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Linguistic Processing in Good and Poor Readers: Phonological Recoding and Semantic Memory

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ABSTRACT

Linguistic Processing in Good and Poor Readers:
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Susan Graham
Concordia University, 1990

According to the Linguistic Deficit hypothesis, fundamental deficits in one or more language processes underlie reading difficulties. In this study, two aspects of linguistic processing, phonological recoding and the structure of semantic memory, were examined in 47 school-aged good and poor readers. Although there is evidence that good and poor readers differ on these two types of language processing, the nature of these differences is controversial and warrants further investigation.

Phonological recoding was examined using a phonological similarity recall task and a continuous recognition measure. On the recall measure, both good and poor readers displayed similar patterns of recall, although at different overall levels of performance. In contrast, good and poor readers' recognition performance was similar both in terms of number of recognition errors and effect of word similarity.

The structure of good and poor readers' semantic memory was compared using a free recall task of typical and atypical category exemplars. As expected, poor readers recalled significantly fewer atypical words than typical words whereas good readers were not differentially affected by typicality of item.

The relative contribution of each of the language processing tasks to reading achievement was assessed using regression analyses. The language processing scores were significantly related to reading recognition for good readers only. In general, the results of the present study are contrary to previous findings. Implications for a linguistic deficit theory of reading disability are discussed.

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LINGUISTIC PROCESSING IN GOOD AND POOR READERS:

PHONOLOGICAL RECODING AND SEMANTIC MEMORY

Skilled reading is a demanding task, requiring the integration of cognitive, linguistic, and perceptual processes. Considering the complexity of this skill, it is not surprising that 4-10% of elementary school children have difficulty learning to read (Mann & Brady, 1988). Unfortunately, the major consequence of reading problems is limited academic achievement. Furthermore, reading-related difficulties are often long-standing during the school years, and may persist into adulthood (LaBuda & DeFries, 1988; Spreen, 1988).

Although the consequences of poor reading skills are serious, there is no single operational definition of what constitutes a "reading disability" (Jorm, 1983). Traditionally, reading disability has been described as a "failure to master reading at a level normal for age when this failure is not the result of a generally debilitating disorder such as mental retardation, major brain injury, or severe emotional instability" (Gibson & Levin, 1975, p. 485). That is, only children who have deficient reading skills and at least average intelligence levels are considered reading disabled. There is, however, limited evidence that such criteria for identifying reading disabled children are easily operationalized or empirically valid (e.g., Kleiman, 1985; Morris, 1988). Recent studies comparing poor readers of normal and impaired intelligence have found few differences on a variety of academic and cognitive tasks (Graham & Kline, 1990; Siegal, 1988; 1990). Although, an extensive discussion of the implications of various definitions of reading disability is beyond the scope of this work, most of the research reviewed below was conducted with children with no obvious causes (e.g., retardation) for their reading problems.

Components of Reading

Before possible causes of reading problems are considered, a brief review of some of the processes involved in skilled reading is necessary. According to Shankweiler and Crain (1986), there are two basic levels of processing involved in reading: 1) word identification, or the deciphering of individual words from their orthographic representations; and 2) the processing of sentences and other higher-level units of text.

Given the visual presentation of a word, the reader must first extract the critical features from the display (Chabot, Petros, & McCord, 1983). Thus, the child must possess reliable representations of alphabetic characters and be familiar with the unique visual patterns that define specific words. He or she must also be aware of the letter combinations that are acceptable in the language (e.g., cho-legal; qyz-illegal; Vellutino & Scanlon, 1982). The reader must then encode or form an internal representation of the printed stimulus.

Following visual analysis and encoding, the representation of the printed word is matched with it's counterpart in the internal lexicon (Chabot et al., 1983; Vellutino & Scanlon, 1982). The lexicon refers to a hypothesized store containing information about the words in a language. Every word has a distinct representation in this `mental dictionary' under which are listed details concerning meaning, spelling, and pronunciation (Davelaar, Coltheart, Besner, & Jonasson, 1978).

There are two hypothesized access routes to the lexical representation of a specific word. The reader might directly match the printed word stimulus with its lexical counterpart, using the visual characteristics of the word (direct route). Alternatively, the child might translate the visual information of the printed word into a corresponding phonological or sound-based representation (mediated approach or phonological recoding). This phonological code is then used to access the word's lexical entry (Davelaar et al., 1978; Humphreys & Evett, 1985; Vellutino & Scanlon, 1982). Once the lexical representation of a word is accessed, the information associated with that word is then activated (Chabot et al., 1983). Thus, the word is identified and it's meaning apprehended.

Both the direct and mediated approaches to word identification rely heavily upon linguistic ability (Vellutino & Scanlon, 1982). Phonological recoding, however, depends more upon knowledge of rule-generated features, such as spelling-sound correspondences. The direct approach, on the other hand, relies more on features unique to a specific word, such as the name, orthography, and meaning of that particular word (Baron, 1977). Both of these access routes are used to a greater or lesser extent by all readers, depending on the familiarity of the word (Wagner & Torgesen, 1987). Phonological recoding appears to be especially important in the early stages of reading acquisition (Doctor & Coltheart, 1980).

Once words are identified, the reader must compute semantic and syntactic relations among successive words, phrases, and sentences, thereby constructing a coherent and meaningful representation of the text. A consequence of the sequential and compositional nature of reading is the dependence on the temporary storage of information while new information is being processed (Daneman, 1987; Shankweiler & Crain, 1986). Several recent models of reading have appealed to the construct of working memory to account for temporary storage during reading (Baddeley, 1982; Perfetti, 1985).

Basically, in reading, working memory is viewed as limited-capacity system responsible for the temporary storage and processing of linguistic material pending further analysis (Daneman, 1987; Mann & Brady, 1988). Briefly, as conceptualized by Baddeley and his associates, working memory consists of a collection of interrelated subsystems

(Baddeley, 1986; Baddeley & Hitch, 1974). The core of this system is the "central executive", a limited capacity work space that can be used to operate control processes or to briefly store information. The "central executive" is able to delegate some of the storage responsibilities to the auxiliary slave systems it controls. One such subsystem, the "phonological store" maintains verbal material by subvocal rote rehearsal. According to the working memory model, verbal information is recoded phonologically and stored in working memory in terms of its phonological features (Baddeley, 1982; Wagner & Torgesen, 1987).

Clearly, skilled reading is a complex and demanding task, relying on several different yet related processes. Reading difficulties could result from deficiencies in any one or more of these processes. Indeed, numerous studies have documented a wide variety of processing differences between good and poor readers. In an effort to consolidate these results, researchers have attempted to isolate underlying cognitive deficits in poor readers. Common to most current views of reading problems is the assumption that poor readers suffer a deficit in the performance of one or more cognitive processes, such as attention or perception (Morrison & Manis, 1982). Key process-deficit views of reading problems will be briefly reviewed below.

<u>Process-Deficit Views of Reading Problems</u>

Proponents of one major process-deficit view of reading problems argue that poor readers have deficiencies in visual-perceptual or visual-motor skills (Cruickshank, 1972). Poor readers are believed to have poor spatial organizational skills, which disrupt their visual perception and visual memory (Vellutino & Scanlon, 1982). This type of deficit is thought to be manifested in orientation and sequencing errors often observed among poor readers during le and word decoding.

Other process-deficit approaches to reading problems include the view that poor readers have difficultly controlling and sustaining attention (Tarver, Hallahan, Kauffman, & Ball, 1976). The resulting attentional deficits are hypothesized to account for reading problems.

Another view of reading problems is that short term memory deficits underlie the difficulties of poor readers (Jorm, 1979). Compared to good readers, poor readers recall less information (Ceci, Lea, & Ringstrom, 1980), have a shorter memory span (Corkin, 1974; Torgesen & Houck, 1980), underutilize organizational strategies (Suiter & Potter, 1978) and have difficulty retaining the serial order of items in short-term memory tasks (Cohen & Netley, 1978). Within this approach, some researchers have hypothesized that the ability to apply appropriate task strategies differentiates good and poor readers (Bauer, 1977; Torgesen & Goldman, 1977; Torgesen, 1980). (See Morrison & Manis (1982) or Vellutino (1979) for a more comprehensive discussion of process-based approaches to reading problems.)

Although all of the above types of cognitive processes undoubtedly affect reading competence, there is little evidence that any one of them can account for poor reading achievement. For example, some researchers have found an attentional deficit among poor readers but others have not (e.g., Anderson, Halcomb, & Doyle, 1973; Noland & Schuldt, 1971; Tarver et al, 1976). Furthermore, none of process-deficit approaches discussed can explain why the manifestation of the deficient process is limited primarily to reading acquisition (Morrison & Manis, 1982; Vellutino, 1979). If a poor reader possesses a general problem in short-term memory or perception, deficits should manifest themselves in other academic areas or in daily cognitive processing. Moreover, process-deficit approaches do not adequately explain the severity of some poor readers' problems. That is, it is difficult to fathom how a child who has a mild short-term memory deficit can obtain a normal IQ score but barely be able to read single words. It would be difficult to derive severe deficiency and normality from the same set of processes (Morrison & Manis, 1982).

In summary, the evidence for any of the process-deficit views discussed above is inconsistent. Moreover, given the multifaceted nature of skilled reading, it is unlikely that there is one single cause of poor reading (Vellutino & Scanlon, 1982). A more recent perspective is that multiple cognitive processes affect reading competence. One such proposal is the linguistic deficit hypothesis, reviewed below.

The Linguistic Deficit Hypothesis

Since reading is strongly dependent on language, particularly during the initial stages of acquisition, many investigators have argued that deficits in one or more language processes, such as phonemic awareness, linguistic working memory, semantic and syntactic knowledge, could underlie reading difficulties (e.g., Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1977; Mann & Brady, 1988; Shankweiler & Crain, 1986; Vellutino, 1979; Vellutino & Scanlon, 1982). A crucial link between deficient language processing and reading problems is suggested by several observations. First, reading is primarily a linguistic skill and thus relies more strongly on language than on any other representational system such as the visual or motor systems (Vellutino & Scanlon, 1982). In fact, it is the linguistic components of printed words that imbue them with meaning and substance rather than their visual components or the motor responses used in naming them. Furthermore, the reader is required to merely recognize a word's visual features, but must recall it's verbal components which is a more demanding task.

A further link between poor reading and deficient linguistic processing is suggested by the finding that poor readers do consistently worse than more proficient readers on many language tasks but generally do as well on tasks that are not linguistically based (e.g., Mann, Cowin, & Schoenheimer, 1989). For example, Liberman and her colleagues asked good and poor beginning readers to remember different types of visual stimuli (Liberman, Mann, Shankweiler, & Werfelman, 1982). Good and poor readers were equivalent in their memory for nonlinguistic visual material, such as faces of strangers and nonsense doodle drawings. In contrast, poor readers made significantly more errors than good readers when asked to remember linguistic visual material, such as printed nonsense syllables.

There is also evidence linking general language development to reading skills. Children who are language-delayed encounter reading problems at least six times more often than control subjects, in contrast to the lack of relationship between other types of handicaps and reading (Ingram, Mason, & Blackburn, 1970). Similarly, Mann and Liberman (1984) found that deficient language skills in kindergarten were related to subsequent reading problems in the first grade.

Thus, unlike other process-deficit hypotheses, the linguistic deficit proposal can explain the specificity of reading problems, due to the strong link between language and reading. As reading has been viewed as "parasitic" on language (Rozin & Gleitman, 1977), it is reasonable that a language disorder would manifest itself primarily, though not exclusively, in reading acquisition.

Assuming that linguistic deficiencies constitute the primary bases of reading problems, it is important to consider the nature of such deficits. Many areas of language processing have been studied in poor readers, including phonological recoding, the structure of semantic memory, sentence comprehension, lexical processing, and syntactic knowledge (Mann & Brady, 1988; Morrison & Manis, 1982). The purpose of the present study is to examine two types of language processing in good and poor readers: phonological recoding and the structure of semantic memory. It is evident from the earlier discussion of reading processes that both of these processes are crucial for skilled reading. Specifically, deficiencies in phonological recoding and semantic memory processes have been implicated in word identification problems, the basic impediment to the acquisition of skill in reading. (Vellutino & Scanlon, 1982). The results of research examining phonological recoding in good and poor readers will be reviewed below, followed by a survey of the empirical literature on semantic memory differences.

Phonological Recoding

Phonological recoding to maintain information in working memory refers to recoding printed symbols into a sound-based representational system that enables them to be maintained efficiently in working memory during ongoing processing (Wagner & Torgesen, 1987). The term "phonological" will be used in this discussion as it generally refers to a sound-based system. No claim is being made concerning the exact nature of this code (i.e., whether it is acoustic, articulatory, or auditory imagery). Research has suggested that the efficiency of phonological recoding in working memory has an important role in reading. Efficient phonological recoding should enable the reader to apply maximum resources to the task of blending together isolated phonemes to make words when reading (Mann & Liberman, 1984; Wagner & Torgesen, 1987).

The essential use of a phonological coding system in a short-term memory store is well established (Conrad, 1964; Kintsch & Buschke, 1969; Tell, 1972). There is considerable evidence that people employ a phonological code to store visually or aurally presented stimuli even under circumstances where it is disadvantageous to do so, that is, when it penalizes recall (Baddeley, 1966; Conrad, 1964). Even deaf signers may recode stimuli into a phonological form for short-term recall (Hanson & Lichtenstein, 1990).

A task that is frequently employed to document the use of phonological recoding in working memory is the "phonological similarity" task. In this procedure, stimuli (i.e., consonants, syllables, or words) that are phonologically similar and dissimilar are presented to subjects for recall or recognition. A consistent finding is that confusions in recall are greater and recall is penalized when items are phonologically similar rather than dissimilar, implying the use of a phonological memory code (Baddeley, 1966; Kintsch & Buschke, 1969).

Many researchers have proposed that the failure to make use of phonological recoding in working memory may account for some of the deficiencies poor readers typically show in language processing (Liberman et al., 1977). Phonological recoding in good and poor readers has been extensively examined using both recall and recognition paradigms with a variety of stimuli. The results of several key studies will be reviewed below.

In one of the first studies examining phonological recoding in good and poor readers, Shankweiler, Liberman, Mark, Fowler, and Fischer (1979) presented superior, marginal, and poor 8-year old readers with simultaneously presented printed strings of rhyming and nonrhyming consonants. Children were tested twice, once with immediate recall and once after a 15 second delay period. Shankweiler and his colleagues found that superior readers were better at recall of phonologically dissimilar items than poor readers, but the two groups were nearly indistinguishable in their recall of phonologically similar items. The delay condition magnified the penal effect of phonological confusability only in superior readers. Shankweiler et al. replicated these findings in two subsequent experiments using successive visually-presented and aurally-presented letter strings. On the basis of these results, they proposed that good and poor readers differ in their use of phonological recoding, regardless of the modality of presentation.

Using a similar methodology, Siegal and Linder (1984) found that only the young poor readers (7-8 years) did not differ in their recall of phonologically similar or nonrhyming letters. In contrast, both older poor and good readers' recall of rhyming letters was significantly less than their recall of nonrhyming letters. The overall recall level of the older poor readers was, however, much lower than that of their normally achieving age-mates. Siegal and Linder's findings have been replicated in subsequent studies, suggesting a developmental lag in the use of a phonological recoding system in poor readers, rather than a permanent deficit (Bisanz, Das, & Mancini, 1984; Johnston, 1982; Siegal & Ryan, 1988).

In an effort to extend Shankweiler et al.'s results, Brady, Shankweiler, and Mann (1983) presented 8-year old good and poor readers with aural strings of rhyming and nonrhyming words. As in Shankweiler et al.'s study, poor readers recalled fewer words overall than good readers and were less affected by the phonological characteristics of words.

As consonant strings and isolated words are far removed from actual text, Mann, Liberman and Shankweiler (1980) extended previous work on phonological similarity to a more ecologically valid situation involving sentences and word recall. Good and poor readers were presented with auditory sentences that varied in phonological similarity and meaningfulness for recall. Children were also presented with sets of five rhyming or nonrhyming words for recall. Mann and her colleagues found that good readers made fewer errors overall on the sentence recall task than poor readers. Good readers, however, were more affected by phonological similarity than poor readers for both meaningful and meaningless material. Similar to Brady et al. (1983), the performance of good readers on the word string task was markedly impaired by phonological confusability while that of poor readers was not.

Differential sensitivity to phonological similarity in good and poor readers has also been examined with recognition paradigms. Mark, Shankweiler, Liberman, and Fowler (1977) presented 7-year old good and poor readers with a printed test list of words. This was followed by a recognition list, comprised of the original test list words, phonologically similar (rhyming) foils, and phonologically dissimilar foils. Children were required to identify each word on the recognition list as either part of the original list or as new. Mark and his colleagues found that good readers made significantly more recognition errors on the rhyming foils than on the nonrhyming foils whereas poor readers made equal numbers of errors on each foil type.

As a check on the generality of Mark et al.'s (1977) results, Byrne and Shea (1979) employed an aural continuous word recognition test with 7- and 8-year old good and poor readers. Children were presented with spoken words and required to indicate for each word whether it had been previously presented. Some of the words were phonologically similar to previously presented words while others were semantically similar. As in Mark et al.'s (1977) study, poor readers made significantly fewer false positive responses to the phonologically similar words than did more proficient readers. On the semantically similar words, the poor readers did tend to make more false positive responses than good readers, but the effect was not statistically significant. In the subsequent experiment, Byrne and Shea used pseudo-words in the same continuous recognition task. Again, good readers made more false positive responses to the phonologically similar items than to the dissimilar ones. There were no differences among poor readers.

In a subsequent replication of Mark et al.'s study, Olson, Davidson, Kliegl, and Davies (1984) found that only the youngest poor readers (7 years) were insensitive to the phonological similarity of items. The recognition performance of the older poor readers, like that of the good readers', was penalized by phonological similarity. Consistent with evidence from recall paradigms, there appears to be a developmental lag in poor readers' use of phonological recoding in memory.

The results of studies reviewed above indicate that young poor readers are relatively insensitive to phonological similarity under a wide variety of conditions: when memory is tested by recognition or recall, when sentences, word strings, or consonants are employed as stimuli; when items are presented simultaneously or successively; and when items are presented aurally or visually. Furthermore, this deficit in phonological recoding appears to be specific to linguistic material (Brady et al, 1983; Katz, Shankweiler, & Liberman, 1981).

The evidence for deficient phonological recoding in poor readers has not been unanimously accepted by all researchers. In fact, several authors have offered alternate explanations for these results (e.g., Johnston, Rugg, & Scott, 1987). Hall, Wilson, Humphreys, Tinzman, and Bowyer (1983) argued that the results of studies such as that of Shankweiler et al. (1977) are an artifact of using fixed recall list lengths which exceed the memory span of poor readers. Thus, these results really do not reflect differential sensitivity of the groups to phonological similarity. Hall et al. proceeded to conduct four studies using the tasks of Shankweiler and his associates and found no differential effects of phonological similarity between good and poor readers. Furthermore, in Experiment 5, Hall et al. demonstrated that the serial-recall task is relatively insensitive to phonological similarity when difficulty levels are high. College students of normal reading ability did not exhibit a phonological similarity effect when the demands of the task were high but did display a very large phonological confusion effect on a moderately difficult task. Hall et al. argue that when list lengths are used that do approximate memory span for each group, the effects of phonological similarity will be found with both groups.

Hunt and Badawi (1985) also examined the phonological recoding deficit hypothesis in good and poor readers using a release-from-proactive-inhibition task, which is different from tasks previously used. They found that poor readers were influenced by phonological and semantic similarity as much as were normal readers, consistent with Hall et al.'s results. Interestingly, poor readers were more sensitive to visual similarity than good readers.

Thus, the evidence supporting a phonological recoding deficit is still controversial. The number of researchers who have reported differences between good and poor readers in terms of sensitivity to phonological similarity effects is nevertheless substantial. The generality and implications of the results of studies like that of Shankweiler et al. (1979) are still unclear. These results may represent a true difference in the use of phonological recoding between good and poor readers or may be task artifacts. Further research addressing criticisms of these tasks is necessary to clarify these findings. Alternative explanations may account for these results. For example, Gathercole and Baddeley (1990) have suggested that language-delayed children do encode verbal material in a phonological form but the capacity of their phonological store in working memory is simply less than that of children with better language skills. This argument may also apply to poor readers.

Skilled reading, as discussed earlier, is dependent upon a number of component processes. Phonological recoding in working memory is only one linguistic process that may contribute to differences in reading skill. Another important component of reading is semantic memory, reviewed below.

Semantic Memory

Once the representation of a printed word is matched with its lexical counterpart, information associated with that word is activated in semantic memory. This information includes the word's meaning, spelling and other associated information such as subordinate and superordinate category membership (Chabot et al., 1983; Davelaar et al., 1978). Thus, the lexicon and semantic memory can be conceived as a network that links word concepts to abstracted features and to other word concepts (Perfetti, 1985). Once the memorial representation of a word is activated, this activation spreads along the network of information. When relations in semantic memory are strongly established, they can be activated with relatively little expenditure of mental effort (Bjorklund, 1985).

Clearly, having a well-elaborated and organized semantic memory would facilitate word recognition and reading comprehension. There is, in fact, evidence of a link between vocabulary breadth and reading ability. Studies have found that measures of vocabulary in kindergarten are strongly correlated with reading achievement in the first and second grade (Jansky & de Hirsch, 1972; Vellutino & Scanlon, 1982). The results of studies conducted with adult subjects also support the hypothesis that an enriched semantic memory is associated with verbal coding ability. For example, Hunt, Lunneborg, and Lewis (1975) found that college students with high verbal ability performed significantly better than low verbal ability students on a large number of verbal coding tasks.

Several authors have proposed that good and poor readers differ in the structure and organization of semantic memory (e.g., Perfetti, 1985; Swanson, 1986; Vellutino & Scanlon, 1985; Vellutino, Scanlon, & Tanzman, 1988). In particular, the access to and retrieval of higher-order semantic information has been hypothesized to differentiate good and poor readers. One specific type of higher-order information, category membership, has been examined using speed of processing and free recall paradigms. Key studies are reviewed below.

In an examination of differences in speed of processing category information, Howell and Manis (1986) presented good and poor readers with a picture of a stimulus and a verbal description that was either superordinate (e.g., this is an animal) or basic (e.g., this is a dog). Children had to decide if the description given matched the stimulus. The pictorial stimuli were typical and atypical category exemplars. Typicality of category membership refers to the "goodness" of an item as an exemplar of a category (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). There is evidence that children learn the more typical examples of semantic categories first and only later learn the membership of less typical items (Bjorklund, Thompson, & Ornstein, 1983).

Howell and Manis found that poor readers were slower than their more proficient peers at verifying the name of a picture or word stimulus. Furthermore, poor readers were slower at making category decisions, implying they experienced difficultly accessing higher-order semantic information over and above their difficulties in accessing names of the stimuli. Yet poor readers did appear to have the relevant phonological and category information in memory as they made few errors on both the basic level and superordinate level verification tasks. Typicality appeared to affect good and poor readers similarly. Thus, once the semantic information associated with a word or a picture is retrieved from memory, category decisions are made in a similar fashion and require a similar amount of time in good and poor readers.

In a similar study, Chabot et al. (1983) also found that poor readers were much slower than good readers at judging if two words represented objects from the same semantic category. The results of these two studies suggest that the higher-order pathways in the semantic memory of poor readers are not as easily accessed as those in good readers.

Another method by which semantic memory has been compared in good and poor readers is the free recall of items from the same category. Bjorklund and Bernholtz (1986) examined differences in semantic memory (or as they term it, "knowledge base") and the effects of typicality of category exemplar on good and poor readers' recall performance. They found evidence that good and poor readers differed in category knowledge: there was a significant difference in the percentage of appropriate items poor readers versus their more proficient peers included as category exemplars. Furthermore, the typicality ratings of good readers were more highly correlated with those of adults than were those of poor readers.

Bjorklund and Bernholtz then compared typicality effects in recall between good and poor readers on both an incidental cued recall task and a free recall task. They argued that good readers perform better than poor readers on free recall tasks because relations among test items in semantic memory are readily activated. Group differences in memory were found, however, only when adult-nominated typical and atypical category exemplars were used. Good readers outperformed the poor readers with the difference being the most dramatic for the adult-rated atypical items. When child-generated norms were used to develop stimulus lists for each subject, no differences in recall were found.

Bjorklund and Bernholtz's results demonstrate strong "knowledge base" effects between good and poor readers. When child-generated norms were used, the ease of activation of semantic relations was comparable between the good and poor readers and so was memory performance. When adult-generated norms were used, the structure of the lists was more similar to the semantic memories of the good than the poor readers. This resulted in greater ease of activation of semantic memory relations for the more proficient reader group, which in turn lead to higher levels of memory performance.

From the literature reviewed above, there does appear to be evidence that good and poor readers differ in the structure and organization of semantic memory. In particular, poor readers are characterized by slower lexical access and retrieval of higher-order information. The implications of these findings for differences in recall between good and poor readers have only been addressed in one study using good and poor readers of junior high school age. Further replication and extension of Bjorklund & Bernholtz's findings with children of different ages is necessary.

Statement of the Problem

The purpose of the present study was to examine two aspects of linguistic processing in good and poor readers: phonological recoding and semantic memory. There is evidence that good and poor readers differ in their use of phonological recoding and in the structure of their semantic memory. The existence of these differences, however, is controversial and warrants further investigation with refined methodologies. In particular, these differences in linguistic processing have most commonly been examined using aurally presented stimuli. Reading, however, is clearly a visual task. Thus, in this study, the stimuli were presented visually as this modality seems to be the most relevant for examining reading ability.

It is unclear whether findings of differential sensitivity to phonological similarity in good and poor readers represent a true difference in linguistic processing or a task artifact. To examine this question in detail, phonological recoding in good and poor readers was examined using recall and recognition paradigms. The first measure was a phonological similarity task, similar to that used by Brady et al. (1983) and Mann et al. (1980). Good and poor readers were presented with printed strings of three monosyllabic words, comprised of either rhyming, nonrhyming, and orthographically similar words.

Because stimuli have been aurally presented in most previous studies, the orthographic similarity of many phonologically similar words (e.g., chair and fair) has been overlooked. Consequently, few researchers have considered the possibility that visualized spelling pattern may be a confounding source of confusability in recall. In order to control for both phonological and orthographic similarity, the phonologically similar words used in the present study were as visually dissimilar as possible. Furthermore, an orthographic similarity condition was included in which visually similar words that were phonologically dissimilar were presented for recall. Thus, an examination of the individual effects of phonological and orthographic similarity was possible using this task. If poor readers are indeed deficient in the use of phonological recoding in working memory, it was expected that their recall performance would not be differentially affected by the type of word string (rhyming or nonrhyming). It was also hypothesized that orthographic similarity would affect good and poor readers to a similar extent.

Phonological recoding was also investigated in a continuous recognition task similar to that used by Byrne and Shea (1979). This measure examined the reliance of good and poor readers on phonological and semantic codes in working memory. It was expected that good readers would make more recognition errors on phonologically similar words than dissimilar words, and that this effect would not be found with poor readers. It was also expected that poor readers would exhibit a strong reliance on the semantic code in the absence of competition from the phonological code.

The other aspect of linguistic processing examined in the present study was semantic memory processes. Several studies have found that good and poor readers differ in the structure and organization of semantic memory (e.g., Bjorklund & Bernholtz, 1986, Vellutino et al., 1988). In order to extend these results, a free recall task similar to that of Bjorklund and Bernholtz (1986) was used to investigate differences in the structure of semantic memory. Children were presented with a printed list of 16 words for free recall. The list was comprised of atypical and typical category exemplars based on child-generated norms from four different categories. It was expected that good and poor readers would differ only in their recall of atypical words because of semantic memory differences between the two groups.

If true differences in linguistic processing do exist between good and poor readers, it is likely that both phonological recoding and semantic memory processes are not equally deficient in poor readers. Moreover, both processes may not have equivalent effects on reading competence.

Hence, in the present study, relations between the measures of phonological recoding and semantic memory were examined. As well, the contribution of each of the measures to reading comprehension and recognition was assessed.

Method

Subjects

Participants were 23 poor readers (PR) and 24 good readers (GR) enrolled in Anglophone classrooms in the metropolitan Montreal area. Data from 24 additional children were excluded because the criterion for good versus poor readers (see below) was not met. Demographic characteristics and test scores for the poor and good reader groups are summarized in Tables 1 and 2 respectively.

The poor readers were recruited from "free-flow" special education classes (i.e., they spend only part of the school day in these classrooms) in grades 3-6 at two public schools. To qualify for the poor reader group, children had to obtain a score at or below the 30th percentile on the Reading Recognition subtest of the Peabody Individual Achievement Test (PIAT) and be without any obvious sensory impairment. All poor readers, except one male, also obtained scores at or below the 30th percentile on the PIAT Reading Comprehension subtest.

The 24 good readers were selected from the same grades and, when possible, the same homeroom classes as the poor readers. Children were included in the good reader group if they scored above the 50th percentile on the PIAT Reading Recognition subtest. A total of 21 of the children in this group also scored above the 50th percentile on the PIAT Reading Comprehension subtest; three children scored at the

Table 1

Demographic characteristics and test scores of poor readers by grade

	Grade				
	3	4	5	6	Total
n	3	9	3	8	23
Male	3	7	2	2	14
Female	0	2	1	6	9
Age (M)	114.0	127.0	133.0	152.1	134.8
(SD)	15.2	5.0	8.5	6.6	16.7
Vocab. (M)	4.7	6.4	5.7	5.3	5.7
(SD)	2.1	2.7	2.1	1.9	2.2
B.D. (M)	8.7	8.0	7.7	7.8	8.0
(SD)	1.5	2.1	4.9	3.4	2.8
Recog. (M)	78.3	80.0	87.3	80.9	81.0
(SD)	7.1	4.5	1.2	3.2	4.8
Comp. (M)	83.3	81.7	86.7	78.1	81.4
(SD)	8.3	3.4	7.2	6.7	6.1

Note. M = mean; SD = standard deviation; Vocab. = WISC-R Vocabulary standard score; B.D. = WISC-R Block Design standard score; Recog. = Reading Recognition standard score; Comp. = Reading comprehension standard score.

Table 2

Demographic characteristics and test scores of good readers by grade

	Grade				
	3	4	5	6	Total
n	4	8	3	9	24
Male	2	7	2	3	14
Female	2	1	1	6	10
Age (M)	101.5	115.0	131.0	143.9	125.6
(SD)	5.7	3.9	3.5	4.4	17.1
Vocab. (M)	7.0	10.6	10.3	11.4	10.3
(SD)	1.4	2.3	1.2	2.1	2.5
B.D. (M)	8.5	13.1	8.3	11.7	11.2
(SD)	3.4	2.7	3.5	3.9	3.7
Recog. (M)	108.7	114.0	106.7	115.6	112.8
(SD)	3.6	12.1	5.5	6.5	8.7
Comp. (M)	101.5	115.0	131.0	143.9	111.6
(SD)	6.6	5.0	2.1	9.8	7.8

Note. M = mean; SD = standard deviation; Vocab. = WISC-R Vocabulary standard score; B.D. = WISC-R Block Design standard score; Recog. = Reading Recognition standard score; Comp. = Reading comprehension standard score.

45th, 46th, and 47th percentiles.

The poor readers were somewhat older than the good readers, but this difference was not statistically significant. As expected, children in the poor reader group scored significantly lower than good readers on the Vocabulary subtest of the WISC-R ($\underline{F}(1, 45) = 44.67$, $\underline{p}<.01$), but they also obtained lower scores on the WISC-R Block Design subtest ($\underline{F}(1, 45) = 11.38$, $\underline{p}<.01$). According to a parental report questionnaire attached to the consent form (Appendix A), the poor readers read at home less frequently than did good readers ($X^2(3, \underline{N} = 47) = 10.16$, $\underline{p}<.05$). The two groups did not differ, however, on the language predominantly spoken at home, which in 70% of the cases was English, or the frequency with which their parents read to them (which ranged from once a week to daily).

Measures

To obtain a measure of their general cognitive functioning, all children were administered the Vocabulary and Block Design subtests from the Wechsler Intelligence Scale for Children-Revised (WISC-R; Wechsler, 1974), the two subtests that are the best predictors of Full Scale IQ scores (Sattler, 1988). The children were also administered the Reading Comprehension and Reading Recognition subtests of the Peabody Individual Achievement test (PIAT; Dunn & Markwardt, 1970) in order to obtain estimates of their reading proficiency. Three experimental memory tasks were administered to each child and are described below.

Phonological Similarity Task. This task was employed to examine whether good and poor readers rely on phonological codes or orthographic codes in working memory. The stimuli consisted of fifteen strings of three monosyllabic words, five rhyming, five nonrhyming, and five orthographically similar. With the exception of some of the orthographically similar word strings, all three words within each string had similar Thorndike-Lorge frequency ratings (Thorndike & Lorge, 1944). In the rhyming strings, words had the same vowel and final consonant, but were as orthographically dissimilar as possible to avoid confounding visual and acoustic similarity. Nonrhyming words had both different vowels and final consonants. In the orthographically similar word strings, words were as visually similar as possible while being pronounced as differently as possible. The words were stencilled on individual 12.7 x 20.3 cm white index cards, with uppercase letters 1.2 cm high. The word strings used in this task are presented in Table 3.

The order of presentation of the word strings varied randomly across subjects, however, the sequence of the words within each string was constant. Children were told they would see a series of three words that should be remembered. After the children read each string aloud, they were instructed to count aloud for 5 seconds. Children were then asked to

Table 3

Phonological Similarity Task: Rhyming, Nonrhyming and Orthographically Similar Word Strings

Rhyming Word Strings		
great	eight	date
bear	chair	dare
bee	tea	key
fly	tie	sky
four	store	door
Nonrhyming Word Strings		
roar	aunt	tail
ship	nail	card
bed	set	hat
kiss	milk	farm
girl	tree	hair
Orthographically Similar Word Strings		
bow	box	boy
cap	cat	can
war	car	ear
fan	fat	far
pen	pan	pin

recall the words in the order of presentation. They were given as many practice trials as needed with an additional word string to ensure that they understood the task requirements. Subjects' responses were recorded by the examiner and audiotaped for later verification and analysis.

The children's responses were first analyzed for the correct reading of each word. If a child misread even one word in a string, that string was not scored. Protocols wherein more than 50% of the word strings contained a misread word were excluded from the data analyses.

Subjects' responses were then scored in two ways. In the more stringent, order-correct recall procedure, a response was considered correct only if the word was correctly reported and was recalled in the appropriate serial position within the string. In the second scoring method, the order-free recall procedure, serial position was disregarded and all words correctly recalled from a given string were counted. Because of misread words, children's recall performances were expressed as a ratio of the number of words recalled to the number of words correctly read, multiplied by 100. The number of words correctly read refers to the words that were not misread nor part of a word string which contained a misread word. Recall proportion scores were obtained for the total recall and recall of each of the three types of word strings, phonologically similar, nonrhyming, and orthographically similar.

Word Recognition Task. This measure was used to examine the differential reliance upon semantic and phonological codes in working memory by good and poor readers. A similar continuous recognition procedure was used previously by Byrne and Shea (1979).

The word lists for the task were based on 6 clusters of 5 words each. Each antecedent word (A) was coupled with a semantically related word (S, a synonym or antonym) and a phonologically similar (R, rhyming) word. For each S and R word, there was a control word (CS and CR, respectively). In all but a few cases, the control words matched their experimental partners (S and R words) in part of speech, syllabic length, and Thorndike-Lorge (1944) frequency rating. The selected R words were orthographically dissimilar to their A counterparts to eliminate the confounding effect of visual similarity. The 6 clusters of words are presented in Table 4.

In the list each A word appeared twice with the second presentation separated from the initial one by seven intervening items. Each experimental and control word appeared only once. Experimental and control word pairs were separated by one item. In half of the clusters, the experimental word appeared first, with this arrangement being reversed for the remaining clusters. The appearance of the experimental and control words always followed the second presentation of the appropriate A words by 9 or 14 places.

Table 4

Word Recognition Task: Antecedent, Experimental and Control Words

	Semantic		Rhyming	
Antecedent	S	CS	R	CR
gun	rifle	bubble	done	cut
slow	fast	next	toe	hang
high	low	first	my	her
white	black	round	right	best
go	come	keep	row	feed
take	give	kill	ache	help

On half the presentations, an _S_ word occupied position 9 after the _A_ word, with _R_ words on the other half.

The six clusters of words provided 36 items, including the two presentations of each _A_ word. In total, there were 70 items in the list. Nineteen words that bore no obvious relation to the other words were used as fillers. Seven of these filler words appeared once, 9 twice, and 3 three times. The filler words that appeared more than once were randomly chosen from the list of filler words. The second or third presentation of a filler word followed the initial presentation by a maximum of 15 positions. The filler words occupied positions 1-5, 7, 8, 10-13, 15, 16, 18, 20, with the remaining 34 positioned in spaces in the list after location of _A_, _S_, _R_, _CS_, and _CR_ items. The words were stencilled on 12.7 x 20.3 cm white index cards with uppercase letters 1.2 cm high.

Children were instructed to read each word aloud as it was displayed and specify whether each word was "new" (i.e., it has not appeared in the list before), or "old" (i.e., the item has been previously presented). Practice trials were presented to ensure that the children understood the task requirements. Words were presented 5 s after the child had read and identified the previous word. The participants' responses were audiotaped for later transcription and analysis.

The responses of children who misread more than 50% of the words were excluded from the analysis. If a child misread an antecedent word on either of the two presentations, that whole cluster was excluded from the scoring. When children misread either an R, CR, S, or CS word, that particular word pair was eliminated from the scoring.

Subjects' responses were then scored for two kinds of errors: false positive errors (i.e., saying 'old' to a word that had not been previously presented), and false negative errors (i.e., saying 'new' to any item that had been previously presented). Children's recognition performance was expressed as a ratio of the number of recognition errors to the number of words correctly read, multiplied by 100. The number of words correctly read refers to the words that were not misread nor eliminated because of other misreads in the cluster. Recognition proportion scores were obtained for the total recognition errors, and for each of the specific types of errors.

Free Recall Task. This measure was used to examine the effects of typicality on recall of words by good and poor readers. This task is similar to the procedure used by Bjorklund and Bernholtz (1986).

Words were generated from four different categories. These categories are similar to those used by Bjorklund and Bernholtz (1986), and are as follows: CLOTHING, FURNITURE, ANIMALS, and PARTS OF THE BODY. The typicality of list items was based on grade 2 children's typicality ratings (Poznansky, 1978). Four typical and four atypical exemplars were chosen from each category and two recall lists of 16 items were generated. For List One, two categories, ANIMALS and FURNITURE, were randomly chosen and exemplars from these two categories were typical. The remaining two categories, PARTS OF THE BODY and CLOTHING were represented by atypical exemplars in this list. A second list was generated in which the typicality of items from the different categories was reversed. Half of the children received one list and the other half received the second list. The items were randomly ordered within each list such that no two items from the same category were presented consecutively. Each word was presented on white 12.7 x 20.3 index cards in black 1.2 cm uppercase letters. The words on which the recall lists are based are presented in Table 5.

Children were instructed to read and later recall a list of words. Each child was asked to read the word aloud as it was presented. Each word was displayed for as long as the child required to read the word. Following the presentation of the last item, children were asked to name colours aloud. After 10 seconds, the experimenter asked the child to remember as many of the words on the list that he or she could in any order they wished. Once children responded that they could remember no more words or after a 15 second period in which no words are recalled, the experimenter asked the

Table 5.

Free Recall Task: Atypical and Typical Category Exemplars

Category	Atypical	Typical
CLOTHING	belt	pants
	tie	shirt
	vest	dress
	scarf	socks
FURNITURE	bench	chair
	shelf	table
	rug	bed
	stool	desk
ANIMALS	wolf	dog
	rat	cat
	moose	horse
	fox	cow
PARTS OF THE BODY	tooth	leg
	chin	head
	face	arm
	bone	hand

Note. For List One, items from the ANIMALS and FURNITURE categories were typical and items from CLOTHING and PARTS OF THE BODY were atypical. The reverse is true for List Two.

children if they were certain they couldn't remember any more words. Subject responses were transcribed by the examiner and audiotaped for later verification and analysis.

If a child misread more than 50% of the words on the list, his or her data were excluded from the data analyses. Subjects' responses were scored in three ways. First, the number of words correctly recalled from the typical and atypical categories were calculated for each child, and expressed as a ratio of the number of words recalled to the number of words correctly read multiplied by 100. Recall proportion scores were obtained for the total, typical, and atypical word recall.

Clustering scores were then calculated separately for the typical and atypical items using the ratio of repetition measure (Bousfield, 1953). The ratio of repetition measure is defined as $r/(n - 1)$, where r represents the number of intracategory words recalled contiguously, and n refers to the total number of words recalled. In the present study, the ratio of repetition scores was calculated separately for the typical and atypical words, so r referred to the number of intracategory repetitions for only the typical or atypical items. The total number of typical or atypical words recalled on a trial was represented by n.

Finally, an observer listening to the recorded subject responses signalled latencies between consecutively recalled words by depressing a key on a microcomputer each time the child uttered a word. Interitem latencies were subsequently classified as either between category (two words from different categories recalled consecutively), atypical (two atypical words from the same category recalled consecutively), or typical (two typical words from the same category recalled consecutively) (Bjorklund & Bernholtz, 1986). Latencies involving repetitions or intrusions were excluded.

The scores derived from all of the tasks administered in this study are listed in Table 6.

Procedure

All children were tested individually in quiet rooms in their schools during regular school hours. The 7 measures were administered in a single session, which lasted approximately one hour. Ten testing sessions were interrupted for a period of fifteen minutes each due to recess. The order of task presentation within a session was randomly determined for each child with the stipulations that no two processing tasks be administered consecutively and that the PIAT Reading Recognition task be presented before the Reading Comprehension subtest.

Table 6

Summary of Scores from all Measures

Task	Score
Reading Recognition	Standard Score (age-based, M=100, SD=15)
Reading Comprehension	Standard Score (age-based, M=100, SD=15)
Vocabulary	Standard Score (M=10)
Block Design	Standard Score (M=10)
Phonological Similarity task	Order-correct recall: total, phonologically similar, nonrhyming, and orthographically similar
	Order-free recall: total, phonologically similar, nonrhyming, and orthographically similar
Word Recognition task	False positive recognition errors: total, rhyming, rhyming control, semantic, semantic control
	False negative recognition errors: total, rhyming,rhyming control, semantic, semantic control
Free Recall task	Recall: total, atypical, typical
	Clustering: atypical and typical
	Latencies: between category, atypical, typical

Results

The data were analyzed in two phases. Data from each of the language processing tasks were first analyzed individually to examine group differences. Multiple regression analyses were then conducted to determine whether language processing task scores were related to reading achievement.

Phonological Similarity Task

Data from five subjects were excluded from the analyses of this task as they misread more than 8 or 50% of the word strings. Thus, the following analyses are based on 18 poor readers and 24 good readers.

To examine word recognition errors on this task, the number of words misread by both reader groups was compared in a 2 (group) x (3) (type) repeated measures analysis of variance (ANOVA). As expected, the two groups differed on the total number of misread words (PR: M=3.60; GR: M=.70; $F(1, 40) = 23.53$, p<.01). Neither the type main effect nor the group x type interaction effect were significant. Although poor readers misread more words than good readers, the type of word string (phonologically similar, nonrhyming, orthographically similar) was unrelated to number of word recognition errors.

The analyses of primary interest for this task were comparisons of the two reader groups on the proportion of words recalled. First, children's recall scores derived from the order-correct scoring procedure were examined using a 2 (group) by (3) (type) repeated measures ANOVA. As expected, the overall accuracy of recall was greater for good readers, ($F(1, 40) = 22.26$, $p<.01$). Poor readers recalled 52.4% of the words they had correctly read in the appropriate serial position, but the good readers accurately recalled 77.8% of the words. The main effect for word string type (phonologically similar, nonrhyming and orthographically similar) was also significant ($F(2, 80) = 7.41$, $p<.01$). Post-hoc evaluation of this effect with Tukey's HSD test indicated a significant difference between the recall of words in orthographically similar word strings and both phonologically similar words and nonrhyming words (see Table 7). The interaction between reading group and word string type was not significant. Thus, both poor and good readers' recall was penalized by the visual but not phonological similarity of the words strings, suggesting that neither group was relying upon phonological recoding in working memory.

In the second main analysis of the recall data, proportion recall scores derived from the order-free scoring method were examined with a 2 (group) X (3) (type) repeated measures ANOVA. Only the group main effect was significant ($F(1, 40) = 28.65$, $p<.01$) (see Table 7). Poor readers recalled 74.3% of the words they had correctly read; good readers recalled 90.0%. Thus, while children's order-correct

Table 7

Phonological Similarity task: Percentage Recall Scores by Group and Word String Type.

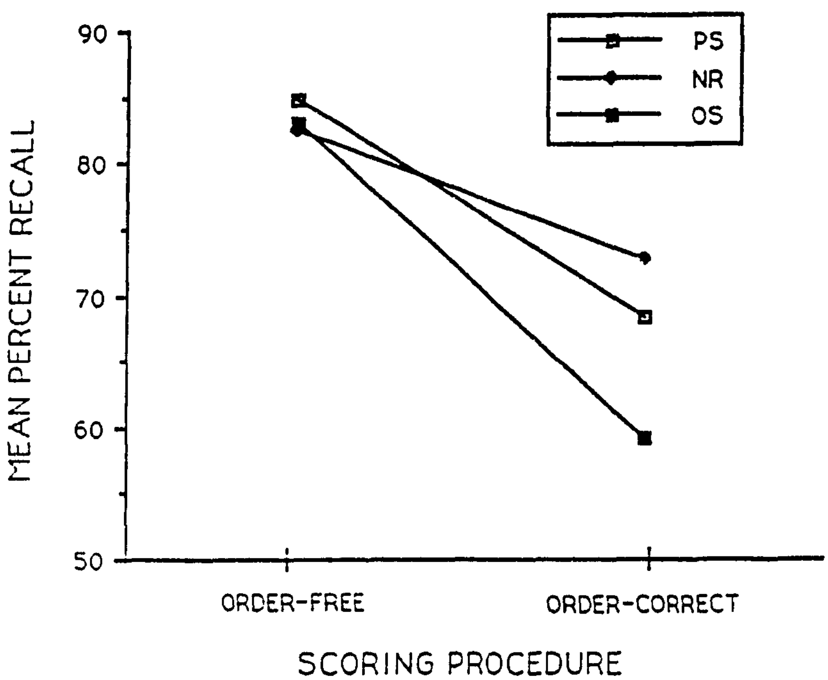
	Order-correct		Order-free	
	PR	GR	PR	GR
PS words	56.54	77.29	76.94	90.56
NR words	56.60	84.82	71.17	90.79
OS words	43.21	71.07	75.18	88.77

Note: PS = phonologically similar; NR = nonrhyming; OS = orthographically similar; PR = poor readers; GR = good readers recall was affected by orthographic similarity, the free recall of words was not affected by either phonological or orthographic similarity.

The results of other studies using lists of high intralist similarity have indicated that the recall of order information is more difficult than the free recall of items (e.g., Brady et al., 1983). To evaluate this possibility, a 2 (group) x (2) (scoring procedure) x (3) (word string type) repeated measures ANOVA was conducted using order-free recall proportion scores and order-correct recall scores. The group main effect and the scoring procedure main effect were both significant ($F(1, 40) = 28.38$, $p<.01$; and $F(1, 40) = 74.68$, $p<.01$). As expected, good readers recalled significantly more words than poor readers, and the free recall of information (PR: M=74.3%; GR: M=90.0%) was easier than ordered recall (PR: M=52.4%; GR: M=77.8%). The group by scoring procedure interaction effect was significant ($F(1, 40) = 6.23$, $p<.05$). The results of subsequent scoring type-at-group simple effects tests indicated significant scoring type differences for both good readers ($F(1, 40) = 22.00$, $p<.01$), and poor readers ($F(1, 40) = 52.80$, $p<.01$). As can be seen in Figure 1, the interaction between scoring procedure and word string type was also significant ($F(2, 80) = 15.21$, $p<.01$). The results of follow-up simple effects tests indicated that for all three types of word strings, ordered recall scores were much lower than free recall scores

Figure 1

Phonological Similarity Task: Mean Percentage Recall as a Function of Scoring Procedure and Word String Type



(phonologically similar words: $F(2, 80) = 77.66$, $p<.01$; nonrhyming words: $F(2, 80) = 27.17$, $p<.01$; orthographically similar words: $F(2, 80) = 165.42$, $p<.01$). Thus, the recall of words in order of presentation was more difficult than the free recall of words for both good and poor readers, regardless of word string type.

Word Recognition task

Data from two children were excluded from this analysis. This task could not be administered to one poor reader because he could not read any of the words in the list. Responses from a second child, a good reader, were excluded due to equipment failure. Thus, the following analyses are based on 22 poor readers and 23 good readers.

A 2 (group) x (6) (word type) repeated measures ANOVA was conducted to compare the number of words misread by children in each reading group. There was a significant effect for group ($F(1, 43) = 22.92$, $p<.01$), and for word type ($F(5, 215) = 8.95$, $p<.01$). The group by type interaction was also significant ($F(5, 215) = 8.95$, $p<.01$) (see Table 8). Results of group-at-type simple effects tests indicated that the two reader groups differed only on the number of misread filler words ($F(1, 43) = 22.12$, $p<.01$), and antecedent words ($F(1, 43) = 5.93$, $p<.05$). This finding is likely artifactual because only these two types of words, filler and antecedent, were presented more than once in the list. As expected, the poor readers did make more word recognition errors than the

Table 8

Word Recognition Task: Number of Word Recognition Errors by Word Type and Group.

Word type	Group	
	Poor Readers	Good Readers
Filler	2.64	0.09*
Antecedent	1.32	0.00*
Rhyming	1.14	0.40
Rhyming control	0.60	0.04
Semantic	0.73	0.09
Semantic control	0.46	0.04

*significant difference ($p < .05$) between the two reading groups.

good readers.

A oneway ANOVA was used to compare the total proportion of recognition errors (false positives and false negatives) made by children in both groups. The two groups did not differ significantly: poor readers erred on 6.29% of the words they correctly read and good readers incorrectly identified 3.04% of the words.

The main analysis for this task concerns false positive responses (i.e., incorrectly responding "old" to words that had not previously appeared) to experimental and control words. The percentage of false positive errors to rhyming and control rhyming words were compared with a 2 (group) by (2) (type) repeated measures ANOVA. Only the type main effect was significant, ($F(1, 43) = 4.50$, $p<.05$). Children incorrectly identified as "old" more rhyming words (M = 3.85%) than control rhyming words (M = .93%). A similar analysis was performed using the semantic and control semantic words. This analysis yielded no significant effects.

To examine differential reliance on phonological and semantic recoding by good and poor readers, the false positive data were analyzed in two different ways. First, as in Byrne and Shea's (1979) study, the differences between the percentages of false positives to R and CR words, and to S and CS words were calculated and subjected to an analysis of variance. This analysis revealed only a marginally significant effect for type ($F(1, 43) = 3.98$, $p=.052$). As can be seen in Table 9, the R-CR difference was 2.93 while the S-CS difference was -2.07. The interpretation of these results is complicated by the high number of false positives to both the S and CS words and relatively low number of false positives to the CR words. Because of these interpretational problems, the percentage of false positive responses to S and R words were directly compared using an ANOVA. This analysis revealed no significant effects. Thus, good and poor reader's recognition performance was equally penalized by phonological and semantic similarity.

Free Recall task

Data from one poor reader were excluded from these analyses because he misread more than 50% of the words. Latency data from one good reader was unavailable for scoring due to equipment failure. Thus, the following analyses are based on data from 22 poor readers and 24 good readers.

Data from this task were analyzed in four steps: the misread words; recall data (the analyses of main interest); clustering scores; and latencies. Two recall lists were used in this task. A total of 20 children received List One and 27 received List Two. Thus, list is included as a between-subjects variable in the following analyses.

Misread words. A 2 (group) x 2 (list) x (2) (word typicality) repeated measures ANOVA was conducted to compare the number of word recognition errors across the reader

Table 9

Mean Percentage of False Positives to Rhyming and Semantic (Experimental and Control) Words

Word Type	Readers		
	Poor Readers	Good Readers	Total
Rhyming			
Rhyming	5.30	2.46	3.85
Control Rhyming	1.14	0.73	0.93
R-CR difference	4.17	1.74	2.93
Semantic			
Semantic	6.06	5.07	5.56
Control Semantic	7.12	8.12	7.63
S-CS difference	-1.06	-3.04	-2.07

groups. Only the group main effect was significant ($F(1, 42) = 18.85$, $p<.01$; PR: $M=2.09$; GR: $M=.17$) among the between-subjects effects. Among the within subjects effects, the two-way interaction between list and typicality was significant ($F(1, 42) = 9.54$, $p<.05$) as was the three-way interaction between list, group and word type ($F(1, 42) = 7.24$, $p<.05$). Results of simple interaction effect tests indicated that the group by typicality interaction was significant for List One only ($F(1, 42) = 12.47$, $p<.01$). Subsequent group-at-type simple effects tests indicated that only the difference between groups on misread atypical words was significant ($F(1, 42) = 20.87$, $p<.01$) with poor readers ($M=1.91$) misreading more of the atypical words than good readers ($M=0.13$).

The number of word recognition errors was further analyzed according to the specific categories of the words, that is ANIMALS, PARTS OF THE BODY, FURNITURE, and CLOTHING. A 2 (group) x 2 (list) x (4) (word category) repeated measures ANOVA was performed on the number of words misread by each group. There was a significant effect for group ($F(1, 42) = 18.85$, $p<.01$), and for word category ($F(1, 42) = 6.32$, $p<.01$). The group by word category interaction was also significant ($F(3, 126) = 4.63$, $p<.01$). Results of group at type simple effects tests indicated that poor readers misread more words in the following categories: clothing (PR: $M=0.91$ GR: $M=0.08$, $F(1, 42) = 13.55$, $p<.01$); parts of the body (PR: M=0.59 GR: M=0.04, $F(1, 42) = 6.01$, $p<.05$); and furniture (PR: M=0.55 GR: M=0.04, $F(1, 42) = 5.04$, $p<.05$).

Recall. As noted earlier, the proportion of words correctly recalled from the typical and atypical categories were calculated for each child. Mean recall proportions, computed separately for the typical and atypical categories, are presented for the good and poor readers by list in Table 10. These data were then analyzed using a 2 (group) x 2 (list) x (2) (typicality) repeated measures ANOVA. The group, list, and typicality main effects were not significant nor was the list by typicality interaction. This analysis did indicate a significant group x typicality interaction ($F(1, 42) = 4.08$, $p<.05$) and a significant group by list by typicality interaction ($F(1, 42) = 4.15$, $p<.05$) (see Figure 2). Results of simple interaction effects tests indicated that the group by typicality interaction was significant only at List One ($F(1, 42) = 8.22$, $p<.001$). Further examination of this interaction using type-at-group simple effects tests indicated that poor readers recalled significantly fewer atypical words than typical words on List One ($F(1, 42) = 8.53$, $p<.01$). Good readers, on the other hand, recalled as many atypical words as they did typical words ($F(1, 42) = 0.98$, n.s.). Thus, the typicality of the category exemplars affected only the poor readers' recall.

Recall of words from the specific categories was then examined in a 2 (group) x 2 (list) x (4) (word category)

Table 10

Free Recall task: Percentage Recall and Clustering Scores for Atypical and Typical Exemplars by Group and List

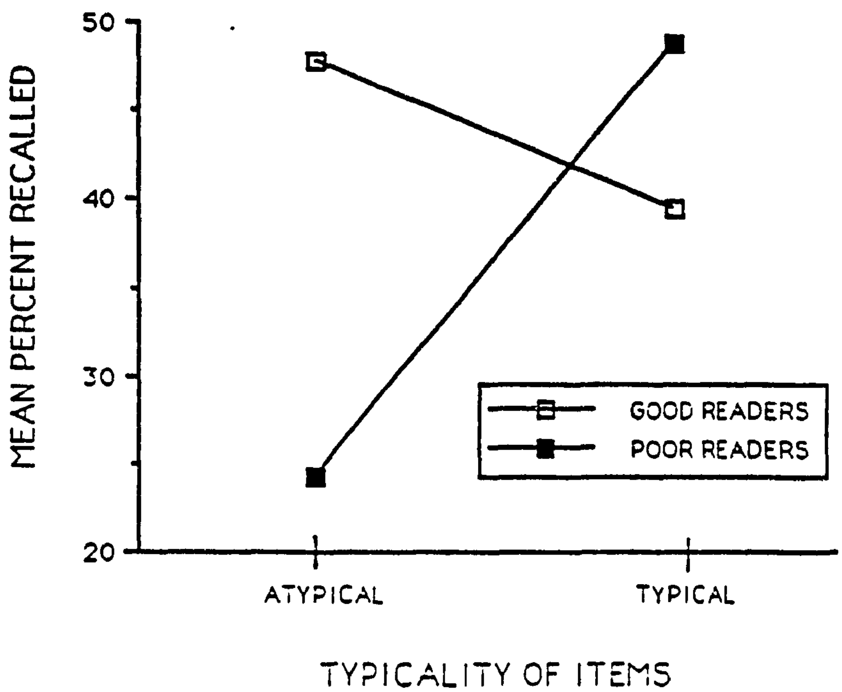
	List One		List Two	
	AT	TY	AT	TY
Recall				
PR	24.30	47.78	27.55	35.78
GR	48.88	39.51	35.17	43.53
Clustering				
PR	0.00	1.33	0.17	0.53
GR	0.26	0.43	0.43	0.68

Note. AT = atypical; TY = typical; PR = poor readers; GR = good readers

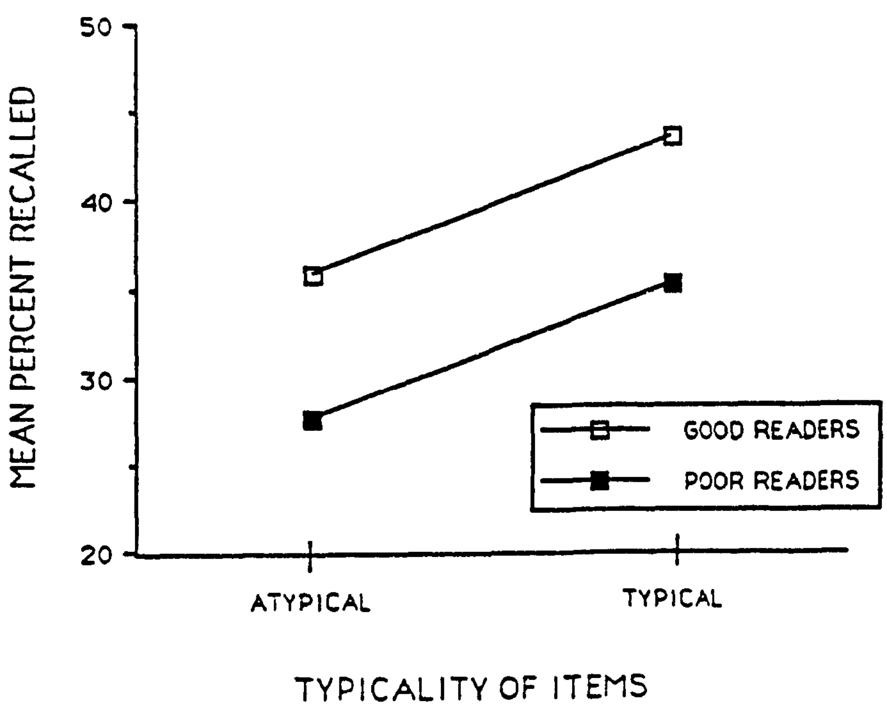
Figure 2

Free Recall Task: Mean Percentage Recall by Group and Typicality for List One and List Two

List One



List Two



repeated measures ANOVA. This analysis yielded no significant effects, indicating that the category to which a word belonged had no effect on it's subsequent recall.

Clustering. Because children who misread words did not have the same opportunities to cluster typical and atypical words in recall as the children who correctly read all the words, these analyses were performed using only data from children who read all the words in the list. As a result, the sample size was decreased to 5 poor readers and 15 good readers. Clustering scores were computed separately for the typical and atypical words, using the ratio of repetition measure (Bousfield, 1953). Mean ratio of repetition scores are presented by group and typicality level in Table 10. Results of a 2 (group) x 2 (list) x (2) (typicality) repeated measures ANOVA of these clustering scores indicated a significant main effect of typicality ($F(1, 16) = 7.69$, $p<.05$). Children tended to recall in clusters typical words of the same category more often than atypical words. The main effects for group and list and the interaction effects were not significant.

Latencies. Latency analyses were also conducted using data from children who correctly read all words in the list. Latencies involving intrusions and repetitions were excluded from this analysis. Results of a 2 (group) by (3) (latency type) repeated measures ANOVA indicated no significant effects.

Regression Analyses

In order to assess the relative contribution of each of the processing tasks to the prediction of reading achievement, a series of multiple regression analyses were conducted. First, the role of recall, recognition, and knowledge-based recall processes in reading achievement was examined with multiple regressions using global scores from each task. Scores representing the major manipulations of each task were then entered into regression analyses to assess the contribution of more specific types of recall and recognition (i.e., recall of phonologically similar words) to reading achievement. Data from children who misread more than 50% of the words on any task were omitted.

Prediction of Reading Recognition. A multiple regression analysis was first performed between the PIAT standard Reading Recognition score (dependent variable) and the global task scores (independent variables). Because the recall scores derived using the order-correct scoring procedure indicated both group and type differences, the phonological similarity task was represented by the total proportion recall score from this scoring procedure. The proportion total recognition errors score from the word recognition task and the proportion total free recall score from the free recall task were also included. The overall multiple correlation was .66 ($F(3, 35) = 8.93$, $p<.01$). Only the proportion recall score from the phonological similarity task, however, contributed significantly to the prediction of reading recognition (standardized beta = .64, $t = 4.76$, $p<.01$).

Unfortunately, when children who score at the two extremes of reading ability are included in an analysis, even the weakest predictors of reading ability can appear extremely powerful. Thus, the above regression analysis was performed separately for each reader group. For poor readers, the multiple correlation was .32 and was not significant ($F(3, 12) = .47$, $p=.71$). In contrast, for good readers, the multiple correlation was .62 and did differ significantly from zero ($F(3, 19) = 4.03$, $p<.05$). The only significant predictor of reading recognition was the proportion recall score from the phonological similarity task (standardized beta =.08, $t = 2.77$, $p<.05$). Thus, the language processing tasks appear only to be measuring some of the cognitive processes involved in skilled reading by good readers. In particular, the recall of words in their appropriate serial position is highly related to reading recognition for good readers only.

A separate standard multiple regression analysis was calculated between more detailed task scores and reading recognition. Because of the small sample size, this regression could not be performed separately for each group. From the phonological similarity task, the order-correct recall proportion scores for phonological, nonrhyming, and orthographically similar word strings were entered into the equation. The word recognition task was represented only by one score, the total recognition error proportion score, as other variables from this task had limited variance. The typical recall and atypical recall proportion scores from the free recall task were also entered into the equation. The overall multiple correlation was .72 ($F(6, 32) = 5.78$, $p<.01$). The major contributor to the prediction of reading recognition was the nonrhyming word string proportion recall score from the phonological similarity task (standardized beta =.39, $t = 2.12$, $p<.05$). Thus, the recall of nonrhyming words in the appropriate serial position appears to involve similar cognitive processes to reading recognition.

Prediction of Reading Comprehension. To assess the relation of the processing tasks to reading comprehension, a multiple correlation was calculated between the PIAT standard Reading Comprehension score and the global task scores (total proportion recall score from the order-correct scoring procedure of the phonological similarity task; the proportion total recognition errors score from the word recognition task; the proportion total free recall score from the free recall task). The resulting multiple correlation was .55 ($F(3, 35) = 5.15$, $p<.01$). As in the prediction of reading recognition, only the recall score from the phonological similarity task contributed significantly to the prediction of comprehension (standardized beta =.55, $t = 3.55$, $p<.01$).

Because of the problems associated with extreme-groups designs, the above regression analysis was performed for each group separately. As in the prediction of reading recognition, the major task variables did not significantly predict reading comprehension for the poor readers ($R = .34$; $F(3, 12) = .52$, $p = .68$). Furthermore, these variables did not significantly predict reading comprehension for the good readers ($R = .43$; $F(3, 19) = 1.50$, $p = .25$). Thus, it appears that the language processing tasks are not significantly related to reading comprehension for either the good or the poor readers.

The contribution of more detailed task scores to the prediction of reading comprehension was assessed with a second multiple correlation analysis. The detailed task scores used in this regression are the same as those used in the second prediction of reading recognition. Because of the small sample size, this regression could not be performed separately for each group. These variables predicted reading comprehension with a significant overall multiple correlation of .60 ($F(6, 32) = 3.03$, $p < .05$). No single individual variable had a significant beta weight. Only the orthographically similar recall score contributed to the prediction of reading comprehension and its effect was marginal (Beta =.39, $t = 1.94$, $p = .06$). See Table 11 for a summary of the multiple regression analyses.

Table 11

Summary of Multiple Regression Analyses

Predictors	D.V.	R	Variables[d]
1. Set A[a]	Recog.	.66**	PS task recall score
2. Set A (poor readers)	Recog.	.32	n.s.
3. Set A (good readers)	Recog.	.62*	PS task recall score
4. Set B[b]	Recog.	.72**	PS task nonrhyming recall score
5. Set A	Comp.	.55**	PS task recall score
6. Set A (poor readers)	Comp.	.34	n.s.
7. Set A	Comp.	.43	n.s.
8. Set B	Comp.	.60*	n.s.[c]

[a]Predictor Set A: Phonological Similarity task order-correct recall score; Word Recognition task total recognition errors score; Free recall task total recall score
[b]Predictor Set B: PS task order-correct recall scores for phonologically similar, nonrhyming and orthographically similar word strings; WR task total recognition errors score; FR task typical and atypical recall scores
[c]No single variable contributed significantly to this equation
[d]Variables contributing significantly to the equation
*$p < .05$; **$p < .01$

Discussion

The purpose of the present study was to examine two aspects of linguistic processing in good and poor readers: phonological recoding and the structure of semantic memory. Two measures, the phonological similarity task and the word recognition task, were used to examine phonological recoding. The results of these two tasks will be discussed first, followed by an examination of the findings from the free recall task, concerning differences in the structure of semantic memory. Finally, the contribution of language processing tasks to the prediction of reading competence will be discussed.

Phonological Recoding in Good and Poor Readers

Phonological similarity Task. This task was used to examine the effects of phonological and orthographic similarity on the recall performance of good and poor readers. As expected, good readers recalled significantly more words of any type, regardless of the scoring method used (i.e., order-free versus order-correct). Thus, poor readers had more difficulty than good readers with the both the free and ordered recall of linguistic information. This finding is consistent with the results of earlier studies which have repeatedly found that good readers exhibit superior recall when compared to poor readers (e.g., Katz et al., 1981; Siegal & Ryan, 1988; Torgesen & Houck, 1980). Also consistent with previous research was the finding that the recall of ordered information was significantly more difficult than the free recall of items for both reader groups regardless of word string type (e.g., Brady et al., 1983).

In contrast to many previous studies, good and poor readers did not exhibit differential patterns of recall to the various types of word strings. When children's recall performances were scored using the order-correct scoring method, both good and poor readers' recall was penalized by orthographic similarity. Both reader groups recalled significantly fewer orthographically similar words as compared to phonologically similar and nonrhyming words, although at different overall levels of performance. This finding suggests that both good and poor readers used visual codes, rather than phonological codes, to hold information in working memory. Thus, when asked to recall information in the order of presentation, the visual similarity of the items interfered with the order information and recall was penalized.

When the order-free method was used to score children's recall performances, both groups displayed similar recall patterns: they recalled equal numbers of phonologically similar, nonrhyming, and orthographically similar word strings. The poor readers' overall level of performance was, of course, significantly lower than the good readers'.

Interestingly, the orthographic similarity of the words interfered with recall only when ordered information was considered. When order was disregarded, that is, when the words were recalled in any sequence, the visual similarity of the words did not affect recall. Recalling information in the order of presentation is a more difficult task than the free recall of items; in this study, the recall of order information was significantly lower than the free recall of words for both reader groups. Ordered recall is also a more complex processing task than free recall: the stimuli themselves must be encoded and retrieved from memory as well as the order in which they were presented. It appears, then, that orthographic similarity interfered only when the recall task required more complex processing.

As discussed earlier, previous studies have used similar recall measures with good and poor readers and have found that good readers appear to make use of phonological recoding while poor readers do not (e.g., Brady et al., 1983; Mann et al., 1980). In contrast, neither good nor poor readers showed any evidence of using phonological recoding in the present task. There are methodological differences between this task and those used in previous studies that may account for the discrepancies in results. First, the words to be remembered were presented visually rather than aurally. Although consonants have been presented visually in recall studies, words have only been presented aurally. It is possible that visual coding is more expedient than phonological recoding when subjects must encode a printed word.

Furthermore, in this study, the phonologically similar words were as visually dissimilar as possible. Thus, the effects of phonological and orthographic similarity were not confounded. In previous studies, few researchers have controlled for the possibility that visualized spelling pattern may be interacting with phonological similarity to lead to confusions in recall.

A further methodological difference between the present task and those used in previous studies is the number of items to be remembered. Subjects were presented with three words for recall followed by a five second interference task. Previous studies have presented children with lists of four or five items to be recalled. Several authors have argued that poor readers do not show phonological similarity effects because the number of words to be recalled in the task place more demands on them than on good readers (e.g., Hall et al., 1983; Johnston, 1982). It is unlikely, however that phonological similarity effects were suppressed in this study because of the difficulty level of the task. The memory spans of good and poor readers tend to range from three to five items (Johnston et al., 1987). One can be reasonably confident that the word strings of three words did not exceed the memory spans of good or poor readers. Furthermore, both reader groups recalled a minimum of 50% of the items presented. Thus, the lack of phonological similarity effect cannot be attributed to the difficulty of the task. It is possible, however, that with only three items to recall, the demands of the task were such that neither reader group needed to process the words phonologically.

The lack of phonological similarity effect found in the present task may also be due to the interference task used in this study. After the list was presented, subjects were given a five second delay period during which they counted aloud. It may be that this interference task of counting acted as a type of suppression and prevented the recoding of words into a phonological form. A consistent finding in the phonological recoding literature is that the phonological similarity effect is completely abolished if subjects articulate an irrelevant sound while the list is being presented visually (e.g., Murray, 1967; Peterson & Johnson, 1971; Wilding & Mohindra, 1980). The accepted interpretation of this finding is that suppression prevents visual information from being recoded into a phonological form.

Unlike earlier studies, good and poor readers were also compared on their recall of visually similar words in the present task. Only one other study has compared good and poor readers' recall of both phonologically and orthographically similar words. Hunt and Badawi (1985), using a release-from-proactive-inhibition task, found the two reader groups performed comparably when the dimension of similarity was phonological. However, good readers showed evidence of build up of proactive inhibition and its release with visually similar words while poor readers did not. The present findings are inconsistent with these results, as good and poor readers were not differentially affected by visual similarity.

In summary, the results of this task indicate that good and poor readers display similar patterns of recall, although at different overall levels of performance. Furthermore, both groups appear to be using visual codes to hold information in working memory rather than recoding into a phonological form. It appears, then, that the nature of the task was such that visual encoding was more expedient than phonological recoding. Further research must be conducted in order to clarify the present findings. One possibility would be to examine good and poor readers' recall of visually and aurally presented phonologically similar, nonrhyming, and orthographically similar word strings of varying lengths within the same task and compare these results with the present findings.

Word Recognition task. This measure was used to examine differential reliance upon phonological and semantic codes in working memory using a recognition paradigm and is based on a task used by Byrne and Shea (1979).

Good and poor readers did not differ on the total number of recognition errors they made, a finding consistent with Byrne and Shea's (1979) results. The analyses of main interest, however, involve false positive responses to the semantically similar words (S), phonologically similar words (R), and their control words (CS and CR). When the differences in false positives between R and CR words and between S and CS words were calculated and compared, a marginally significant type effect was found. Using Byrne and Shea's logic, this result would be interpreted to indicate that the recognition performance of good and poor readers was penalized by phonological but not semantic similarity. In contrast to Byrne and Shea's findings, the good and poor readers in this study were not differentially sensitive to phonological or semantic similarity.

The above analysis, however, may not reflect true differences in the present data. Because of a large number of false positive responses to the CS words, the difference in false positive responses calculated between the S and CS words is negative. The number of false positive responses to the CR words was, however, much smaller. Thus, the R-CR difference was positive and quite large. When the two difference scores were compared in a analysis of variance, the R-CR difference was marginally significantly different from the S-CS score. It must be noted that the control words (CS and CR) were matched with their respective R or S mates only in terms of part of speech, syllabic length, and frequency rating. They are also positioned near the their mate in the recognition list. The rationale behind the matching of certain control words with a certain target words is fairly weak. Thus, an analysis resting on the relative difference between the controls and target words is difficult to interpret.

A direct comparison of the number of false positives to R and S words more accurately examined differential reliance upon semantic and phonological codes. The results of this analysis indicated that both good and poor readers made similar numbers of false positive responses to S and R words. Thus, good and poor readers' recognition performance was equally penalized by semantic and phonological similarity.

The present results are contrary to those found by Byrne and Shea, even though the word clusters used were identical to those used in their study. They, however, used a list of 120 words and an auditory presentation. In the present study, the recognition list was comprised of 70 words presented visually. These discrepancies in methodology and the different statistical analyses may account for the discordance between the present results and Byrne and Shea's findings.

In summary, the results of this task indicate that good and poor reader's recognition performances were similar both in terms of number of recognition errors and effect of word similarity. These findings and the results from the phonological similarity task have important implications for the study of differences between good and poor readers, which will be discussed below.

Conclusions and Implications. In contrast to earlier findings, there were no differential effects of phonological or orthographic similarity among good and poor readers. Furthermore, neither the good nor the poor readers appeared to be recoding words phonologically to store in working memory. The results of these two tasks indicate that when items are not processed phonologically, both good and poor readers display similar recall and recognition patterns.

These results confirm that there are differences in good and poor readers' recall performance on word lists. These differences, however, do not extend to the recognition of items. Recognition does entail the processing of less detailed information than does recall, in that the sensory stimulus is fully available and does not have to be reproduced or reconstructed (Kintsch, 1970). Thus, it may be that when processing requirements are less demanding, good and poor readers perform similarly.

In view of the results obtained from both the phonological similarity and word recognition task, the hypothesis of differential phonological recoding by good and poor readers cannot be confirmed. The findings from the phonological similarity task suggest that both good and poor readers were relying on visual encoding rather than phonological recoding.

There is some evidence that as children grow older, reliance on visual encoding, as opposed to phonological recoding, becomes progressively more important in lexical access (e.g., Doctor & Coltheart, 1980). There is some debate concerning whether the phonological code that is used to gain lexical access is identical to that used for the maintenance of information in working memory (e.g., Besner & Davelaar, 1982). Nonetheless, some authors have argued that both of these processes are to some degree, manifestations of a single type of phonological processing (e.g., Wagner & Torgesen, 1987). Although adults do generally display a phonological similarity effect when holding information in working memory, it is possible that there is an increased reliance on visual encoding when recalling words. Perhaps, as in lexical access, there are certain conditions under which visual encoding rather than phonological recoding is used to hold information in working memory.

Given the discrepancies between the present results and earlier findings, further research is necessary to resolve these contradictory findings. The effect of orthographic similarity on good and poor readers should be further explored, using alternative recall and recognition paradigms. Furthermore, the conditions under which good and poor readers utilize visual or phonological codes in working memory must be identified. It is possible that findings of differential phonological coding only hold for specific recall situations.

Thus, the results of the two tasks reviewed above do not provide any evidence that good and poor readers differ on one specific aspect of linguistic processing, namely phonological recoding in working memory. In the present study, however, good and poor readers were also compared in terms of structure of semantic memory, using a free recall task. These results will be discussed below.

The Structure of Semantic Memory in Good and Poor Readers

The free recall measure was used to examine the effects of typicality of category exemplar on the recall of words by good and poor readers. The typicality rating of the stimuli was based on child rather than adult-generated norms. Consistent with earlier findings using a similar task (e.g., Bjorklund & Bernholtz, 1986), good and poor readers recalled the same number of words from the list . Thus, when child-defined typical and atypical category exemplars are used as stimuli, differences in memory performance between good and poor readers are minimized.

The typicality of the words to be recalled, however, did appear to differentially affect good and poor readers. As expected, poor readers recalled significantly fewer atypical words than typical words In contrast, there were no differences in good readers' recall of typical or atypical words. This finding, however, held only for children who were presented with List One for recall. Good and poor readers who were presented with List Two recalled similar numbers of atypical and typical words.

The typicality of items also affected the clustering of words in recall. Although the group effect could not be evaluated because of word recognition errors and the resulting small sample sizes, there was a significant effect of typicality. Children tended to recall typical exemplars of the same category in clusters more often than atypical exemplars. Typicality, however, did not affect the length of interitem latencies. This may be due to the extremely small sample size used in these analyses.

It seems that good and poor readers do differ in the structure or organization of their semantic memories. That good readers did not differ in their recall of atypical and typical items suggests they possess extensive category knowledge and well-elaborated relations among atypical and typical items in semantic memory. In contrast, it seems that the relations among atypical items in semantic memory are not as well developed as those between typical items for poor readers. Thus, for poor readers, the recall of one atypical word may not have easily activated other atypical words from the same category. These findings are consistent with earlier studies who found differences in semantic memory between good and poor readers (e.g., Swanson, 1986; Vellutino & Scanlon, 1985).

It must be emphasized that the differential effects of typicality were found only for words on List One. Thus, these results cannot be generalized beyond the words in this list. It is unclear whether these findings are unique to the specific categories used in List One (atypical: parts of the body and clothing; typical: animals and furniture). Further research using different sets of atypical and typical category exemplars is necessary.

The findings of differential recall of typical and atypical items by good and poor readers are inconsistent with the results of an earlier study that used a similar methodology. Bjorklund and Bernholtz (1986) found that typicality affected good and poor readers in a comparable manner. Both reader groups recalled more typical than atypical words when either child- or adult-generated typicality ratings were used to construct recall lists. These researchers used a longer recall list (24 items) than that used in the present study and aural rather than visual presentation. The children included in the present study were also slightly younger than those used in Bjorklund and Bernholtz's study.

In summary, good and poor readers were differentially affected by typicality of category exemplar on a small subset of words. Further research is necessary to determine the generalizability of these findings. It is unclear whether these differences in semantic memory are the result of limited reading experience or a causal factor in reading problems. That is, poor readers may have a less elaborated semantic memory because they have not been exposed to as many different words by reading. On the other hand, these differences in semantic memory may reflect basic acquisition problems that result in poor reading achievement. An interesting possibility for future research would be to compare good and poor readers' recall of exemplars from natural categories (i.e., category knowledge that is acquired from experience) and categories that are learned by more indirect exposure such as reading.

Linguistic Processing and Reading Achievement

The relative contribution of each of the language processing tasks to reading recognition and comprehension was assessed using multiple regression analyses. When the analyses were performed with both groups, the three processing measures appeared to predict both recognition and comprehension with a high degree of accuracy. However, when these analyses were performed separately for each reader group, the results were quite different. The three language processing tasks only predicted reading recognition for good readers. Thus, it is highly likely that the results of the analyses performed with both reader groups are artifactual. It has been noted that when extreme-groups designs are used, as in the present study, even the weakest predictors can appear extremely powerful in regression analyses (Daneman, 1987).

From the separate groups regression analyses, the language processing scores were significantly related to reading recognition for good readers. Only the proportion recall score from the phonological similarity task was a significant contributor to the prediction of reading recognition. Thus, it appears that the recall of words in their appropriate serial position is highly related to the processes involved in reading recognition for good readers. There is a strongly sequential aspect to reading. When reading, the individual must retain an array of letters in their appropriate serial position in order to recognize the word being read. He or she must also attend to the sequence of words within the sentences and sentences within the text to comprehend what has been read.

That few of the language processes measured in the present study appear strongly related to reading is notable. Theoretically, it would seem that these skills are intrinsically involved in both reading recognition and comprehension. The regression analyses were restricted, of course, by the limited variability within the groups and small sample sizes. Furthermore, the tasks used to measure these language processes may be not sensitive enough to the type of processes that are involved in reading. Further research with larger sample sizes and varied tasks is necessary to clarify these findings.

In sum, the purpose of the present study was to examine two aspects of linguistic processing in good and poor readers. As discussed earlier, the results of this study do not confirm the hypothesis of differential use of phonological recoding in working memory by good and poor readers. In terms of semantic memory processes, there appears to be some differences between good and poor readers in the structure and organization of semantic memory. These differences, however, appeared only with a specific subset of words.

Despite the present results, the linguistic deficit hypothesis of reading problems merits further investigation. It is still unclear whether true differences in all aspects of linguistic processing exist between good and poor readers. Furthermore, if there are such differences, whether they are the cause or the result of poor reading achievement must be clarified.

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Appendix A

Parental consent form and questionnaire

Parental Consent Form

Susan Graham, a student in the clinical psychology doctoral program at Concordia University, is conducting research about the skills that are important to reading comprehension. I give permission for my child to be tested by Susan Graham.

I understand that my child will be tested by Susan Graham on one day for about one hour. My child will be administered reading and learning tests. I understand that my child's test scores will be completely confidential and that the records will be identified by number only. Because of this, I understand that I cannot receive individual feedback on my child's performance. However, I can request a summary of the research findings based on the results of all children. I understand that the participation of my child in this research is entirely voluntary, and I can withdraw my child from this study at anytime.

I understand that I can contact Susan Graham at 848-7549 at Concordia University to ask any questions that I may have about this study.

I give my permission for my child, ____________________
(child's name)

to participate in this study.

____________________________ ____________________
(print your name) (signature)

____
(date)

Please complete if you would like to receive a summary of the results of this study.

Mailing Address:

____

____

____

Please answer the following questions to provide us with some information about your child's reading behaviour. Your replies will be kept completely confidential.

1. Do you or your spouse read to your child?

   yes _______ no ________

   If yes, how often?

   daily ____ 4-6 times a week ____ 1-3 times a week ____

   less than once a week _____

2. Does your child read by him or herself?

   yes _______ no ________

   If yes, how often?

   daily ____ 4-6 times a week ____ 1-3 times a week ____

   less than once a week _____

3. What language does your child speak predominantly at home? ________________________________