions.

Overall, as indexed by the proportion of whole word reading responses which resulted in correct and incorrect readings for stimulus and distractor choices alike, it can be seen that the poor readers had significantly fewer whole word reading successes. This suggests a number of conclusions. First, the observation that the proportion of whole word reading responses and distractors read as stimulus words was significantly higher in the normal reader Ability group, suggests the degree to which normal and poor readers differ in verbal code formation and verbal code mapping. However, the fact that normal readers were more apt to read a distractor as a stimulus word suggests that less attention was being given to the orthographic structure of these word types. Similarly, that these errors were comparatively rare for poor readers suggests that their principal focus was on visual learning. The other point of interest is that explicit training had facilitated a whole word processing attitude, and thus subjects in the Phonics Implicit Training conditions were seen to employ proportionately more sounding out attempts. Thus, the benefits arising from the direction of subjects’ attention in the Mixed Phonics Explicit Training condition clearly outweighed those in the Implicit Training condition. As well, the overall use of whole word and sounding out strategies employed by these Ability groups and their respective Training conditions yields some comparatively interesting patterns with respect to acquisition.
Educational Implications

Although many factors that contribute to early reading ability have been discovered through the investigation of reading and language relationships (Liberman, 1977; Liberman & Shankweiler, 1989; Perfetti, 1985; Vellutino, 1979), there still remains the problem of which elements of language are most associated with encountered difficulties or failure in reading. Throughout this research it has been suggested that a possible source of reading difficulties appears to rest within the poor readers’ difficulty in integrating visual and verbal codes. And there is much consensus that the poor readers’ deficiencies in language and linguistic coding are the cause of young children’s reading problems (Stanovich, 1986; Vellutino, 1979; Vellutino & Scanlon, 1982, 1987). However, all that is implied by ‘language’ has increased the area from which suspected elements can be pooled. For example, it has been suggested that reading difficulties are the result of inefficiencies in the mapping of the phonological properties of words in both printed and spoken form as reflected in difficulties with phoneme awareness and segmentation tasks (Bradley & Bryant, 1985; Juel, Griffith, & Gough, 1986; Lundburg, Frost, & Petersen, 1988; Mann & Liberman, 1984). For others it is a matter of access to these structures in memory, as manifested in difficulty in phonological information retrieval which may inadvertently affect automatized word recognition processes (Wagner & Torgesen, 1987). Likewise, links between poor sentence comprehension and short-term memory processing limitations caused by difficulty with phonetic recoding in working memory have been identified (Liberman & Shankweiler, 1989). Other limitations are said to involve the inability to make use of the semantic and syntactic components of
language in consequence of educational practices which over-emphasize phonics instruction (Goodman, 1967), as cited by Share (1995). In this respect, research has demonstrated that inefficiency in phonological processing and working memory are indeed factors of reading disability. However, the claim concerning the use of context to facilitate reading has been shown to be a compensatory strategy in poor readers rather than a means by which skilled reading is accomplished (Stanovich, 1982).

Yet, overall it is clear that deficits in visual-verbal associative learning can be said to characterize the poor readers in this study. These deficits were most apparent in the comparison of poor and normal readers and their ability to provide a reading response to the selected words on the visual recognition memory choice task, in addition to the observed differences on verbal code formation as indexed on the free recall measure. In regards to the differences in these Ability groups’ performance on the latter measure, this finding secures support from the literature in which such differences in visual-verbal association tasks were viewed as being due primarily to group differences in learning the verbal response components in these tasks (Vellutino et al., 1975). Thus, as success on a free recall measure is regarded as relying heavily on a reader’s ability to phonologically code, store, and retrieve this representation, the observed differences in performance for these Ability groups on this measure could suggest that deficiencies in phonological coding stand at the root of these poor readers’ encountered difficulties. This contention may be supported by the finding that normal reader subjects who received the Mixed Phonics Explicit Training performed significantly better than those in the Implicit Training condition. However, for the poor reader Ability group, no such differences were
found. In this same regard, it is difficult to dispute the fact that the poor and normal readers who received this training demonstrated the greatest ability in the visual recognition memory choice task. Similarly, although such training has been known to foster analytic processing attitudes and strategies (Vellutino & Scanlon, 1987), it would appear that in this study at least, Explicit Phonetic training and the directing of the readers' attention to the interior vowel digraph resulted in substantially more wholistic processing attempts and successes.

On a more practical note, the consideration of which approaches to instruction can assist the poor reader in whole word acquisition must be advanced. Yet, in this regard, although it has been shown that poor readers as a group are largely characterized by deficiencies in phonological processing, this does not imply that all are equally impaired (Share, 1995). Nevertheless, there are implications also for whole word learning, that can prove to be as much of a problem for poor readers as a phonic or sounding out approach. This is perhaps most apparent in the poor readers' difficulty in recalling the names of words in this study. However, as benefits were nevertheless noted for the Explicit Training on word family stimuli and the repeated structure inherent of these word types, it should come as little surprise that this approach and the use of such words may be of benefit to the poor and normal reader alike. Yet, because this instruction and the use of these stimuli were seen to induce processing strategies that appear to be uncharacteristic of previous studies, it requires that some account of these differences be given.

In this regard, as it has been shown that explicit training in phonics has resulted in more analytic processing attempts (Lesgold et al., 1985; Vellutino & Sanlon, 1987), it is a
curious finding that the reverse pattern was noted in this study. Yet, as it is also suggested that explicit phonics training may facilitate word learning by means of directing the learners' attention to the interior phoneme-grapheme correspondences in words (Vellutino & Scanlon, 1987), then the instruction received by subjects in the Mixed Phonics Explicit Training may have advanced these readers' wholistic processing attempts. Similarly, as training in phonological awareness has been shown to assist reading development (Ball & Blachman, 1991; Bradley & Bryant, 1983), it would appear that this approach to reading instruction is also a logical step. However, it is important to note that readers in the normal Ability group were shown to benefit from the explicit training received. This observation, alongside of the reminder that all readers do not necessarily possess an equal ability to access phonemic structures, poses a larger and more complex problem regarding the issue of reading instruction. In sum, the usual manner of teaching such awareness must be considered, particularly where the poor reader is concerned.

Several approaches (Rosner, 1974) to the teaching of letter-sound awareness initially require the learner to analyze spoken word forms and segment these into their respective syllables. The learner then proceeds to the analysis of syllables and the breakdown of these into respective phonemes. However, it has been suggested that this method and others like it may be missing the important intermediate step of providing instruction in the analysis of syllables into onsets and rhymes (Treiman & Zukowski, 1991). Thus, at this stage of the instruction, the learner would be required to analyze the word 'stop' as 'st' and 'op', without breaking these segments further into individual
phonemes. This, however, could be asked of learners in the event that they are successful at this stage.

Connected to this approach is the suggestion that reading instruction could begin with the teaching of letter-sound correspondences at the level of onsets and rhyme, rather than at the level of single phonemes (Treiman & Zukowski, 1990). In this regard, the learner would memorize sounds which correspond to various letter combinations. Although this is commonly done with letters ‘sh’, ‘ch’, and so forth, it could also be applied to the learning of ‘ip’, ‘op’, as well as to other commonly occurring letter constructs in words. Other researchers (Beck and Roth, 1987) designed programs in which poor readers received practice in identifying and applying sub-word letter patterns to create and identify words requiring distinction of letter patterns. This approach led to increased efficiency and accuracy in word recognition, improvements that were not restricted to the studied words in practice. This improved efficiency also permitted the comprehension of phrases and short sentences, however, not at the passage level. Thus, in the interest of examining the degree to which efficiency in learning can be enhanced by different instructional approaches, questions of which teaching methods are most effective can begin to be answered, and likewise practical aims met by research that investigates learning through controlled instructional means.

Nevertheless, results obtained from the free recall measure suggested that the poor reader is far less adept than the normal reader at forming verbal memory codes for visual stimuli that have also been provided auditorally. Moreover, given that the poor reader had significantly more reading response errors than the normal reader, one may infer that the
poor reader is especially weak at forming verbal memory codes, since corrective feedback was provided for all incorrect reading responses in the training measures. Thus, beyond the issue of arriving at instructional approaches to the reading of words, from a practical standpoint consideration must also be given to possible methods of instruction through which educational methods can better assist the development of whole-word auditory codes. Additionally, this finding and its relevance to word acquisition as a whole carries implications for the degree to which the importance of forming such codes may be grossly underestimated by the classroom teacher. As a result, the teacher may assume that whole-words that are understood and spoken have been completely learned in terms of their phonological structure when in fact this may not be the case. Consequently, children with difficulties in word recognition may be especially taxed by unfamiliar or complex spoken or word forms (Vellutino et al., 1975, 1987). As could be seen in this investigation poor readers take much longer not only to read new reading words, but also to develop an auditory code for the whole word. Thus, as learning can be expected to be only partially intact, and therefore incomplete, it is important that the expectations of the teacher coincide with actual learning. In short, it will be of no benefit to learners should the rate of introduction of new reading words exceed their capability of forming accurate and complete auditory representations for these words. One practical suggestion in this regard, therefore, is that the teacher spend sufficient durations of time on introducing new reading words as an auditory form before moving to associative learning instruction where learners are introduced to the corresponding sounds of the word’s visual features. However, as can be seen from this investigation, the fact that the learner is able to repeat
a word form orally will not mean that an auditory representation has been fully learned in
despite of the learners’ correct repetition of the word. Yet, beyond this, the possibility that
the main effect which was noted for these Ability groups on the free recall measure could
be connected to differences in these readers’ ability to repeat aloud spoken pseudo-words
is unlikely for two reasons. First, in the initial selection of poor reader subjects, those
with identified speech and language impairments were excluded from the potential pool.
Additionally, when pre-test screening measures were administered, any subject with
obvious speech impairment did not participate. Second, subjects in this study were
required to demonstrate capability in the pronunciation of the to be learned words in the
introductory stage of this investigation. Moreover, the subjects likewise received
corrective feedback on reading errors in the training stages of each trial. Furthermore, as
cited in Share (1995), it is important to note that difficulties in verbal repetition appear to
be specific to low-familiarity words and pseudo-words (Snowling, 1981; Snowling et al.,
1986, 1991). Moreover, the verbal repetition of pseudo-words is regarded as a task which
heavily burdens phonological processes (Snowling et al., 1986, 1991). It has also been
shown that phonological processing remains impaired even when overt articulation is not
required as in phonological identity judgements (Ellis & Miles, 1978; Olson et al., 1985),
as cited in Share (1995). Therefore, it would appear that the poor readers’ difficulty in
verbal code formation is more closely associated with phonological processing than with
articulatory deficits. However, as it has been suggested, these readers’ difficulty in
recalling a name may be connected to their inability to either store or access these
structures in memory, as it has been noted that poor readers may have difficulty in
retaining representations in short-term memory for sufficient periods required of learning them (Wagner & Torgesen, 1987). This problem, of course, could be the outcome of deficiencies in phonological processing in that it is more difficult to retain and process unfamiliar or partly learned information in short-term memory than well learned information.

In this regard, the evidence which suggests that poor readers encounter difficulty in retaining auditorally or visually presented verbal information in short-term memory (Jorm & Share, 1983; Wagner & Torgesen, 1987) is consistent with the data which suggests that this memory deficit is largely restricted to tasks requiring phonological coding. Moreover, where this type of coding is not required, memory deficits have not been noted (Baddeley, 1986; Hulme, 1981; Jorm, 1983). Similarly, poor readers attempt to compensate for inadequate ability in phonological processing by relying on context (Stanovich, 1986), semantic information (Vellutino & Scanlon, 1987), or orthographic cues (Holligan & Johnston, 1988), and this would suggest that encountered difficulties in providing a verbal response to visually and auditorally presented stimuli are closely related to phonological processing memory deficits.

However, as this current investigation could not accommodate the inclusion of additional measures of auditory memory and phonological processing, the degree to which these processes are factors in reading disability can only be inferred. What can be addressed, however, are the implications which arise from the finding that poor readers have normal visual processing abilities, and that certain types of training may assist recognition. In short, there is sufficient evidence to suggest that poor readers have been
noted to perform more poorly than normal readers on tasks which provide measures of auditory processing, auditory working memory, phoneme awareness, phonetic decoding, etc. By and large these measures are what form the basis of the evaluation of reading related subskills in standardized tests for educational and clinical purposes. Therefore, perhaps the question of whether an instructional approach should be explicit in the imparting of skills such as letter naming and phonetic analysis, or have a more discrete focus such as that involved in whole word or implicit learning, becomes a matter of contention with respect to whether or not the capabilities of the student will permit such instruction. Thus, in the final analysis the question is not one which asks which approach is better, but is the approach beneficial to learning.

Conclusions

In all of the current literature on reading comprehension it is widely acknowledged that word recognition is a prerequisite for the skilled reader. However, for those who do not develop such efficiency, the methods of approach for developing this skill are not as well known. Results of attempts at developing word recognition efficiency in the poor reader are as varied as the approaches themselves. Similarly, approaches to the facilitation and improvement of these in an instructional setting are as varied as the many interrelated processes that underlie each of them, and thus any one approach is not certain to work for all problem readers.

Thus, for children to arrive at the reading to learn stage they must begin with learning to read. This process however, is preceded by the notion of how we approach the teaching of reading. In this, the specific end is to produce a competent decoder of print;
one who operates at an independent level. One fundamental aspect of reading for meaning involves the recognition of words and their semantic definition. Currently, contention between proponents of the 'meaning first' and the 'phonics first' approaches to word recognition and comprehension remains strong. At the one end of the spectrum is the skills approach to the teaching of reading (an approach based on the premise that literacy is acquired through direct instruction of discrete skills such as letter sound correspondences which are taught separately and then integrated through practice), contrasted by whole language (in which there is a shift from an emphasis on skills to an emphasis on meaning in which strategies are used to determine word pronunciations and meanings in connected text). In light of the controversies that surround the question of how literacy should be taught, it is important to consider the work of researchers and what these findings reveal with respect to the reading process.

In this respect, the identification of cognitive processes involved in reading can guide research towards the advancement of instructional practice. However, improvement noted as a result of employed techniques with some individuals is unfortunately not generalizable to others that appear to share similar language deficits. Given that the mere existence of books presupposes an educated body that can read them, the success for an individual who arrives at the stage of proficiency in reading is immeasureable. Thus, to the teacher of reading, the goal appears to be to apply whatever measures that will make the reader independent. In short, the teacher must be fundamentally pragmatic; if an idea works, use it. Likewise, it appears that performance should override competence, as the ongoing key is to get the student to do better than at present. In this, the teacher must
become a diagnostician, diagnosing and prescribing and modifying the instructional program in order to meet specific end results.
References


Appendix A: Stimulus Sets for Training

Stimulus Set #1
(Word Family Words)

1. The pilot, Mrs. Haboamit, flew the plane.
2. The cook, Mr. Hakoamit, boiled the carrots.
3. The doctor, Mrs. Hapoamit, tapped his chest.

Single Word Types

4. The painter, Mr. Semouket, cleaned the brush.
5. The singer, Mrs. Fajoither, played the piano.
6. The goalie, Mr. Dekaishep, stopped the puck.

<table>
<thead>
<tr>
<th>Word Family</th>
<th>Stimulus Set #2</th>
<th>Stimulus Set #3</th>
<th>Stimulus Set #4</th>
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<tr>
<td>Semouket</td>
<td>Fajoither</td>
<td>Dekaishep</td>
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<td>Fanoither</td>
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<tr>
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<td>Fapoither</td>
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<td></td>
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### Appendix B: Stimulus Sets for Testing

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Orthographic</th>
<th>Phonetic</th>
<th>Initial</th>
<th>Final</th>
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<tr>
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<td>Felaishep</td>
<td>Delaishep</td>
</tr>
</tbody>
</table>

Stimulus sets with target stimulus and four distractors: orthographic (look alike), phonetic (sound alike), initial (altered consonant), final (altered consonant).
Appendix C: Response Categories

1. Recognition memory errors (independent of reading response) refers to the proportion of distractors selected on the visual recognition memory choice measure. For example, the subject may choose one of four distractors (Habaomit, Habowmit, Faboamit, or Haboamik) instead of the stimulus word (Haboamit) on the visual recognition memory choice measure (examples of these appear in the previous Appendix). Visual recognition memory choice errors are based on the choice only; errors on the reading response to this choice are separate.

2. Stimulus word selected and read correctly. In this instance the subject has selected the stimulus word (Habomit) and has read it correctly.

3. Distractor selected and read as stimulus word. In this instance the subject has selected a distractor (Habaomit), yet read this memory choice as though it were the stimulus word, Habomit.

4. Distractor selected and read correctly. This refers to the subject’s selection of a distractor (e.g., Remouket) on the visual recognition memory choice measure, and correct reading of this choice.

5. Distractor selected and read incorrectly. This refers to the subject’s selection of a distractor (e.g., Semoukef) on the visual recognition memory choice measure, and an incorrect reading of this choice (e.g., Semorkit).

6. Stimulus word selected and read incorrectly (e.g., Semouket = Semowket).

7. Stimulus word selected and read as a distractor (e.g., Haboamit = Fabomit).
All correct and incorrect readings for test words were coded on the basis of whether the response was characterized by a sounding-out (indirect retrieval), or whole-word (direct retrieval) reading response.