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PROCESSING WORDS AND PICTURES

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THE DEVELOPMENT OF ENCODING PROCESSES DURING READING: PROCESSING WORDS AND PICTURES

By

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ABSTRACT

THE DEVELOPMENT OF ENCODING PROCESSES DURING READING: PROCESSING WORDS AND PICTURES

By

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This study addresses the question of what perceptual encoding mechanisms and memory representations drive reading as a skill that improves with time. Repetition benefits in oral reading were used to diagnose the participation of an abstract, conceptual level of representation in children's reading performance.

Three experiments were conducted: 1. to assess the use of repetition benefits within two modalities--the reading of regular text and "rebus" text (in which pictures were substituted for nouns); 2. to address the transfer between the two modalities; and 3. to address the level of processing at which transfer from one experience to the next improves performance. Elementary students (grades 1- 5) and college undergraduates each read several repeated paragraphs aloud to assess whether or not they benefit from multiple presentations of the same paragraph. The results conclude that visual stimulus properties provide retrieval cues to guide accumulation of episodic experiences that drive reading.

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CHAPTER 1.

INTRODUCTION

One of the aims of research in cognitive development is to identify the origins of complex, automatized knowledge and abilities. Reading is one such ability that has multiple processes that develop over time:

> "Reading is a process by which the child can, on the run, extract a sequence of cues from printed texts and relate these, one to another, so that he understands the precise message of the text. The child continues to gain in this skill throughout his entire education, interpreting statements of ever-increasing complexity" (Clay, 1972).

Clay's reference to reading development notes that reading is a skilled performance. As the child progresses through elementary school, reading becomes, with practice, a series of smooth actions which are promptly executed and interpreted with little effort (Downing and Leong, 1982). The present study documents knowledge and performance as reading skills develop during the grade school years.

Several questions arise in regard to the development of this complex skill. What does the child bring to the beginning reading experience? Young children entering grade school have generally good control over verbal language; they are able to name objects and people that they see. How do their understanding of objects and their verbal abilities help them to transition into the world of reading? Children accumulate knowledge about letters, words, and books, gaining control over the pronunciation of words and syntax. Children become increasingly aware of the formal properties of language stemming from their experiences with verbal language. They come to an understanding of symbols and signs (McDonald's, Mickey Mouse, a stop sign) long before formal reading instruction.

How does their understanding of pictures/ objects play a role in the transition to an understanding of print and written discourse? How do they store their experiences with objects and words, and what is the nature of these representations? At what point are we able to treat pictures and words as representing the same concept?

These questions will be addressed within the framework of reading as a skilled performance. When people do the same perceptual, cognitive, or motor tasks more than once, speed and accuracy of performance usually increase, and with enough repetition, attention demands often decrease (Fitts and Posner, 1967; Logan, 1979; Newell and Rosenbloom, 1981; Schneider and Shiffrin, 1977). This improvement is known as practice or repetition benefit.

Repetition benefit is clearly evident in reading, which is a skill that requires much practice in order to perform with speed and accuracy. When a particular task is carried out repeatedly on the same word or text, improvements in performance nearly always result (Dixon and Rothkopf, 1979, Kolers, 1975). These effects of past exposures have been attributed to repetition of the individual words' processing, the text's processing, or both. To date, however, studies of repetition benefits have focused almost entirely on adults and the mature reading system.

The present study extends the investigation of repetition effects to children, asking how abstract and generalizable is the information processing that goes on in the early stages of reading development, and what level of abstraction characterizes the enduring representations left by this processing. During the first elementary school years, children acquire a "linguistic awareness" (Mattingly, 1972); they begin to think about language objectively, with the knowledge that it is different from things and events, and that language can represent them. They learn that there is an arbitrary assignment of symbols, and that a word isn't a feature of an object. Finally, they learn that linguistic information can be extracted from a line of squiggles as well as from a sequence of speech sounds. At first, this extraction is hard to achieve, but with practice and increased experience with a variety of texts and fonts, reading skill becomes less effortful.

Repetition effects in reading tasks have been an important tool to investigate how reading knowledge is represented, how reading-related information processing proceeds, and how knowledge representation and processing change with practice. The purpose of the present research is to trace the growth of the young reader's ability to generalize knowledge from one individual experience to another, which is the basis of improvement with repetition. This paper will also attempt to get at the nature of perceptual processing required by reading and the relation between the success of perceptual processing and the success of comprehension.

In studying the generalization of reading-relevant knowledge and processing, an initial assumption is made that generalization is an implicit act of categorization, and that categorization depends in large part on similarity (Smith, 1989; Rueckl, 1990; Potter, 1979). The kind of similarity investigated here is the abstract, conceptual similarity of meaning and reference that exists between a picture of an object and the object's printed name. Thus, the primary concern is with the levels of lexical-semantic and thematic processing most closely related to comprehension and understanding.

This thesis discusses the rationale of using repetition benefit to investigate these issues. It is organized into three general sections on cognition that contribute significantly to the basic question at hand: What is the nature of memory representations that help drive reading as a skill that improves with time? Each section will review the adult literature in the area followed by a review of the child literature, wherever possible. The sections are as follows:

A. Theoretical notions of the storage of pictures and words: How people represent verbal and imaginal information in memory.

B. How pictures and words are stored: How reading knowledge is represented, how reading-related information processing proceeds, and how knowledge representation and processing change with practice.

C. The use of repetition benefit to assess children's growing reading competencies and changing memory stores

Three experiments were conducted. The first experiment was designed to examine the development of repetition benefit within each of the two modalities, focusing on word processing and picture processing individually by asking subjects to read several repetitions of either a regular all-word or a "rebus" text, in which pictures have been substituted for many of the nouns. A second experiment addressed the transfer between modalities that is the primary object of investigation, by comparing repetition benefits in mixed sequences of all-word and rebus texts to the benefits that occur in pure, unmixed sequences. A third experiment addressed the level of processing at which transfer from one experience to the next improves performance. This level will be investigated by scrambling the passages, and removing coherence at sentence and text levels, while preserving the need for word-level processing.

THE STORAGE OF PICTURES AND WORDS: How people represent verbal and imaginal concepts in memory

Adult literature

This section will address several questions about the nature of internal representations of concepts. At what point in development can we abstract meaning from print and extract the same meaning from a picture or object in the environment?

Two theories address the mechanisms involved in the abstract similarity of meaning and reference that exists between a picture of an object and the object's printed name. These are Paivio's (1979, 1986) dual code theory and Potter's (1979, 1986) conceptual store theory. Investigations of these theories primarily involve the adult system and address the question of how differently words and pictures are processed. This paper will attempt to address the nature of children's representations of pictures and words in light of these theories. No directly relevant research exists that answers this question for children learning to read. This section will review some adult studies and provide related developmental evidence that will point to a possible answer.

Within dual coding theory (Paivio,1979; 1986), word meaning and picture meaning are explained by separate verbal and imaginal representations. Semantic information is represented in verbal or imaginal forms, and the verbal store is accessible by both words and pictures, though perhaps in different ways. The nonverbal subsystem is specialized for processing information about nonverbal objects and events, whereas the verbal system is specialized for processing language. Performance on cognitive tasks involves activation of the two representational subsystems, either individually, in parallel, or in an interactive fashion depending on task materials, task requirements, and individual differences in representational skills. The two subsystems are interconnected by referential pathways that permit mental translation from the nonverbal to the verbal subsystem (as in naming pictures) or from the verbal to the nonverbal subsystem (as in imaging to words).

In support of the dual code theory, Pellegrino, Siegel, and Dhawan (1976b) examined the effects of acoustic interference and visual interference on the recall of pictures and words with adults. Paivio's two systems were operationalized as visual and acoustic systems. Pellegrino et al. (1976b) concluded that visual interference had a relatively small effect on recall of visually presented words and pictures as a result of dual storage of stimuli with a pictorial component. Acoustic interference caused a decline in recall of both visually presented words and pictures, but words suffered significantly more in recall performance. The differences were attributed to the fact that pictures are available from the visual store, compared to words that are restricted to the acoustic store that has experienced interference. This provides evidence for separate modality-specific stores.

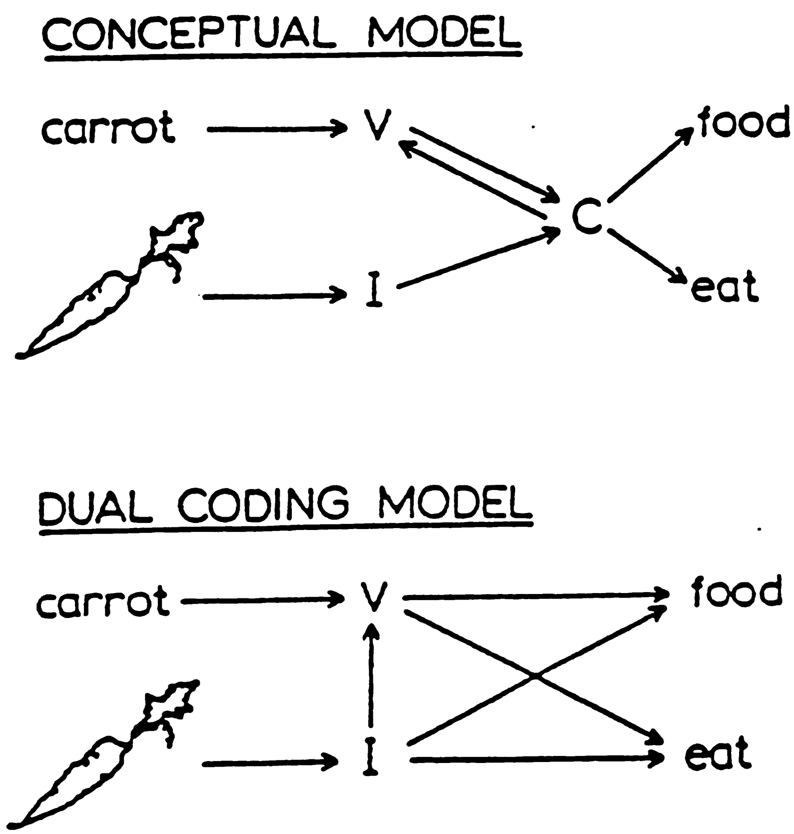
The alternative model, the conceptual store theory (Potter, 1979; Potter, Kroll, Yachzel, Carpenter & Sherman, 1986), assumes that meaning is available only in a common conceptual system and that both verbal and imaginal stores have direct access to this amodal store. In this model, pictures require an extra step to activate the verbal/lexical store and are named more slowly than words. Pictures access meaning as rapidly as words because both are connected directly to the conceptual representation that holds plausibility and categorization information (Potter et al., 1986).

Potter, Kroll, Yachzel, Carpenter, and Sherman (1986) varied their presentation of stimuli by using a rapid visual presentation format on a computer screen. Voice-key naming latencies were obtained for words and pictures that were presented alone and in serially presented sentences. These sentences had characteristics of rebus sentences, where concrete nouns were replaced by black line drawings of the nouns. Measures tapping meaning were based on reaction times. Subjects made yes/no judgments about category membership and sentence plausibility. The results indicated that individual pictures were named more slowly than individual words, and rebus sentences were read aloud more slowly than all-text sentences. Nevertheless, the rebus sentences did not produce any deficits in speed or accuracy of comprehension or in accuracy of immediate recall. Therefore, the names given to words and pictures may be processed differently , but once a meaning is activated, it appears that readers can process a word integrated into a sentence as well as they can process a picture integrated into a sentence or text level representation. These results are quite consistent with the conceptual store model.

Both models employ two types of representation, a verbal store and an imaginal store, yet their relationship differs within each of the two models. Both models agree on one aspect: they predict that written words will be named faster than pictured objects because both argue that the phonological information about words is stored in the verbal code. The models differ in their assumptions about the processing of meaning for the two types of stimuli.

A study by Potter and Faulconer (1975) confirmed that for adults, naming a drawing of an object takes longer than reading its name (a difference of 260 msec). The same adults were shown words and pictures and were asked whether or not they represented real concepts. When given lists of words and pictures to classify, pictures were classified significantly faster than words (a difference of 51 msec). The conceptual model explains that naming a drawing is slower than naming a word because naming a picture requires an extra step from the abstract concept to its associated name. Naming a word only requires that the word pattern itself be identified and then it may be articulated even before the concept is evoked (Potter and Faulconer, 1975).

Alternatively, dual code theory explains that pictures are named more slowly than words because pictures involve an extra connection between the verbal representation and imaginal representation corresponding to its name. Figure 1 provides as description of the relationships, where the symbol V represents the verbal store while the I represents the imaginal store, and C represents the conceptual store.



V= Verbal store

I= Imaginal store

C= Conceptual store

Figure 1. Conceptual and Dual Coding Models

Child literature: Concept acquisition, the emergence of storage for pictures and words, and the development of perceptual encoding mechanisms

Developmental psychologists have tried to address the questions of how children represent verbal and imaginal information in memory, and how this representation changes as they mature. Piaget (1970) marks these changes occurring during the shift from the sensorimotor to the concrete operational period, where mental representations change. Bruner (1964) hypothesizes that motor representation precedes visual representation, which precedes verbal representation, and Rohwer (1970) notes that because language is a relatively coherent and well-organized system, it develops prior to imagery. Generally, these theorists suggest that it is not until about the age of 4 or 5 that imaginal encoding becomes efficient, and then by 6 or 7, children begin attempts to master reading. As children mature, they learn to use different symbols for the same referent. Over time, the lexicon/ verbal store gains more entries and information about sound, orthography, and articulation. In parallel, the imaginal store gains information about percept shapes and other characteristics.

When addressing perceptual aspects of children's reading development, one can observe the growth of a child's ability to understand and to produce the cultural symbols of speech and written language. The capacity to acquire concepts on the basis of perceptual experience takes time to mature, and it is conceivable that a child first represents knowledge in a form close to perception. An early example, conceptualized by Bruner (1964), indicates that six-year-olds group objects more often according to perceptual attributes, whereas older children group the same objects according to functional attributes or linguistically based superordinate features (Bruner, 1964). This behavior reflects a basis in imagery, both in what six-year-olds use as a basis for groupings and in how they form groups. Similarly, from age six on, linguistic structures increasingly guide what and how things will be judged alike. The developing child becomes increasingly able to understand that words represent concepts and objects. Concepts achieve stability by gaining additional amounts of perceptual information acquired through language, pictures, and other symbol systems. Before reviewing the literature on the development of imaginal and verbal stores, a review of the acquisition of basic concepts is in order.

Current theories of concept acquisition provide evidence that very young children are able to acquire knowledge of objects and their labels and to transfer knowledge from one learned situation to another. Children are able to categorize (Markman, 1989; Mervis, 1987; Waxman, in press) and to understand the difference between animate and inanimate objects (Carey, 1985). A growing body of evidence shows that infants and preschool children can distinguish between examples of animate and inanimate objects, either as they appear in the world or are represented by words, drawings, or 3-dimensional replicas (Bullock, 1985; Gelman, Spelke, & Meck, 1983; Golinkoff & Harding, 1980; Keil, 1979, 1987; Mandler, Bauer & McDonough, 1989; Richards & Siegler, 1986; Smith, 1989). Young children can distinguish between natural and material kinds (S. Gelman, 1988; S. Gelman & Markman, 1987) and can also show insightful learning and transfer on the basis of deep structural principles (relations) rather than mere reliance on salient perceptual features, such movement (Brown, 1990). They are also sensitive to the different kinds of mechanisms involved in initiating and governing the motions of animate and inanimate objects (Gelman, 1990; Baillargeon, 1986; Bullock, Gelman & Baillargeon, 1982; Leslie & Keeble, 1987; Poulin-Dubois & Schulz, 1986).

Even as early as infancy 1 to 4-month olds are able to distinguish between subtle acoustic properties of speech signals (Eimas, Siqueland, Jusczyk, & Vigorito, 1971).

Research on 3-month-olds have also shown that they are also able to respond categorically to different stimuli that share common physical or functional properties, such as mobiles (Rovee-Collier & Hayne, 1987). 3-month olds are able to acquire same-different concepts on the basis of the serial order in which they encounter different or novel events. These observations are the earliest indication that very young infants are able to learn about objects and people in their immediate surroundings. They are indeed able to deal with spoken language and to manipulate learned terms far before they learn to deal with written language.

A consistently noted observation has been that sometime during the last half of the child's second year, a "naming explosion" occurs. Word learning, particularly object names, is very rapid at this point (Bloom, Lifter, & Broughton, 1985; Corrigan, 1983; Dromi, 1987; Halliday, 1975; McShane, 1979; Nelson, 1973). Very young children appear to use words to refer to objects in the world and they may be just another associate the child has to a given situation. Children seem quite motivated to learn the names for the objects around them from an early age. During the naming explosion, children become intensely interested in learning what as-yet-unnamed things are called (Bloom, 1973; Gopnik & Meltzoff, 1986, 1987; Nelson, 1973, 1988).

Given the speed with which they learn words, problems arise for early language learners. Objects are often found in spatial, causal, temporal or other relations with other objects, so what prevents the child from thinking that the label refers to the objects that are related? How do children acquire labels for objects and what strategies do children use?

One general strategy is the use of constraints, which are useful for young children for figuring out what words mean. Constraints are defined as any factors intrinsic to a learner that result in a nonrandom selection of the logically possible characterizations of an informational pattern (Keil, 1990). Constraints, such as whole object and taxonomic assumptions, and mutual exclusivity, allow the young child to make good first guesses about the meaning of a term (Woodward & Markman, in press).

Several studies have shown that children from age 18 months on honor whole object and taxonomic assumptions (Backsheider & Markman, in preparation; Huttonlocher & Smiley, 1987). By roughly 18 months of age, children assume that a novel label refers to the object as whole--not to its substance, parts, color, size, shape, and so on. Taxonomic assumptions are employed when children believe that they are learning a new word, while they shift their attention from thematic to taxonomic organization. Young preschoolers can use mutual exclusivity to avoid making redundant hypotheses, and this exclusivity can be used to figure out the referent of a novel word, or help the child learn terms that refer to a part or substance or other properties of objects. Mutual exclusivity also helps children to narrow overextensions (Barrett, 1978; Clark, 1983, 1987; Merriman & Bowman, 1989). These constraints may be accountable for the child's sudden ability to acquire words rapidly.

During preschool and then elementary school, children's modes of representation begin to evolve toward more abstract and flexible forms, from concrete to more abstract imagery. It seems that this development parallels or overlaps with the emergence of verbal symbolic processes, which also become more abstract, differentiated, and precise (Paivio, 1986). It appears that separate stores for imagery and verbal symbols first emerge because of their distinct characteristics. Images and words may be coordinated to concrete-abstractness in the sense that images designate concrete objects in terms of their perceptual and figural properties, whereas words can signify concepts-relations, classes, and numbers (Piaget & Inhelder, 1966).

What is the nature of the imaginal and verbal representations in young children? At what age can we begin to look at verbal and imaginal representations? One might begin by examining a range of children who show understanding of concepts, including children who have not yet reached reading age. One such study by Tyler and Marslen-Wilson (1981) demonstrated that naming and categorization abilities can be observed in children as young as five. They investigated the processes involved in children's on-line interpretations of spoken language. According to the theoretical framework within which Tyler and Marslen-Wilson work, these processes begin with the mapping of an acoustic-phonetic analysis of the speech signal onto the appropriate locations in the mental lexicon. This activates a set of word candidates, which in turn makes available the syntactic and semantic properties linked to those locations in the mental lexicon (Tyler & Marslen-Wilson, 1981).

Tyler and Marslen-Wilson (1981) determined whether there were developmental changes in the general structure of the comprehension process and changes in the extent to which different sources of processing information contribute to the child's comprehension of an utterance. They used two tasks-- identity monitoring and category monitoring-- to address "whether the presence or absence of an interpretative representation (would) interact with the process of accessing the semantic properties of a word in the same way for all age groups" (Tyler and Marslen-Wilson, 1981). In the identity monitoring task, children were told to name a presented picture, and then were told to press the response button as soon as they heard the name of the object in the picture in an uttered "sentence" heard through headphones. The sentences in each grouping were of different types: normal prose, syntactic prose (only constituent structure is preserved, and makes little sense otherwise), and random word order strings.

In the categorical monitoring task, children were shown a picture containing several members of a particular taxonomic category and were asked to produce the category name. They were told to listen to a sentence played through headphones and to press the response button as soon as they heard a word that belonged to the category. With this task, two stages are involved, a word recognition stage, followed by a second stage in which the semantic attributes of the word that have been recognized are matched against the specifications of the target. The identity and categorical monitoring tasks were counterbalanced across subjects. The position of the target words in the sentences in each task was also varied and counterbalanced.

For all age groups, in the identity monitoring task, monitoring for words heard in a normal sentence was faster than when the targets occurred in syntactic prose. This demonstrates that word recognition decisions in children are sensitive to both the syntactic and interpretative properties of the material. The children, as well as the adults, mapped the input word by word as they heard it onto some form of developing interpretative representation. Results from the category monitoring task provided evidence that young children's immediate analysis of the input is restricted. When considering the effects of the target word's position in the prose, the data suggest that the 5-year-olds obtain no interpretative facilitation of semantic attribute matching when the target word is positioned as the first or second word. Thus, developmental changes in categorizing take place beyond the age of 5. Perhaps the five-year-olds' processing capacities were still limited in performing this task, or they had a specific difficulty with the semantic attribute-matching process itself.

The results of this experiment show that it is possible to examine verbal and imaginal representations in children as young as five. Kindergartners and first graders then become qualified candidates for assessing the transition from on-line interpretation of spoken language to the early stages of written language acquisition. The proposed studies in this thesis will include 1st-grade children in order to assess the early changes in reading development.

With the background knowledge of concept acquisition and the baseline age for naming and categorization abilities for spoken language in place, it is now time to consider the dual code and conceptual code theories in relation to young children. How are pictures and words stored in a developing and expanding perceptual processing system?

Developmental Support for the Dual Code Theory

One way to examine the early acquisition of concepts is via Paivio's dual code theory (1979, 1986). This approach begins with the premise that the storage of newly acquired concepts may be quite separate for words and images. In this model, imagery develops as a symbolic capacity or mode of thought through the individual's perceptual-motor experiences with concrete objects and events. Verbal processes develop through language experience, including associative experiences involving words and concrete objects. With experience, "verbal thought remains functional in coping with concrete situations but then verbal surpasses imaginal thought in its capacity to deal with tasks involving abstract reasoning" (Paivio, 1986).

Burton (1982) examined the dual coding of pictorial stimuli by third grade students. The stimuli were presented either as pictures, printed words, or spoken words, followed by either visual, acoustic, or simultaneous interference, or no interference. Presentations and interference conditions were counterbalanced across subjects. Subjects were asked to recall the list of words initially presented.

In general, recall of pictures was superior under all interference conditions. Specifically, picture recall was superior over both printed and spoken words under conditions of acoustic and simultaneous interference. An explanation for this finding is that single modality interference affected recall only if memory was coded within that channel. Visual interference produced no differences between the presentation types, compared to acoustic and simultaneous interference, which lowered recall for printed words and spoken words relative to pictures. Printed words suffer less than spoken words under acoustic interference and more under visual interference, indicating that they are less "acoustic" and more visual than spoken words. The reason for picture superiority is that pictorial stimuli are automatically labeled on input and stored twice, once in an imaginal system and a second time in a separate verbal system. The author notes that it is possible that concrete words may be stored in both systems, but only if they are "imaged" (Burton, 1982). Thus, dual coding of visual and acoustic stimuli appears to be the case for third graders.

Johnson, Paivio, and Clark (1989) also addressed aspects of the dual code theory with kindergartners and first graders, but instead studied tactual and visual crossmodal recognition. Children completed individual tests of visuospatial and verbal referential abilities prior to performing a shape recognition task under imagery, naming or control instructions. In the tactual to visual crossmodal recognition task, subjects felt an unseen stimulus shape and then identified its counterpart in a visual array of shapes. The question under investigation was, what sort of naming or imagery strategies did the children use in the shift from tactual to visual recognition?

For example, in the imagery condition, the subject arouses a visual image that is later used to identify the target shape in the visual array. Those children who used a naming strategy feel the shape, which first arouses tactual and visual representations, which then jointly activates a mental name for the stimulus. The name is then used to identify the stimulus in the visual array. Johnson et al. anticipated that the unfamiliar shapes would elicit an imagery strategy, whereas a more familiar shape would elicit a naming strategy. The accuracy of children instructed to use imagery was no better than the naming and control children. These results reflect the interaction between visuospatial ability and instructions, where high ability children used the appropriate strategies better.

The primary analysis included multiple regressions, which revealed that the major correlates of crossmodal recognition performance were visuospatial ability under imagery instructions, and verbal referential skill under naming instructions. In other words, the effectiveness of imagery instruction might depend on visuospatial ability and the same relationship between naming instruction and verbal referential ability. This implies that imaginal and verbal representation are distinct, as dual coding theory suggests. The development of strategy specific abilities may be a prerequisite for children to employ imagery and naming strategies successfully. Verbal strategies may be most common, at least for younger children.

Perlmutter and Myers (1975) investigated several possible characterizations of coding and storage processes. Because storage may be predominantly verbal or visual (modality specific) or multirepresentational (coding in both), Perlmutter and Myers (1975) employed a recognition procedure to assess these characterizations. They tested three- and four-year-olds on three recognition memory lists differing in test mode (visual, verbal, combined verbal-visual). The preschoolers, like adults, recognized pictures better than words, which makes it possible to reject a predominantly verbal conceptualization of coding and storage mechanisms in children. The results also showed that switching to a different test modality impaired recognition performance. This suggests that four-year-olds engage in some degree of modality specific processing, and this, in turn, supports an argument for the use of multiple coding and storage. It appears that visually presented items were spontaneously processed in both visual and verbal modalities.

Developmental Support for Conceptual Store Model

According to the conceptual store model, word names are stored separately from the images or appearances of objects, but in addition to the imaginal and verbal systems of representation, there is a third more abstract system present in children at least as young as 6 years of age. Several lines of research (e.g. Gibson, Barron & Garber, 1972; Rosinski, Pellegrino & Siegel, 1977; Pellegrino, Rosinski & Siegel, 1975; Potter & Faulconer, 1975) have shown that adult memory is best characterized by a single-memory, or conceptual, model. This conclusion is based upon comparisons between pictures and words in decision-latency tasks that involve access to the permanent-memory systems. Typical studies involve making comparisons between pairs of pictures, pairs of words, or comparison between a picture and a word. Subjects are asked to make category judgments on the two presented stimuli.

Rosinksi, Pellegrino and Siegel (1977) offer support for the conceptual theory by suggesting two possible routes of how category information may be retrieved from memory. They suggest that within a conceptual store model, picture-word comparisons will equal the average of picture-picture and word-word conditions. A dual code model would predict that picture-word latency will exceed this average by an amount equivalent to transfer time from one memory store to the other. Pellegrino, Rosinski and Siegel (1975) showed that category decisions for picture-picture pairs were 185 msec faster than for word-word pairs. Picture-word pairs yielded a latency only 3 msec above the average of the picture-picture and word-word pairs. Thus a conceptual model was supported for adults.

Evidence for a conceptual store model for children is provided by Rader (1975). Second graders and adults were asked to decide whether two objects, pairs of words, pairs of pictures, or a word and a picture belong to the same or different category. Second graders were slower on categorizing words than drawings, compared to adults, yet for these same children, the mixed pairs took no longer to compare than the average of comparing word pairs and picture pairs. It appears as though there is little support for the dual code theory, if children were able to handle pictures and words equally well.

Rosinski, Pellegrino, and Siegel (1977) found similar results by replicating the task with second and fifth graders. Again, grade school children, compared to adults dealt about as well with a mixture of pictures and written words as they could with words alone or pictures alone. These results revealed that the comparison between picture-word judgments and the mean of picture-picture and word-word judgments did not approach significance for both second and fifth graders.

Potter (1979) argues that the task of comparing superordinate categories as in Rader (1975) and Rosinski, Pellegrino and Siegel (1977) requires an abstraction that cannot be represented in a perceptual-imaginal system. A category such as "animal" or "clothing" cannot be imaged except by thinking of particular exemplars. Superordinate categories may be at a level too abstract to permit category matching on the basis of perceptual features common to all members of the category. Each item would have to be recognized at a basic level before it could be compared with the category. Therefore the two sets of results provide evidence that a conceptual/amodal store may exist for children.

Interference tasks have also been used to provide evidence for a single conceptual store for pictures and words. Rosinski, Golinkoff, and Kukish (1975) used a Stroop-like interference task with children and adults, where pictures were imposed on words. Generally, it has been shown that adults cannot help processing the written words even when they are trying to attend to the pictures. They found the same results for children at all grades 2 through 6. The magnitude of semantic interference effect was found to be constant over age. The study provided evidence that the common words must be automatically processed even at the youngest age. Rosinksi et al. (1975) conclude that "the mapping of the printed word to meaning must take place in the early stages of learning to read. Extraction of meaning from unrelated printed words may be an automatic process (p. 269)." This supports the existence of a conceptual store because both verbal and imaginal information are sent to this third storage, indicating a competition between the two concepts. Interference suggests that both are being processed at once, but word naming wins out. Interference occurs because both names enter the conceptual store. If there were separate stores, no interference should be evident. Unfortunately, no first graders in the beginning stages of learning to read were included in the study.

Perhaps the explanation is a combination of the two models

Given the evidence presented for each model regarding children's development of memory for pictures and words, it appears that the issue is still unresolved. Several criticisms must be pointed out, however. There is great variability among the methodologies that support each model. The dual code tasks include memory and recall tasks, with a variety of visual, acoustic, and tactual crossmodal manipulations. These different manipulations show the variety of interpretations of how to tap into the separate stores. Second, regression analyses and strategy use were the focal points of analysis. The paper by Johnson et al. (1989) includes a younger sample, of kindergartners and first graders, whereas the youngest children in the conceptual model studies were in second graders. Alternatively, the conceptual model tasks include on-line perceptual tasks, such as category judgments, matching, and naming. The reviewed papers by Rader, and Rosinski et al., study the range from second to sixth grade. It should be noted that none of the experiments included first graders where decoding skills first come into play. In addition, the number of subjects in these studies was very small. For example, Rosinski et al. included only 12 subjects at each grade level who attended a university laboratory school and represented upper-middle class backgrounds. Rader's adult sample consisted of graduate students with verbal GRE scores above 700. It is clearly evident that larger, more representative samples need to be recruited for this line of experiments.

With the lack of consistent tasks used for both models, it is difficult to address which interpretation best characterizes the storage of verbal and imaginal information in children's memory, and whether the same organization of processes and representations characterizes both perceptual recognition and classification on the one hand and long term episodic memory on the other. The chosen tasks appear to be model-specific. It may be that memory tasks are best used to demonstrate dual coding, and categorization tasks are best used to demonstrate conceptual coding. No studies have attempted to provide counter-explanations for the data for each model.

It is possible that dual coding in memory occurs early in development, which later develops or is replaced by a conceptual store memory framework. It is plausible that modes of representation generally evolve toward more abstract and flexible forms, from concrete to more abstract imagery, overlapping with the emergence of verbal symbolic processes, which in turn become more abstract as well as more differentiated and precise. It is Paivio's (1971) suggestion that one symbolic mode may not merely be replaced by another: "New modes are added to the symbolic repertoire of the individual and their utilization is a function of situational demands, just as their original development presumably occurs in the interests of utility" (p. 27). It is likely that the modes continually interact in their functioning. The acquisition of language ought not to be thought of as abolishing the underlying perceptual system that continues to guide judgments, decisions and behavior.

Finally, it is possible that on-line tasks do a better job at addressing these stores, to see how these processes work in real time. Perhaps a reading task with a comprehension and/or categorization component may address these stores. It also provides a more "natural" task, common to what most children encounter in school, unlike tactual or auditory tasks. The study by Potter, Sherman, Yachzel, and Carpenter (1986) should be replicated with children between first and fifth grade, to assess developmental changes in memory and reading. The results from adult data may pose a problem in addressing children's developing memory systems. An entirely different picture may just emerge.

Now that the groundwork for the storage of pictures and words has been laid out, the focus should be brought back to the role pictures and words play during the course of reading development. How does our experience with pictures and words contribute to reading development? The question of how pictures and words are stored will bring more pieces to the reading skill puzzle, and it will be examined in the following section. The picture of emerging reading skill may be that we gradually come to store pictures and words according to the conceptual model by the time we are adults, but how did our experiences with pictures and words get placed into storage in the first place? What is the nature of our conceptual representations in memory, and, more importantly, how do these representations drive reading as a developing skill?

HOW WE STORE CONCEPTS: THE ISSUE OF TRANSFER

Review of Studies Investigating Repetition Benefit:

Adult Literature

As defined in the introduction, repetition benefit in reading skill is defined as improvement as the result of repeated perceptual, cognitive and motor tasks which increase the accuracy of reading performance (Fitts & Posner, 1967; Logan, 1979; Newell & Rosenbloom, 1981; Schneider & Shiffrin, 1977). Theoretical interpretations of repetition effects have been the central focus in debates between abstractionist and episodic (or nonanalytic) accounts of how knowledge is represented and how information processing proceeds (Carr & Brown, 1990; Carr, Brown, & Charalambous, 1989; Jacoby & Brooks, 1984; Jacoby & Hayman, 1987; Kirsner, Dunn & Standen, 1987; Levy & Kirsner, 1989; Logan, 1988; Logan, 1990; Whittlesea, 1990; Whittlesea & Brooks, 1988).

According to the abstractionist viewpoint, the memory storage that supports a skill like reading is categorical and highly generalizable. Stored categorical information consists of common content and shared general patterns of processing activity, not specific details unique to each individual experience. Though previous experience may be necessary, when encountering a task in order to achieve the best performance, relevant past experience need only be similar to current task conditions. Exact repetition in every detail is not necessary for the system to apply a past encounter to a present one in an efficient manner.

The alternative episodic viewpoint indicates that information is stored in the form of performance-relevant specific memories. Current performance depends on the individual's particular past encounters and specific concrete memories. To the extent that current task conditions differ from past conditions, the benefit of past encounters to current processing will diminish, perhaps quite rapidly. Thus a major difference between these viewpoints involves their implications for the scope of transfer or gradient of generalization from one processing encounter to another (Brown & Carr, in press; Carr, Brown & Charalambous, 1989; Jacoby & Brooks, 1984).

In the context of this debate, two questions arise regarding the development of encoding processes during reading: Are the perceptual encoding mechanisms of reading abstract or episodic? What relationship exists between representations of surface characteristics and representations of message or text-level information in mediating transfer of skill?

In reference to word processing and reading performance, there are two representative word recognition models. The abstractionist side offers the logogen model (Morton, 1969). The lexicon (a mental dictionary stored in long term memory) is made up of word prototypes, or logogens, which are generic representations corresponding to words in the reader's vocabulary. The logogens are activated by patterns of sensory input produced by stimulus instances of the represented words. In other words, the printed or written letters are fit into preexisting patterns that serve to activate the appropriate prototypes. With repeated use, the prototype is more easily activated.

In addition, there are many other words associated with each word that is repeated in the logogen system. As an example, consider the word "CHILDREN." As a result, this word prototype would also trigger other words associated with it, such as school, playground, or toys. In addition, the prototype may trigger other words that look similar to it, such as "chil" in "chill" or "chili." Reading the word CHILDREN then facilitates a general category under which these words can also be activated. Hence, there can be both semantic and orthographic priming within the logogen system (Morton, 1969).

As an alternative, the episodic side offers the memory trace model. Reading leaves memory traces of what was read and the processes used to read it. Further reading is supported by these traces that are retrieved by cues from sensory input, context, and task activity. So referring to the CHILDREN example, one may read about different types of children and their development: "Autistic children have slower language development" or "Feral children grow up in the wild". The act of reading about these two types of children leaves a memory trace of what has been read and of the operations that were carried out to achieve the reading. Therefore, specific memories of reading about each type of child and their impairments can be triggered in subsequent reading encounters, allowing one to recognize the two children. An extreme episodicist would claim that only specific encounters with these terms in the same or very similar context would allow one to recognize these words.

Thus, the crucial difference between the two models lies in the scope of their representations' sensitivity to variation in tne stimulus input, context, and task activity. The specific memories of the episodic model are supposed to respond differentially to new instances of a word or text on the basis of similarity of surface form or typography, similarity of context, and similarity of the particular reading task being performed (Jacoby & Brooks, 1984; Jacoby & Hayman, 1987; Logan, 1990; Whittlesea, 1990; Whittlesea & Brooks, 1988).

A series of experiments has been completed by Carr and his colleagues, regarding the abstractionist side of the debate. Carr, Brown, and Charalambous (1989) conducted four experiments, each designed to address some aspect of the effects of repetition on reading. Subjects were asked to read a series of paragraphs while being timed and tape recorded. In all cases, several paragraphs were presented twice, to assess whether or not the subject read the second presentation at a faster rate. If the subjects were able to read faster, this indicated a repetition benefit, where the first presentation facilitated the reading of the second presentation. Four different manipulations on the first presentation included: a change in text, such as scrambling the words (creating an incoherent paragraph); presenting the paragraphs in handwriting, as opposed to a standard printed typeface; constructing the text from nonsense words rather than real words and then presenting the text in typed or handwritten form; and finally manipulating the subjects' expectations of what surface form they were going to read, typing or handwriting.

Carr et al. (1989) were able to conclude that the repetition benefit exhibited in these experiments showed insensitivity to contextual variation, to typographical manipulation, whether the material being read consisted of words or pseudowords, and to changes in surface form expectations. Subjects benefited from repetition regardless of any of these manipulations, which provides support for the abstractionist view. Subsequent studies by Carr and colleagues have refined the utility of repetition benefits in diagnosing reading processes. Given Carr et al.'s (1989) surprising findings, the focus was changed to examine the representations responsible for benefit.

Transfer of repetition benefits across variations in stimulus materials can help to identify what levels of text processing are being improved with each repetition (Carlson, Alejano, & Carr, 1991; Carr & Brown, 1990; Carr, Brown, & Charalambous, 1989; Jacoby, Levy & Steinbach, 1992; Levy & Kirsner, 1989; Logan, 1990; Tulving & Schacter, 1990). The findings of Carr et al. (1989) suggest that orthographic, phonological and lexical processes involved in word perception are the levels at which repetition benefit accrue. Other studies, however, expand on that conclusion and in some cases challenge it.

Levy and her colleagues approach the question of representational levels responsible for repetition benefits from an alternative viewpoint (Levy, 1983; Levy & Begin, 1984; ; Levy & Burns, 1990; Levy & Kirsner, 1989; Levy, Newell, Snyder, & Timmins, 1986). Their experiments have involved the use of indirect measures to tap the involvement of conceptually-driven processes during reading. Their subjects demonstrated transfer benefits from reading to rereading of the same passage, with no loss in either data or conceptually driven analyses. In their view, in contrast to that of Carr et al. (1989), repetition facilitates reprocessing through more efficient data-driven and conceptually-driven processing with no evidence that as conceptual processing increases, data level processing is curtailed. They note that rereading fluency reflects improvement in both types of processes (Levy & Burns, 1990).

For example, Levy and Burns (1990) addressed the representation level responsible for benefit by measuring transfer across varying degrees of context change. This is in contrast to that of Carr et al., who concluded that improvement from repetition benefit attached to orthographic and lexical processing regardless of the context in which the words appear. The multiparagraph passages that their subjects read were manipulated by reordering paragraphs, sentences, and individual words. Subjects read each passage twice, silently and rapidly as possible, while still trying to maintain comprehension and memory. After the first reading, subjects took a free recall test. Following the recall, subjects were given a second reading, which was either the same version as the first reading or a manipulated version. Each of Levy and Burns' experiments paired intact passages with one of the tree types of reordered passages.

The results indicated that repetition benefit was accrued from reading paragraph reordered passages and intact passages. In other words, each version facilitated the speed of reading the other as much as itself. Yet a different picture emerged for the other manipulations: sentence reordered and word reordered passages. Less benefit occurred if the subject read a sentence reordered passage followed by an intact passage, as compared to reading two identical intact passages. Even less benefit occurred if the subject read the word-reordered manipulation. In fact, the benefit in this case was not even significant, which poses a challenge to the findings of Carr, Brown and Charalambous.

Levy and Burns' results support the conclusion that all repetition benefit to the reading of coherent intact passages was mediated through sentence and paragraph representations, with no measurable amount arising from lexical repetition by itself in the absence of sentence or paragraph repetition. Thus the repetition benefit exhibited in their initial experiments showed sensitivity to contextual variation. Yet when Levy & Burns reversed the order of passages, with the second reading as the reordered manipulation, their results pointed to a different conclusion. Reading sentence-reordered target passages yielded as much benefit as reading the intact version first as having read the same reordered passage read twice. Subjects who read word-reordered target passages appeared to benefit more from having read the intact version first than from having read the same reordered version twice. The implication is that the coherence of the target text played an influential role in the amount of benefit observed and in the level of processing at which the benefit occurred.

Levy and Burns' final experiment used only intact and word reordered passages, this time requiring subjects to read orally. The experiment maintained instructions to read for comprehension, and administered the recall test after each reading. When the target passages were intact texts, the results were the same as with silent reading. When the targets were reordered text, the reversal of the context match disappeared; reading an intact passage followed by a reordered passage yielded as much benefit as reading two identical versions of the reordered passage. This result falls in line with Carr et al.'s (1989) findings with scrambled targets.

The majority of results and conclusions of Levy and Burns (1990) conflict with those of Carr et al. (1989). The tasks differ greatly, where Carr et al.'s subjects read single paragraphs orally with heavy emphasis on speed and accuracy of pronunciation; these instructions lack tasks requiring comprehension or memory. Levy and Burns' subjects read multiparagraph passages either silently or aloud with heavy emphasis on comprehension and memory, and a recall test was included.

With the slight variations in tasks, the experiments from both the Carr and Levy groups roughly conclude that repetition benefit does not arise solely at the word level as claimed by Carr et al. (1989), nor does it arise solely from retrieval of processing records by cues from higher levels of linguistic organization as claimed by Levy and Burns (1990). Some combination of lexical repetition and context repetition appear to be responsible for the overall repetition benefit.

Focal Attention: The compromise

Despite the task differences between Levy and Burns (1990) and Carr, Brown, and Charalambous (1989), the emphasis on reading instruction was analyzed by Carlson, Alejano, and Carr (1991) to bridge the inconsistencies between the two studies to focus on a third factor, focus of attention (Carr & Brown, 1990).

Carlson, Alejano, and Carr (1991) suggest that the strategies adopted in response to the demands of different reading tasks may influence the locus of repetition benefit, when coherent texts are read as targets. The instructions given to Carr et al.'s subjects encourages word by word processing because they are asked to clearly and quickly read the passages, without necessarily concentrating on processing the words at text level. In contrast, Levy & Burns' subjects were directed to comprehend and later recall the passages. This processing leads the reader to establish text level memory representations rather than speeded word-level enunciations. Carlson, Alejano, & Carr (1991) suggest that if these task differences influence the type of representation that endured after the task, then they might influence the level of processing at which repetition benefit could be observed. They investigated the differences by using Carr and Brown's (1991) "level of focal attention" hypothesis, which is a version of a transfer-appropriate processing hypothesis. Transfer appropriate processing occurs as a result of maximum transfer between two experiences that occurs when the information processing operations used in dealing with the two experiments are the same (Morris, Bransford, & Franks, 1977; Roediger & Blaxton, 1987; Roediger, Srinivas, & Weldon, 1989; Srinivas & Roediger, 1990).

When subjects focus attention on word level processing, as in speeded oral reading with emphasis on pronunciation (as in Carr et al., 1989), the locus of repetition benefit is proposed to shift toward the processes that support lexical recognition and articulation. In this case, repetition of words or orthographic/ phonological patterns should be enough to facilitate subsequent reading. Alternatively, when subjects focus on understanding the text and creating text-level memory representations of higher order constituent structure or propositional content (as in Levy & Burns, 1991), the locus of repetition benefit will shift to a higher level. The whole passage or major parts of its constituent organization should produce benefit (Carr & Brown, 1990, Carlson, Alejano, & Carr, 1991).

Carlson, Alejano, and Carr (1991) tested the level of focal attention hypothesis by giving readers strong instructions about the level of processing toward which they should direct their attention. Two experiments examined benefits from lexical repetition in speeded oral reading of coherent texts and random word lists.

In experiment 1, subjects were asked to read pairs of paragraphs where the target text read second was always a coherent paragraph. When the target was a repetition, the text read first was either the same coherent paragraph or a randomly scrambled version containing all the same words. When the target was a new text, the text read first was either a coherent or a scrambled version of a different paragraph containing different content words.

Half of the subjects were told to read with a word by word strategy, to keep track of individual words used in the text. The remaining subjects were told to read using a higher level comprehension strategy, to grasp the overall message from the whole text. These latter subjects were asked to use this strategy to the best of their ability even if they were given a scrambled passage.

The results showed that when a coherent text was the target that was to benefit from repetition, instructions to focus on the lexical level and read word by word resulted in equal benefit from having read either a coherent or a randomly scrambled version of the target text. When subjects were asked to read the passages for comprehension, their reading times for the second pair decreased, which is evidence for repetition benefit. This occurred when the first reading matched the target in coherence, and in the local context in which each word was encountered. When the readings mismatched, there was no evidence of benefit. When subjects were instructed to read word by word, they benefited from repeated lexical content alone, regardless of whether the linguistic organization of that content matched between readings. Carlson et al. (1991) were able to replicate the results of both Carr, Brown and Charalambous (1989)and Levy and Burns (1990). They were unable to find the same conclusion for targets that were randomly scrambled (Experiment 2).

Carlson, Alejano, and Carr concluded that the level of focal attention hypothesis is correct only for coherent texts. The linguistic structure of the target appears to play a large role in determining the nature of repetition benefit, and the level of analysis at which benefit accrues will depend on the strategic approach of the reader.

Taking linguistic structure into account, one can return to the issue of memory representations and reading development: How does focal attention play a role in learning to read as a developing skill?

Focal attention and children

Constituent structure may not be an issue for beginning readers. Early readers provide a situation where text reading is effortful, and many investigators have argued that their focus is, or ought to be, placed on decoding individual words (See Evans & Carr, 1985; Gibson & Levin, 1975; Perfetti, 1985; Perfetti & Lesgold, 1979; Rieben & Perfetti, 1991). If their level of focal attention is directed to word level processing, then the locus of repetition benefit ought to arise from the processes that support lexical recognition and articulation. Beginning readers have knowledge of the relationship between spelling and sound, and use this knowledge to recode written words into a phonological code, which is then used to access the meanings of words (Backman, Bruck, Hebert & Seidenberg, 1984). Lower level word recognition skills may be a facilitator or prerequisite to reading comprehension, and there is general agreement that the development of automatic and accurate word recognition skills are of primary importance, at least in the beginning stages of reading acquisition (Cunningham, Stanovich & Wilson, 1991).

It is possible that higher level comprehension skills play a role in reading comprehension only after a criterion level of word recognition ability has been reached (Biemiller, 1970; Gleitman & Rozin, 1977; Rozin & Gleitman, 1977; Stanovich, 1980; Carr et al., 1991). It follows, then, that word recognition skills must be above a certain level in order for the reader to have some information about the basic meaning of text so that attentional resources are not exhausted to the point that they leave few processing resources for higher level skills (Curtis, 1980; Lesgold & Perfetti, 1981; Perfetti, 1985; Singer, 1982).

Shankweiler and Liberman (1972) suggest that the major barrier in reading acquisition is not in reading connected text but rather in dealing with words and their components. Reading with little comprehension is a consequence of reading individual words poorly, rather than reading words poorly is a consequence of poor comprehension.

Extrapolating from the findings of Carlson, Alejano, and Carr (1991), it follows from these developmental arguments that repetition of words or orthographic/ phonological patterns should be the primary basis for improvement in future rereadings among beginning readers. Before experiments can be proposed to assess this improvement, a review of the factors involved in the developmental changes that occur during reading acquisition is needed. Once the reading acquisition groundwork is set in place, a review of repetition benefit and its place in children's literature will be in order.

DEVELOPMENTAL CHANGES DURING READING ACQUISITION

As children learn to read, they also grown in their ability to understand and to produce the cultural symbols of speech and written language. The capacity to acquire concepts on the basis of perceptual experience takes time to mature and can be understood in relation to Piaget's stage theory of cognitive development. The acquisition of concepts parallels the capacity to represent a permanent object, one that persists even when it is out of sight or has altered in appearance (Piaget, 1970).

It is conceivable that a child first represents knowledge in a form close to perception. For example, six-year-olds group objects more often according to perceptual attributes, whereas older children group the same objects according to functional attributes or linguistically based superordinate features (Bruner, 1965, Bruner, Olver and Greenfield, 1967; Smiley & Brown, 1979). This behavior reflects a basis in imagery, both in what six-year-olds use as a basis for groupings and in how they form groups. Similarly, from age six on, linguistic structures increasingly guide what and how things will be judged alike. Language is given a special function in that it organizes concepts (Bruner, Olver & Greenfield, 1967).

With experience, the increased understanding of abstract concepts is precipitated by and closely tied to the acquisition of language. The concept achieves stability by gaining additional amounts of perceptual information acquired through language, pictures, and other symbol systems (Paivio, 1971). During preschool and then elementary school, children's modes of representation begin to evolve toward more abstract and flexible forms, from concrete to more abstract imagery. It seems that this development parallels or overlaps with the emergence of verbal symbolic processes, which also become more abstract, differentiated, and precise (Paivio, 1986). Piaget, like Bruner, views the development of symbolic capacities in terms of increasing abstractness of functioning in that the child's understanding of abstract concepts develops gradually: "Images and words are correlated with differences in concrete-abstractness, in the sense that images designate concrete objects in terms of their perceptual and figural properties, whereas words can signify concepts-relations, classes, and numbers" (Piaget and Inhelder, 1966 pp. 450-451). Developing changes in abstract functioning are accompanied by developing changes in both the verbal symbolic system and in imagery.

In time, the developing reader becomes increasingly able to deal with abstract symbols and is able to solve problems that require taking account of information about temporally and spatially remote objects and events. As children learn that words represent concepts and objects, they learn about the object's conceptual referent, its qualities as an object, and the relation between the two. Initially, the child cannot interpret all these facets of meaning. A child's limited ability to hold two or more things in mind simultaneously may prevent him from realizing the relation between the properties of the symbol and those of the referent (Case, 1985; Piaget, 1979).

Children may be able to keep less information active in memory because of their inefficient use of working memory capacity (Case et al., 1982, 1985), knowledge limitations (Chi, 1976), or diminished memory capacity (Pascual-Leone, 1970). These different possibilities all support the idea that younger children have more difficulty dealing with texts and, in particular, with the referential relations between texts and perceptible situations.

Beginning readers learn the mechanisms of the reading process that directs attention to graphic and orthographic information. They concentrate on the translation from orthographic representations to speech sounds and to scanning the text in the correct path. These mechanical processes must become smooth and automatic before attention can be strongly concentrated on the meaning to be extracted, for the beginning reader finds it hard to attend to all these activities at once (Bryan & Harter, 1898; Weber, 1968; Biemiller, 1970; Gibson & Levin, 1975; Perfetti & Lesgold, 1978; Perfetti, 1985; Stanovich, 1984; Evans & Carr, 1985).

As children change from needing to pay a lot of attention to decoding to being able to focus on extracting meaning from text, they store specific memories of reading particular words or texts, which enable them to read more efficiently when they encounter the same word or text several more times. In line with the episodic hypothesis of memory representations, children gain experience reading several types of texts in different print styles, and they gradually gain more understanding of concepts and the words used to convey their meanings.

How can we assess the changes that occur in children's memory representations as they begin to read? With each repeated reading experience, children are improving their reading skill, much like learning an athletic skill such as tennis. With more practice, improvement results, but what aspect of the reading process improves? Experiments will be proposed to examine reading skill as a function of repetition, but a review of repetition benefit and its place in children's reading development is first in order.

REPETITION BENEFIT: Child Literature

Much of the existing research on repetition effects involves adults, and the literature on the development of perceptual encoding mechanisms using repetition effects as a diagnostic is essentially nonexistent. In the adult literature, it has been argued that in essence, both the abstractionist and the episodic view of repetition effects are correct, but at different points in the development of a visually-addressable lexical memory representation (e.g. Feustel, Shiffrin, & Salasoo, 1983; Salasoo, Feustel, & Shiffrin, 1985). Therefore, when addressing children's reading development, it is conceivable that when children are initially learning to read, their experiences with text are purely episodic in nature, since most of their visually addressable word memories are just being established.

Educational research has included reading repetition methods that have primarily addressed the improvement of oral reading performance. These studies focus on improving reading rate, accuracy, and fluency of prosodic reading. Many different types of repeated reading methods have been created (Chomsky, 1976; Clay, 1985; Samuels, 1979; Smith & Johnson, 1980), and although the terminology and methods differ, these varying procedures share a common goal--to increase the fluency of slow halting readers. The common strategy, which is to have the beginning reader reread a passage until oral production is fluid and less effortful, is widely used to help nonfluent readers achieve automatic word identification skills (Dahl, 1974; Samuels, 1979).

Repeated reading procedures can be grouped into two categories. Assisted procedures allow the reader to model his/her reading after another reader (Morgan and Lyon, 1979), teacher (Smith, 1979), or audiotape (Chomsky, 1976). The other is an unassisted procedure, where the reader reads independently (Samuels, 1979). Support for these methods is based on information-processing paradigms such as Samuels and LaBerge's (1983) automaticity theory, Perfetti and Lesgold's (1979) verbal efficiency theory, and Schreiber's (1987) prosodic cue development theory.

Empirical evidence suggests that reading repetition procedures improve reading rate and word recognition accuracy from the first to the last reading of the same passage (Chomsky, 1976; Dahl & Samuels, 1979, Herman, 1985, Samuels, 1979; see Dowhower, 1987 for a review). Most of the repeated reading studies have been designed to investigate gains of subjects with special reading problems. For example, Herman's (1985) goal was to validate the method of repeated reading with nonfluent remedial readers at the intermediate grade level. She addressed aspects of reading and fluency that change with repeated practice, specifically reading rate, speech pauses, and word recognition accuracy. Similarly, Rashotte and Torgesen (1985) tested the effectiveness of different types of repeated reading on non-fluent learning disabled students. Carver and Hoffman (1981) and Samuels (1979) looked at the use of repeated readings as a way of enhancing the accuracy of word recognition and rate of reading in young, poorly skilled readers.

Dowhower (1987) examined the utility of repeated reading on transitional second grade readers--children who are in transition from the decoding stage to learning to read fluently. She looked specifically at the fluency and comprehension of a special population of second graders who had good decoding ability but below average reading rate. The children were asked to reread a story until they reached a criterion of 100 words per minute for a 200 word story. The children showed improvement on reading rate, accuracy, comprehension and prosodic reading. Upon investigation of transfer effects, individual passages were read faster and more accurately with more understanding, with no carryover effect on reading new passages. Only prosodic reading carried over to new passages. Overall, practice of one story was not as effective as combined practice of several stories. In the short run, speed and prosodic reading indicators were positively affected for individual stories, but in the long run (after processing all the passages, there was a cumulative practice effect across stories. The experiment was conducted on a special sample of 17 second graders, who reached specific criteria on slow reading rate and scored in a 4th-6th stanine of the Sequential Test of Educational Progress (1976). Therefore, the drawback is that the results cannot be applied to a more general population of second grade readers.

Other "repeated reading" studies have addressed relative effectiveness of various study strategies used by students to learn and remember information. Such strategies include notetaking, underlining, outlining, and read-reread strategies (Anderson, 1980). These types of studies support Mayer's (1983) quantitative hypothesis, which proposes that repetition allows a learner to add more overall information to knowledge previously obtained, thereby affecting how much is learned. Studies in this area do not specifically address whether reading skill in general is improved with repeated readings. They tend to focus on accomplishments within one particular passage. For example, one of the only existing studies on study strategies, Krug, Davis and Glover (1990) addresses massed versus distributed repeated reading, manipulating the amount of time between readings to see whether comprehension is affected. College-age students read 600 word essays. Some students read the passage, reread it immediately, and then were tested for content. Other students were given a one-week delay between readings, and some were given paraphrases of the essay as the repeated reading. Kruger et al. (1990) found that massed repeated reading led to better passage recall than distributed repeated reading, but they fail to address exactly what gets transferred between the repeated readings and instead focus on the spacing effects in study time.

Some studies note that individual word practice is a major source of the speed increment found in repeated reading. In most reading programs, only words and phrases are repeated to any degree. Fleisher, Jenkins, and Pany (1979) found that repeated practice on isolated words and phrases increased speed of reading single words, but there was not a significant degree of transfer to reading in context or to comprehension. The question whether repeated practice on isolated words or on connected discourse is more effective in increasing reading speed remains unresolved.

Generally, the repeated reading method is used for classroom instruction in connection with beginning readers and unskilled problem readers. The literature in education regarding repeated reading focuses on redundancy as a way of reducing the amount of information available that may confuse the beginning or problem reader. The various studies do not address representations in memory per se, but rather focus on teaching programs to strengthen the mechanisms needed to read fluently and prosodically for better school performance. In addition, little support exists for claims that repeated reading instruction helps children understand practiced materials better. Researchers do not agree as to whether gains in comprehension on practiced text transfer to increased understanding of unpracticed text (for a review, see Dowhower, 1987). Just which mechanisms or levels of processing get strengthened with repeated reading, and whether the mechanism that is strengthened might change with reading development, have not been studied.

Transition to Experiments

Because of its potential importance to beginning reading and the transition from decoding to comprehension, the particular level of processing of interest in the present investigation is the abstract, conceptual level of meaning and reference involved in lexical recognition. At this level of processing, an object could be represented by two perceptually very different types of symbols, the printed name of the object, as in reading, or a rebus-picture of the object. One of these symbols, the printed name, is linguistic and part of the reading process. The other, the rebus, is nonlinguistic and is instead a part of the child's already established system for recognizing visual objects. The two symbols therefore would differ dramatically in concrete features of surface form but would nevertheless be approximately equivalent at the more conceptual levels of meaning and reference.

CHAPTER II.

OVERVIEW OF EXPERIMENTS 1,2, AND 3

In order to help organize the overall rational of the three experiments, this section provides a summary outline of the purposes and possible outcomes for each experiment.

EXPERIMENT ONE: Development of the tool

Can the use of multiple readings of rebuses and texts document trends in reading speed, accuracy and magnitude of repetition benefits?

Hypothesis 1. Younger children should be able to read rebus passages faster than rebus passages. **Hypothesis 2**. Younger and poorer readers should gain more benefit from multiple readings.

Possible outcomes:

1. No developmental changes will be seen, no benefit gained from rebus repetitions.

2. Yes. Developmental changes will be documented. All grades should be able to show repetition benefits within each format.

EXPERIMENT TWO: Application of the tool to assess reading development

Are pictures and words equivalents? If experience with pictures and words contribute to reading development, how does it guide the development of this skill?

Hypothesis 3. Do children's information processing systems treat words and pictures as different entities?

Possible outcomes:

1. Yes: Repetition of rebus followed by the same text in all all words should show less or no benefit. "Match" of format occurs when all-text filler paragraphs precede an

all-text target paragraph. "Mismatch" of format occurs when all-text filler paragraphs precede a rebus target paragraph. When comparing match/mismatch of format of the type of text, the size of benefit from matched formats should not equal mismatched formats.

2. No: When processing becomes more automatic, words equal pictures, benefit representing the same concept. Change in surface form should make no difference, should be able to benefit from cross-modal repetitions. When comparing match/ mismatch, the size of benefit for same format should equal mismatch of format.

Hypothesis 4. Adults appear to code pictures and words according to the Conceptual Code Theory. How did we get this way?

Possible outcomes:

1. We are conceptual coders all along. There should be no differences between match and mismatch of format for all grades. Contextual influences will be present as early as first grade.

2. Dual coding develops into conceptual coding. Over time, there is a change in access times to verbal and imaginal memory. There should be mismatch of format differences in 1st grade, with differences decreasing as age increases. COntextual influences should be apparent with the skilled readers only.

EXPERIMENT THREE: The influence of context

Hypothesis 5a: What level of representation is responsible for benefit? The context of the paragraphs will be scrambled, so that the reading system will be less able to control the level of analysis.

Possible outcomes:

1. Text level is responsible for benefit. Scrambling should make a large difference

in the amount of benefit accrued.

2. Word level is responsible for benefit. Scrambling lists should NOT make any difference in the amount of benefit accrued.

Hypothesis 5b. Can this tool detect the difference between picture-word and word-word repetition found in single stimulus processing studies, where format mismatch decreases benefit?

Possible outcomes:

1. No. Something about the results is special to rebus and text stimuli.

2. Yes: This tool provides an alternative way to address the processing of pictures and words. Format mismatch should affect repetition benefit.

Hypothesis 5c. What about focal attention that influences the level of processing at which benefit is accrued? All subjects are forced to process lists word by word, hence one should see benefit accrued at individual word level.

Possible outcomes:

1. Focal attention does not influence the level of processing. Benefit may accrue at word level and/or text level.

2. Focal attention influences the level of processing. Repetition benefit is sensitive to word scrambling. Benefit should accrue at word level only.

Hypothesis 6. Is context necessary for benefit to occur? There should be no difference between experiments 2 and 3 for the younger readers if they are processing text at word level.

Possible outcomes:

1. Yes, context makes a difference. Top-down processing is evident, as found with adults. Benefit is controlled by an abstract level of lexical processing. Mismatch will make a difference in the amount of benefit accrued.

2. No, context makes no difference: bottom-up processing is evident. Benefit is controlled by an abstract level of text processing. Mismatch of format will not make a difference in the amount of benefit accrued.

CHAPTER III.

EXPERIMENT ONE

Though rebus text is sometimes used as instructional material for beginning readers, little is known beyond the findings of Potter and her colleagues about how it is read, or how the reading of rebus text compares to the reading of regular, all-word text. When words are formed into sentences, or when pictures replace the content words in sentences, do they behave in a similar fashion? To date, Potter et al. (1986) and Kroll (1991) are the only studies that address the issue of processing pictures embedded in a text.

Potter, Kroll, Yachzel, Carpenter, and Sherman's (1986) study, which was discussed earlier, found that rebus texts take longer to read aloud than regular texts, which is consistent with the findings in studies of single-stimulus processing that pictures take longer to name than words (Potter & Faulconer, 1975; Carr, McCauley, Sperber & Parmelee, 1982). Yet their Rapid Serial Visual Presentation conditions did not lead subjects to lose any comprehension when the text was read in this format. This is consistent with the finding in single-stimulus processing that pictures can be categorized and understood just as fast as words (Theois & Amrhein, 1989) or even faster (Potter & Faulconer, 1975; Smith & Magee, 1980).

Kroll (1990) conducted two experiments that indicated that sentence context can influence picture as well as word recognition. She argued that the conceptual representation of a sentence "can engage in interaction with output from a number of representational systems, including the perceptual knowledge associated with the recognition of objects and scenes and the lexical knowledge associated with each of the various languages an individual speaks or reads"(p. 749). Her experiments show that contextual priming effects in reading texts aloud are similar for both word and picture targets. Pictures can benefit from preceding sentence contexts as much as words do, regardless of the placement of the picture in the sentence. Her results show that words and pictures access common conceptual representations (Potter, 1979; Theois & Amrhein, 1989), even those that are constructed on line during sentence processing (Potter et al., 1986). These findings support the conceptual model in which processing of sentence meaning can accept a range of conceptual representations as input, regardless of their original surface form. Kroll notes that only abstract conceptual features of the sentence context and target word or picture are likely to be involved in sentence processing.

The findings from Potter et al. (1986) and Kroll (1991) support the possibility that at the semantic level and above, processing of rebus texts is very similar to the processing of regular texts consisting only of words.

Predictions/ Hypotheses:

Results from Potter et al. (1986) and Kroll (1991) allow one to speculate that once readers have developed perceptual encoding operations to some threshold level and are applying them under conditions that allow a focus on comprehension of coherent text, transfer of repetition benefits between pictures and words might be quite substantial. As a precursor to examining picture-word transfer, documentation of developmental trends in reading speed, reading accuracy, and magnitude of repetition benefits for the two types of text was needed. Experiment 1 explored these developmental trends with first, second, third, fourth, and fifth grade students.

Experiment 1 was designed to assess the differences between reading all-word and rebus text, from first to fifth grade.

1. Younger children should be better able to read rebus-version passages, than all-text passages. Reading time should be faster for rebus for younger children but should gradually get better for text with the development of decoding skills and letter to sound correspondence skills. Older children should be able to read rebus and all-text passages equally well. If there is one advantage over the other, it should be for all-text passages.

2. In contrast to younger children and poorer readers, older readers who are already familiar with reading words should benefit more (i.e. get faster with repeated readings) from multiple exposures to passages. For beginning readers, all encounters are new and unfamiliar, so with more experience, they ought to increase the speed with which they read subsequent passages. Older children may already be at baseline in speed, therefore not showing much more improvement over repeated readings (Logan, 1988, 1990; Newell & Rosenbloom, 1981).

Method

Subjects. The subjects were 320 native-English speaking school children (64 children at each grade between 1 through 5) from Lansing area elementary schools. Family socioeconomic statuses ranged from lower middle to upper middle class standing. The mean ages for each grade were as follows: first grade: x=7;1, second grade: x=8;2, third grade: x=9;3. fourth grade: x=9;11, fifth grade: x=10;10. Consent for subjects was obtained from parents. Parents were given a form that included information about the details of the task, the duration, and benefits resulting from the study. They were asked to return the permission slip to the teacher as soon as possible. Once the permission slip was returned, the child was invited to participate in the reading task. Ultimately, the child had the final say as to whether or not he/ she wanted to participate. Only after the teacher and child gave approval did the child participate. An example of the consent form is included in the Appendix.

Design. Table 1 summarizes the design of the experiment. Each child was given 12 passages to read. Half of the subjects in each grade read 12 all-text paragraphs. The other half read 12 rebus-format paragraphs. Some of the passages in the series read by each child were repeated either once or twice, allowing comparison of speed and accuracy on repeated versus new passages. Several different sequence orders were used to avoid confounding repetition with overall practice, but each order contained the four repetition conditions diagramed below. T represents target paragraphs, A,B,C and D represent filler paragraphs. Identical schemes were designed for all-word paragraphs, and for rebus paragraphs.

Table 1. Experiment 1: Design and Repetition Scheme.

Paragraphs			Target manipulation
A	B	T1	No repetitions
T2	C	T2	1 repetition spaced
D	T3	T3	1 repetition massed
T4	T4	T4	2 repetitions

In the no-repetition baseline condition, two different filler passages preceded a target, represented by T1. In the two one-repetition conditions, a target was preceded by one repetition and one filler. Finally, in the two-repetition condition, the target was preceded by two repetitions. All four targets were counterbalanced across repetition schemes, and across the repetition scheme.

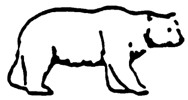
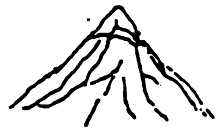
Materials. The story lines for each passage were taken from a variety of first grade readers. Each passage includes three sentences, with a total of 42 words each. On average, 23 were content words and the remaining 19 were closed-class grammatical function words. The paragraphs were composed on a Macintosh computer, using Macwrite Geneva 18 point font and spacing of 1 1/2 lines in between each line of text. An example is shown in Figure 2, but reduced in size by 70% to accommodate the margin requirements.

Rebus passages were created by replacing eight content words with a corresponding picture of the actual object--a substitution rate of about 35% of the content words. The pictures were 64 simple, black-outlined drawings of objects whose names were selected from the Snodgrass and Vanderwart (1980) concept typicality norms. These pictures cover a space of roughly 1 by 1/2 inches. An example is shown in Figure 3, reduced 70% to fit margin requirements. Eight all-text passages were created, and each passage was also converted into a rebus passage. Half of the subjects at each grade level received all-word texts and the other half received rebus texts.

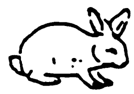
Procedure. Each child accompanied the researcher to a quiet area, and both were seated close to a tape recorder for individual testing. The child was asked to read twelve brief passages aloud as quickly and clearly as he/she could, without mumbling or running his/her words together. Each passage was presented individually, with the other passages placed face-down. The child was instructed not to begin until he/she heard the researcher say a preparatory, "Ready...GO". Each subject's reading times were measured for each passage to the nearest tenth of a second with a stopwatch. Each subject's readings were tape recorded on a Sharp cassette recorder. Pauses were taken

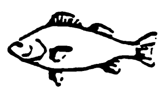
The brown bear went over the big, tall mountain to meet a pretty butterfly, when a smelly skunk passed him by. An owl flew past the sleeping rabbit. He wanted to watch the yellow fish swim in the pond with the frog.

Figure 2. Example of all-text passage

The brown  went over the big, tall 

to meet a pretty  when a smelly  passed

him by. An  flew past the sleeping . He

wanted to watch the yellow  swim in the pond with

the .

Figure 3. Example of rebus passage

between each reading in order for the researcher to record the reading time and the tape counter number on data sheets. After recording the time, the researcher flipped the next passage over and then quickly stated "Ready...GO!". The child had the opportunity to hear his/her own voice once he or she completed reading the series of paragraphs. The subject was then given a decorative pencil or stickers for his/her participation in the project. Participation was completely voluntary, and the child was free to withdraw at any time. The entire session lasted about 15-20 minutes for each child; longer (25-35 minutes) for the slower readers.

Results

The mean reading times in seconds are shown in Table 2.

The primary analysis examined target reading times for each of the manipulations, in order to test predictions concerning the developmental changes involved in repetition effects. The variables in this analysis of variance compared all text and rebus reading times to establish the differences in processing pictures and words. A 5 x 2 x 4 ANOVA whose factors were grade (1,2,3,4, and 5), format (with two levels: rebus and text), and repetition (with four levels: no repetitions, one repetition spaced with one filler between, one repetition presented immediately, and two repetitions) was run. Main effects were found for repetition, $F(3,390)= 82.12$, $MSe= 101.32$ in which repeated targets were read faster than were new targets (Ms= 0 reps= 35.12, 1 rep sp= 27.85, 1 rep ms= 25.21, 2 reps= 23.58); for format $F(1,310)= 4.03$, $MSe= 1992.34$, in which subjects read faster in the text condition (M= 25.43s) than in the rebus condition (M=30.44s); and for grade $(4,310)= 68.49$, $MSe= 1992.34$, in which older students read faster than the younger students (Ms= gr1= 68.66s; gr2= 23.91s; gr3= 17.99s;

gr4= 15.22s; gr5= 13.92s).

This ANOVA also yielded four significant interactions. A grade x format interaction was significant at $F(4,310) = 7.10$, $MSe = 1992.35$. A grade x repetition interaction was significant at $F(12,930) = 25.17$, $MSe = 101.32$, and a significant format x repetition interaction was found at $F(3, 390) = 3.38$, $MSe = 101.32$. Finally, a grade x format x repetition interaction was also found significant $F(12, 930) = 3.999$, $MSe = 101.32$. The remaining analyses were run in order to understand this three-factor interaction.

Table 2. Experiment 1: Mean reading times for all-text and rebus texts.

GRADE	REPETITION	WORD TEXTS 1st reading	WORD TEXTS Rep	REBUS TEXTS 1st reading	REBUS TEXTS Rep	WORD over REBUS Advantage	p<
1	0	112.93	111.39	67.71	68.30	-45.09	.01
	1sp	117.45	91.22	66.36	53.01	-38.21	.01
	1ms	98.28	67.52	67.44	46.05	-21.47	.05
	2	114.74	67.49	69.12	44.30	-23.19	NS
Overall repetition benefit			43.90		24.00		
2	0	32.31	32.29	27.73	28.84	-3.45	NS
	1sp	32.60	22.35	30.58	21.77	-.58	NS
	1ms	33.34	22.00	31.33	22.86	.86	NS
	2	35.78	19.54	30.84	19.68	.14	NS
Overall repetition benefit			12.75		9.16		
3	0	19.79	19.53	24.71	24.03	4.5	.05
	1sp	17.98	15.27	24.13	18.53	3.26	.01
	1ms	20.18	16.59	23.49	18.53	1.94	NS
	2	19.10	14.78	22.18	16.64	1.86	NS
Overall repetition benefit			4.75		7.39		
4	0	16.80	15.45	19.33	17.28	1.83	NS
	1sp	15.52	12.94	19.30	15.01	2.07	NS
	1ms	15.98	13.11	19.75	14.54	1.43	NS
	2	15.26	12.17	19.04	13.02	.85	NS
Overall repetition benefit			3.28		4.26		
5	0	15.74	14.96	16.80	16.54	1.58	NS
	1sp	15.11	12.75	18.25	13.70	3.79	NS
	1ms	15.08	13.64	17.91	14.53	.89	NS
	2	14.98	12.60	17.50	13.33	.73	NS
Overall repetition benefit			2.36		3.21		

First, ANOVA analyses were run for each format. A 5 (grade: 1,2,3,4, and 5) x 4 (repetitions: 0,1,1,2) ANOVA for text passages was run. A main effect for grade was found, $F(4,155)= 42.73$, $MSe= 2782.49$, in which the higher grades read faster than students in the lower grades (Ms= gr1= 84.41s; gr2= 24.17s; gr3= 16.54s; gr4= 13.79s; gr5= 13.31s), and for repetition, $F(3,465)= 39.32$, $MSe= 149.46$, in which repeated targets were read faster than were new targets (Ms= 0 reps= 38.84s, 1 rep sp= 30.84s, 1 rep ms= 26.71s, 2 reps= 25.39s). A grade x repetition interaction was found significant $F(12, 465)= 16.40$, $MSe= 149.46$. Grade was primarily responsible for the significant interaction, as the size of repetition benefit decreased with grade.

As for the 5 (grade) x 4 (repetition) ANOVA run for rebus passages, similar results were found. A main effect for grade was found, $F(4,155)= 26.37$, $MSe= 1202.20$, in which the higher grades read faster than students in the lower grade (Ms= gr1= 52.92s; gr2= 23.64s; gr3= 19.44s; gr4= 16.64s; gr5= 14.53s), and for repetition, $F(3,465)= 52.40$, $MSe= 53.19$, in which repeated targets were read faster than were new targets (Ms= 0 reps= 31.40s, 1 rep sp= 24.86s, 1 rep ms= 23.71s, 2 reps= 21.77s). A grade x repetition interaction was found significant $F(12, 465)= 9.46$, $MSe= 53.19$. As with the text passages, grade was responsible for the interaction, and as grade increased, the size of repetition benefit decreased.

In addition, a 2 (Format: rebus vs. text) x 4 (Repetition: 0 reps, 1 rep sp, 1 rep ms, 2 reps) ANOVA was run for each grade. Table 3 charts main effects and interactions.To further analyze specific differences between grades, ANOVAs for grade x repetition were run for each format, giving comparisons between each grade. Table 4 lists p values showing significance between grades at each repetition.

Table 3. Experiment 1: analyses within each grade.

Main effects for FORMAT (rebus vs. text)

Grade	F	p	MSe	Difference in reading time	
				Rebus	Text
1	(1,3) = 6.77	.012	9368.96	52.92	84.41
2	(1,3) = .05	NS	372.90	23.64	24.17
3	(1,3) = 3.68	NS (.059)	146.06	19.44	16.54
4	(1,3) = 14.41	.000	36.03	16.64	13.79
5	(1,3) = 2.51	NS	37.78	14.53	13.31

Main effects for REPETITION (0 reps, 1 rep sp, 1 rep ms, 2 reps)

Grade	F	p	MSe	Difference in reading time			
				(0 reps to 2 reps)			
1	(1,3) = 36.95	.000	441.47	89.85	72.11	56.79	55.90
2	(1,3) = 39.95	.000	37.66	30.91	22.49	22.53	19.71
3	(1,3) = 25.49	.000	17.51	21.78	16.91	17.55	15.72
4	(1,3) = 25.26	.000	5.97	17.35	14.65	15.13	13.73
5	(1,3) = 27.05	.000	4.00	15.71	13.07	14.03	12.85

Format x Repetition Interactions

Grade	F	p
1	(1,3) = 4.22	.007
2	(1,3) = 1.62	NS
3	(1,3) = 1.41	NS
4	(1,3) = 1.33	NS
5	(1,3) = .41	NS

Table 4. Experiment 1: analyses within format

REBUS TEXT

Comparison between grades	No reps	1rep sp	1 rep mass	2 repetitions
1 and 2	.000	.000	.000	.000
2 and 3	.032	.006	.007	.002
3 and 4	.000	.001	.010	.001
4 and 5	.012	.004	.028	.071

REGULAR TEXT

Comparison between grades	No reps	1rep sp	1 rep mass	2 repetitions
1 and 2	.000	.000	.000	.000
2 and 3	.000	.000	.038	.000
3 and 4	.000	.000	.039	.000
4 and 5	.506	.328	.118	.272

Analyses comparing grades were also run for good and poor readers in each format.

PICTURES: Good readers

Comparison between grades	No reps	1rep sp	1 rep mass	2 reps
1 and 2	.000	.000	.000	.000
2 and 3	NS	NS	.038	.001
3 and 4	.006	.053	NS	NS
4 and 5	NS	NS	.017	.028

WORDS: Good readers

Comparison between grades	No reps	1rep sp	1 rep mass	2 reps
1 and 2	.001	.000	.000	.003
2 and 3	.014	NS	.001	.006
3 and 4	.000	.000	.024	.057
4 and 5	NS	NS	NS	NS

Table 4 (con't)

PICTURES: Poor readers

Comparison between grades	No reps	1rep sp	1 rep mass	2 reps
1 and 2	.000	.000	.000	.000
2 and 3	.053	.025	.048	.057
3 and 4	.003	.009	.011	.001
4 and 5	.016	.004	NS	.000

WORDS: Poor readers

Comparison between grades	No reps	1rep sp	1 rep mass	2 reps
1 and 2	.000	.000	.000	.000
2 and 3	.002	.000	NS	.003
3 and 4	.016	.004	NS	.000
4 and 5	NS	NS	NS	NS

Figure 4 depicts the convergence of understanding pictures and words as referring to the same concept. As the grade increases, the lines representing word processing and picture processing converge, and increase in speed. Eventually the lines cross, showing that reading of word texts becomes as fast or faster than reading of rebus texts, but only after a few years of reading instruction and experience.

The results also met the expectation that as the grade increased, differences in reading picture and word texts decreased. By third grade, word texts are read faster than rebus texts. As seen in Table 2, the benefit due to repetition was greatest for 1st graders, then second graders, in comparison to the third, fourth and fifth graders.

Another analysis of variance was run for each grade, this time accounting for the differences within grade, for "good" and "poor" readers. The results are summarized

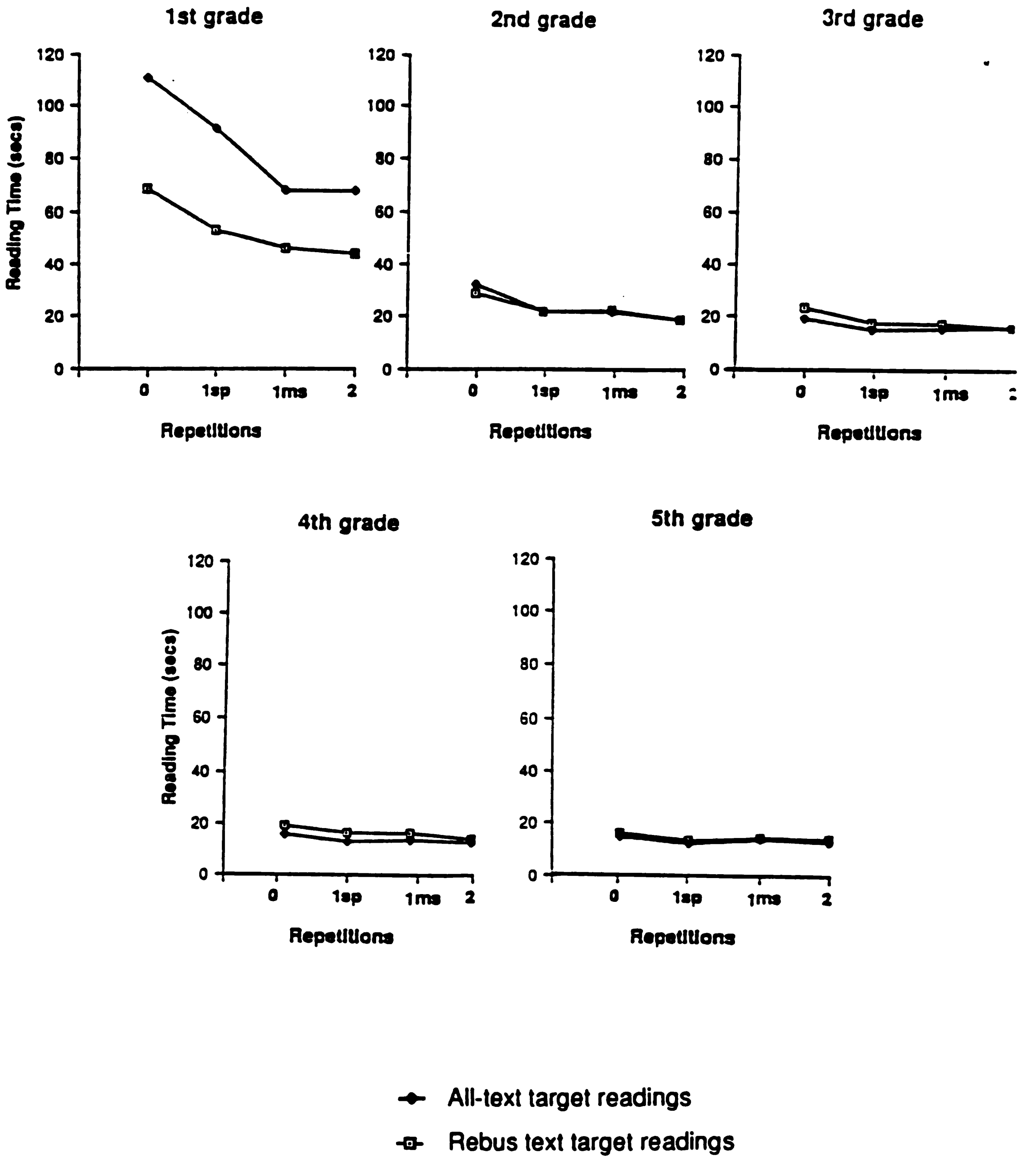


Figure 4. Developmental trends in processing all-text passages and rebus passages

in Table 5. The division was determined by children's individual reading group assignment, and teacher ranking of the child, relative to the other students in the reading class. The child was ranked between 1 and 6, with 1 being the poorest readers and 6 being the best readers in the class. Those students who were ranked three and below were assigned to the "poor" group, and those with rankings four and above were assigned to the "good" reader group.

Discussion

The initial experiment yielded basic developmental results and showed a progression of developmental language competence. Younger readers performed more poorly on the readings, and poorer readers performed less successfully than their peers who read at a higher level. In other words, younger and poorer readers start off reading a given unfamiliar text more slowly, and they also show greater benefit from the repetitive presentations of paragraphs. Both rebus and normal texts show repetition benefit, which indicates that both versions can be used and compared to address developmental changes in reading skill. The magnitude of the repetition benefit is greater for rebus texts than regular texts at every grade level, though the difference decreases with increasing grade level and reading speed.

On the basis of preliminary data from Experiment 1, repetition benefit as a diagnostic appears to have the right properties to assess the changes that go on during this period. We are able to see differences in the way children process pictures as opposed to words. First graders read rebus texts substantially faster than regular texts. This is consistent with the idea that object and picture recognition are already well established and interfaced with oral language skills among beginning readers. By fourth grade, however, regular texts were being read somewhat faster than rebus texts. This is consistent with the adult pattern found by Potter and colleagues in their oral reading data. It is also consistent with a large number of studies of naming single words and pictures (Carr, McCauley, Sperber, & Parmelee, 1982; Huttonlocher & Kubicek, 1983).

Experiment 1 found that regular reading and rebus reading both benefit from repetition, with greater benefit for younger readers and for poorer readers. These results establish that regular and rebus reading are appropriate tools for examining transfer of repetition benefits at the conceptual-referential level of processing.

Table 5. Mean reading times broken down by reading ability

Good Readers

GRADE	REPETITION	WORD TEXTS 1st reading	WORD TEXTS Rep	REBUS TEXTS 1st reading	REBUS TEXTS Rep	WORD over REBUS Advantage	p≤
1	0	59.86	61.59	34.12	38.94	-22.65	.05
	1sp	55.10	45.20	38.47	28.01	-17.19	.05*
	1ms	61.04	36.50	39.50	27.79	- 8.71	.05*
	2	59.73	29.60	38.97	26.35	- 3.25	NS
Overall Repetition Benefit			39.23		12.59		
2	0	21.07	20.88	20.60	20.21	- .67	NS
	1sp	28.85	15.65	21.04	17.23	1.58	NS
	1ms	23.35	17.14	20.95	17.23	.09	NS
	2	24.53	14.89	22.09	15.87	.98	NS
Overall Repetition Benefit			5.99		4.34		
3	0	16.09	15.53	20.63	19.57	4.04	.01
	1sp	14.94	13.60	20.27	15.27	1.67	.05
	1ms	15.62	13.45	18.63	15.21	1.76	.05
	2	15.70	12.52	18.84	13.67	1.15	NS
Overall Repetition Benefit			3.01		5.90		
4	0	13.11	12.00	16.14	15.27	3.27	.01
	1sp	12.53	10.72	16.49	13.61	2.89	.01
	1ms	12.29	11.52	16.17	14.79	3.27	.01
	2	13.19	10.94	17.08	13.63	2.69	.01
Overall Repetition Benefit			2.17		3.31		

Table 5 (con't)

5	0	14.01	12.90	14.37	14.49	1.59	.05
	1sp	13.06	10.81	15.02	12.30	1.49	.01*
	1ms	12.63	11.50	16.08	12.73	1.23	.05
	2	12.83	<u>10.59</u>	15.14	<u>12.00</u>	1.41	.01
Overall Repetition Benefit			2.17		2.49		

Poor Readers

GRADE	REPETITION	WORD TEXTS		REBUS TEXTS		WORD over REBUS	p<
		<u>1st reading</u>	<u>Rep</u>	<u>1st reading</u>	<u>Rep</u>	<u>Advantage</u>	
1	0	159.75	156.63	110.89	106.04	-50.59	.05
	1sp	172.47	135.70	102.22	85.14	-50.56	.05
	1ms	131.14	97.11	103.36	69.52	-27.59	NS
	2	163.28	<u>107.42</u>	107.88	<u>67.39</u>	-40.03	NS
Overall Repetition Benefit			49.11		28.65		
2	0	47.81	45.95	35.79	39.35	- 6.6	NS
	1sp	47.26	29.95	41.41	29.68	- .27	NS
	1ms	46.57	27.91	43.09	29.25	1.34	NS
	2	53.17	<u>24.75</u>	40.77	<u>24.47</u>	- .28	NS
Overall Repetition Benefit			20.95		15.02		
3	0	25.96	26.20	29.96	29.78	3.58	NS
	1sp	23.05	18.08	29.09	22.74	4.66	.01
	1ms	27.79	21.75	29.73	22.80	1.05	NS
	2	24.77	<u>18.57</u>	26.48	<u>20.48</u>	1.91	NS
Overall Repetition Benefit			7.63		9.30		
4	0	19.32	18.35	22.14	22.14	3.79	.01
	1sp	17.57	14.36	21.78	18.89	4.53	.01
	1ms	18.52	15.23	22.91	18.09	2.86	.01*
	2	16.67	<u>14.05</u>	20.78	<u>15.60</u>	1.55	.05*
Overall Repetition Benefit			3.84		5.00		

Table 5 (con't)

5	0	19.06	18.66	19.94	19.16	.50	NS
	1sp	19.01	15.58	22.40	15.49	- .09	NS
	1ms	19.74	17.42	20.25	16.84	- .58	NS
	2	19.07	15.76	20.53	15.05	- .71	NS
Overall Repetition Benefit			2.76		4.11		

CHAPTER IV.

EXPERIMENT TWO

Investigating picture-word equivalence.

What level of lexical processing is driving repetition benefit?

To further examine the use of repetition benefit as a diagnostic, Experiment 2 was designed to determine transfer between pictures and word passages. Since Experiment 1 confirmed benefit can occur within the same text formats, Experiment 2 investigated effects of repetition between text formats. Experiment 2 attempts to assess when children become conceptual in orientation and switch their focus and attention from orthography and letter sounds to extracting overall meaning of the passages.

This "cross-modal" manipulation should be able to tell us whether or not benefit accrues from different representations of the same concept. Repetition benefits from the rebus passage to real text would suggest that children's concepts of words and pictures access the same conceptual amodal code, rather than two visually different representations, one for words, and one for pictures. These results would support Potter, Kroll, Yachzel, Carpenter, and Sherman, (1986), who reported that when sentences were presented to adults one word at a time in very quick succession in rebus format, their readings did not indicate any reduced accuracy of comprehension or recall of what had been read. The results from experiment 1 coincide with the notion that mature skilled readers process words and pictures equally, at least in the sense that they read word and rebus texts at a similar rate than do first graders.

Even if repetition benefits early in reading development occurred entirely in the domain of lexical recognition, there are still multiple components or levels of processing that may be supporting the benefit. If a very concrete, perceptual level of processing supports repetition benefit, as suggested by episodic theory, then benefit will only be observed when a target text is identical or quite similar to a previous text in its concrete, perceptually available features. Such features may be surface form: the typefont, printing, or handwriting, and letter case. Another feature may be surface organization, the chosen words and the particular order in which they are read. At this perceptual level of text processing, changes in the concrete features will reduce repetition benefit because perceptual similarity will be reduced.

Alternatively, if an abstract, semantic, or conceptual level of processing supports repetition benefit, then changes in the meaning conveyed by particular words or organization of words will reduce benefit, but changes in concrete perceptual features will not, as long as they do not also change meaning.

Predictions:

3. In using repetition benefit as a diagnostic of the organization of the information processing system, we would expect that younger children treat words and pictures as different entities. Therefore, for the younger readers, a repetition of a rebus passage followed by the same text in words should have less or no benefit. When processing becomes more automatic, the words and their picture referents come to represent the same concept. A reduction of transfer would indicate that the word and picture are counted as different concepts, and this is expected of the younger children. As children master the orthography, benefit should be less dependent on surface form.

If conceptual-referential transfer occurs at all, it should be found among the literate young adults. Developmentally, one might expect such transfer to emerge around fourth grade if it depends on the establishment and automation of print-specific encoding skills. Many arguments have been made (Gibson & Levin, 1975; Cunningham et al.,

1990) that by fourth grade, the perceptual encoding operations of reading have been mastered to the point that attention can be released from the perceptual aspects of the act and turned to comprehension. By this time, reading becomes a means of gathering information and acquiring knowledge.

Children at the earlier stages are still focused upon the mechanics of reading: decoding, phonology, learning orthography, and the like. As the reading system becomes established, cross-modal transfer should become evident. This view is supported by Carlson, Alejano, and Carr (1990), who showed that storage/ perceptual encoding processes ordinarily operate at the conceptual level in adults. This effect should also appear in cross-modal transfer when looking at older children whose lexical encoding processes are firmly established and well-practiced.

Sharing conceptual-referential content without sharing the concrete perceptual features of surface form may not produce much transfer of repetition benefit early in reading development. Highly literate adults show less priming between a picture and a word that names a picture than they do between two instances of the same word or two instances of the same picture (Carr et al., 1982). If even highly literate adults do not show complete transfer at the conceptual level, it seems likely that young, unskilled readers will not either. Furthermore, when adults deal with unusual and unfamiliar typefonts, they often do not show as much repetition benefit when the same word is presented in different fonts as when the same word is presented in the same font (e.g. Brown & Carr, in press; Jacoby & Hayman, 1987; Kolers, 1975). It follows that early in reading development, all the surface forms of writing are unusual and unfamiliar, and attention must be focused on the effortful mechanics of print-specific perceptual encoding operations. These facts suggest that repetition benefits in young children's reading might be tied to the particular perceptual format in which the first occurrence of the text was encountered.

This would make sense if repetition is in fact an important basis for skill improvement because early in reading development, dealing with perceptual properties of the writing system is exactly the new skill that must be improved (Carr & Posner, in press; Evans & Carr, 1985; Gibson & Levin, 1975; Haynes & Carr, 1990; Perfetti, 1985; Stanovich, 1980;1986).

Thus it may be plausible to suggest that transfer of repetition benefits among young readers will be strictly limited by perceptual format or surface form. Yet this evidence comes from evidence of the processing of single words and pictures. As will be discussed in more detail later, studies of text processing show that more abstract, conceptual levels of analysis govern processing under some conditions. Repetition benefits therefore may be able to transcend changes in surface form. Following this line of reasoning to its conclusion, if conceptual-referential transfer depends on the firm establishment or automation of perceptual levels of processing, then first and second graders should not show it--they should demonstrate surface-form limited repetition benefits. Older readers should instead exhibit benefit from cross-modal repetitions.

Conceptual-referential transfer will be assessed by comparing the reading times between "matched" and "mismatched" conditions. The size of the benefit accrued between same formats (match) will be compared to the size of the benefit between different formats (mismatch). If mismatched formats give the same amount of benefit as matched formats, this demonstrates that it does not matter which format precedes the target paragraph-- benefit still results. Conceptual-referential transfer is possible between text and rebus formats.

4. If experience with pictures and words contributes to reading development, then how does it guide the development of this skill? Two theories have been offered. The dual coding theory claims that to retrieve from memory abstract information about an object, one has to enter the verbal system. Conceptual theory instead argues that abstract information is part of the conceptual system and can therefore be retrieved directly when a picture is perceived, without first naming the object. Since most of the literature on adults provides evidence for the conceptual coding theory, the question remains as to how we come to develop this conceptual/ amodal store.

There are two possibilities. At all points in development, we process words and pictures according to the conceptual coding theory, a conceptual memory system, which becomes more readily accessible by verbal material as reading experience and skill increase. If so, we should see no differences between the matched and mismatched formats across all of the grades. Alternatively, children may begin as dual coders, which allows for changes in access times to the verbal and imaginal memory systems as reading experience increases. Children begin with separate stores and then develop a third conceptual store. By this scenario, we should see differences between matched and mismatched formats initially with the first graders, with the differences decreasing with age. Younger children may begin with separate memory stores for pictures and words and therefore be less skilled in processing words than pictures, whereas older children should have a more conceptual orientation, where the difference between processing words and pictures is smaller than is the case for younger children. This implies that children begin with episodic memory representations for concepts that become more abstract with age. Therefore, if Experiment 2 reveals that older children benefit from cross modal repetitions more than younger children, this would provide evidence that dual coding precedes conceptual coding during the course of reading development (Gibson, Barron, & Garber, 1972).

Method

Subjects. The subjects were 144 native-English speaking school children (36 children at each grade 1,2, and 4) from the same Lansing area elementary schools. Additional subjects were recruited from two Port Huron area elementary schools. A group of literate young adults were also included--undergraduates at Michigan State University. These students were recruited from Introductory Psychology courses, and each received class credit for participation. Consent for subjects was obtained from parents, as explained in Experiment 1.

Design. Table 6 summarizes the first half of the design. Each child was given eighteen passages containing six sets of three passages. Half of the subjects were given a packet of passages where the target paragraphs were all-text paragraphs. The remaining subjects were given readings that included rebus paragraphs as the target paragraphs. Each set of three passages is represented in one cell of the repetition design. The first two passages were either regular texts or rebus texts, and they consisted either of two brand new texts and zero repetitions of the target, one repetition followed by a new text, or two repetitions. Six different manipulations occurred. T represents target paragraphs, A,B,C,D,E, and F represent filler paragraphs. The last columns in Table 6 indicates the comparison relationship between the fillers and target paragraphs. For example, in the first no repetition condition for the text target condition, the two fillers preceding the target are rebus fillers, hence providing a "mismatch" between the two text formats, which provides an no-repetition estimate of baseline reading time when surface form similarity is as low as it can be made between the two formats. The same condition for rebus targets would instead provide a "match" between format comparison, which provides a no-repetition baseline estimate of reading time when the formats are similar in surface form rather than dissimilar.

Table 6. Experiment 2: Design

Cross Modal Repetition Scheme: Word Targets or Rebus Targets

All target paragraphs (denoted T) are all-text passages in one condition, and are rebus targets for the other

Paragraphs			Repetition conditions	Text targets	Rebus targets
A	B	T1	No repetitions: two rebus fillers	mismatch	match
C	D	T2	No repetitions: two word fillers	match	mismatch
T2	E	T2	1 repetition spaced: one rebus filler	mismatch	match
F	T3	T3	1 repetition massed: one rebus filler	mismatch	match
T4	T4	T4	2 repetitions: two rebus fillers	mismatch	match
T6	T6	T6	2 repetitions: two word fillers	match	mismatch

All six targets were counterbalanced across repetition schemes, as well as order within the repetition scheme, creating a total of 36 different schemes. An example of a paragraph is included in the appendix. The sequences consisting entirely of regular texts are the “match” sequences. These provide an estimate of the benefits of exact repetition, whereas the “mismatch” sequences, pairing rebus versions with the target texts, estimate the extent of conceptual-referential transfer. The analogous second half of the design used rebus texts as targets rather than regular texts.

Materials. The same passages from Experiment 1 were used, but this design included two additional passages for the purpose of counterbalancing the cross modal design.

Procedure. The same introductory procedure as explained in Experiment 1 was followed. Once again, each child was tested individually, except this time the child was asked to read eighteen brief passages aloud. Each passage was taped and timed. Each child was asked to read clearly and quickly as possible. After completing all eighteen passages, the child was allowed to hear the tape recording, and was then rewarded with a pencil or stickers. Again, participation was completely voluntary, and the child was free to withdraw at any time. The entire session lasted about 20-25 minutes for each child, although this time was longer for slower readers.

Results

The results can be laid out to make comparisons between grades (1,2,4, and adult), between repetitions (0 ms, 0m, 1ms, 1ms. 2 ms, 2m, where "ms" designates mismatch and "m" designates match between target and fillers) and between formats (text targets and rebus targets). The key reading times are found in Table 7. The table is divided into reading times for word targets and rebus targets. The difference between word and rebus targets is also provided to show the advantage reading regular texts has over reading rebus texts. Overall repetition benefit from 0 repetitions to 2 repetitions for matched and mismatched formats is included as well.

Table 7. Experiment 2: mean reading times for word and rebus targets.

GRADE	REPETITION	WORD TARGETS 1st reading	WORD TARGETS Rep	REBUS TARGETS 1st reading	REBUS TARGETS Rep	WORD over REBUS Advantage	p≤
1	0	51.67	71.48	81.93	68.27	-3.21	NS
	0	75.09	69.86	56.65	67.74	-2.12	NS
	1ms	59.51	49.60	83.72	51.55	1.95	NS
	1sp	52.66	50.59	79.43	49.59	-1.00	NS
	2	56.53	39.59	82.80	43.51	3.92	NS
	2	71.85	44.38	67.15	41.66	-2.72	NS
Overall repetition benefit mismatch			31.89		24.76		
Overall repetition benefit match			25.48		26.08		
2	0	30.23	32.19	26.27	25.23	-6.96	NS
	0	29.74	32.59	25.93	26.35	-6.24	NS
	1ms	30.13	24.37	27.43	22.08	-2.29	NS
	1sp	29.56	23.29	27.46	20.76	-2.53	NS
	2	28.93	21.98	27.28	19.40	-2.58	NS
	2	34.10	20.33	27.47	18.34	-1.99	NS
Overall repetition benefit mismatch			10.21		5.83		
Overall repetition benefit match			12.26		8.01		
4	0	20.38	17.66	16.27	19.56	1.9	NS
	0	18.45	19.07	20.63	18.94	-.13	NS
	1ms	22.26	15.29	16.96	16.19	.90	NS
	1sp	21.99	15.05	16.97	16.22	1.17	NS
	2	19.94	14.37	16.74	15.09	.72	NS
	2	18.04	14.51	18.92	14.65	.14	NS
Overall repetition benefit mismatch			3.29		4.47		
Overall repetition benefit match			4.56		4.29		

Table 7. (con't)

MSU undergrads						
0	12.58	10.19	11.14	12.30	2.11	.01
0	10.26	10.25	12.81	12.21	1.96	.01
1ms	11.97	9.69	11.87	10.90	1.21	.01
1sp	12.32	9.62	12.64	10.96	1.34	.01
2	12.21	9.51	10.76	10.99	1.48	.01
2	10.22	9.53	12.44	10.70	1.17	.01
Overall repetition benefit mismatch		.68		1.31		
Overall repetition benefit match		.72		1.51		

General results in Table 7 illustrate the developmental progression of reading rebus and word texts with varying previous fillers. Over school grades, children have an increasingly easier time processing texts, although none of the differences between word and rebus targets were found to be significant for grades 1,2, and 4. A word advantage was significant for the MSU college sample.

Several analyses were conducted to systematically investigate effects of repetition and match of format for each of the grades. The analyses are organized to look at:

1. All grades in both all-text and rebus formats
2. Grade differences within each format
3. Format comparisons within each individual grade and
4. Comparisons within each format within each grade.

The primary analysis examined target reading times for each of the types of text, in order to reconfirm predictions concerning the developmental changes involved in repetition effects. The factors in the first analysis of variance compared all-word text and rebus reading times to establish the differences in processing pictures and words. A 4 x 2 x 6 ANOVA whose factors were grade (1,2,4, and adult), format (with two levels: rebus target and text targets), and repetition (with six levels: no repetitions preceded by two rebuses, no repetitions preceded by two texts, one repetition preceded by two rebuses, one repetition preceded by two texts, two repetitions preceded by two rebuses and two repetitions preceded by two texts) was run. Main effects were found for repetition, F(5,1400)= 69.56, MSe= 93.93 in which repeated targets were read faster than new targets (Ms= 0 reps= 32.11 and 32.13, 1 rep = 24.96 and 24.51, and, 2 reps= 21.81 and 21.76); and for grade (3,280)= 76.44, MSe= 2105.77, in which older students read faster than younger students (Ms= gr1= 53.98s; gr2= 23.91s; gr4= 16.38s; adults= 10.57s). No main effect for format was found significant. This ANOVA also yielded one significant interaction. A grade x repetition interaction was significant at F(3,1400) = 21.93, MSe= 93.93.

An additional ANOVA was run to look at the effects of matched and mismatched formats within 0 repetitions and 2 repetitions. The mean reading times are shown in Table 8. "Match" signifies the relationship between the format of filler paragraphs and target paragraphs. For example, a sequence consisting of 2 regular text fillers and 1 text target is "matched" in format. A sequence consisting of 2 rebus fillers and 1 text target is "mismatched" in format. Since there were no corresponding "match" comparisons for the 1 repetition condition for text targets, this ANOVA compared 0 and 2 repetitions only.

A 4 x 2 x 2 x 2 ANOVA whose factors were grade (1,2,4, adult), format (rebus targets and text targets), repetition (0 and 2 repetitions), and match of format (mismatched and matched) was run. With this division of the data, main effects remained significant for repetition F(1,279)= 131.21, MSe= 231.62, in which repeated targets were read faster than were new targets (Ms= 0 rep= 32.17; 2reps= 21.88), and for grade F(3,279)=78.00, MSe=231.62, in which older students read faster than the younger students (Ms= gr1= 54.04s; gr2=24.60s; gr3=16.73; adults=10.71s). No main effect for format or match of format was found significant. A grade x repetition interaction was still found significant F(3,279)=41.63, MSe=231.62. No interactions involving match of format and other factors were found significant.

Table 8. Experiment 2: Match vs. Mismatch means for text targets

Grade	Overall Mismatch	Overall Match	signif	Repetition x Match interaction		signif
1	55.53	57.12	NS	0 rep/mis	71.48	NS
				0 rep/mat	69.86	
				2 rep/mis	39.59	
				2 rep/mat	44.38	
2	27.09	26.46	NS	0 rep/mis	32.19	NS
				0 rep/mat	32.59	
				2 rep/mis	21.98	
				2 rep/mat	20.33	
4	16.02	16.79	NS	0 rep/mis	17.66	NS
				0 rep/mat	19.07	
				2 rep/mis	14.37	
				2 rep/mat	14.51	
MSU	9.85	9.89	NS	0 rep/mis	10.19	NS
				0 rep/mat	10.25	
				2 rep/mis	9.51	
				2 rep/mat	9.53	

Table 9. Experiment 2: Match vs. Mismatch means for rebus targets

Grade	Overall Mismatch	Match	signif	Repetition x Match interaction		signif
1	55.89	54.70	NS	0 rep/mis	68.27	NS
				0 rep/mat	67.74	
				2 rep/mis	43.51	
				2 rep/mat	41.66	
2	22.56	22.31	NS	0 rep/mis	25.23	.0427
				0 rep/mat	26.35	
				2 rep/mis	19.89	
				2 rep/mat	18.26	
4	17.32	16.79	NS	0 rep/mis	19.56	NS
				0 rep/mat	18.94	
				2 rep/mis	15.09	
				2 rep/mat	14.65	
MSU	11.64	11.46	NS	0 rep/mis	12.30	NS
				0 rep/mat	12.21	
				2 rep/mis	10.99	
				2 rep/mat	10.70	

ANOVA analyses were also run for each format. A 4 (grade: 1,2,4, and adult) x 6 (repetitions: 0 ms, 0m, 1ms,1ms, 2 ms,2m) ANOVA for text targets was run. A main effect for grade was found, F(3,140)= 26.99, MSe= 3094.40, in which students in the higher grades read faster than students in the lower grades (Ms= gr1= 54.25s; gr2= 25.79s; gr4= 15.99s; adults= 9.80s), and for repetition, F(5,700)= 27.89, MSe= 138.13, in which repeated targets were read faster than new targets (Ms= 0 repms= 32.88s, 0repm= 32.94s, 1 repms= 24.74s, 1 repms= 24.64s, 2 repms= 21.36s, 2 repm= 22.19s). A grade x repetition interaction was found significant F(3,700)= 8.89, MSe= 138.13. With the additional division of repetitions into another factor, match/mismatch of format, a 4(grade: 1,2,4, adult) x 2(repetitions: 0 and 2) x 2(mismatch or match of format) was run. The same main effects were maintained for grade F(3,3)=27.86, MSe= 60741.92 (Ms= gr1= 56.33, gr2=26.77; gr4=16.40; adult=9.87) and for repetition F(3,700)= 48.26, MSe=17855.64 (Ms= 0reps= 32.91; 2 reps= 21.78). The grade x repetition interaction was maintained F(3,140)=15.21, MSe= 5626.63. No main effects for match of format was found, nor were any interactions with any other factors found.

In comparison, a 4 (grade) x 6 (repetition) ANOVA was run for rebus targets, and similar results were found. A main effect for grade was found, F(3,140)= 69.87, MSe= 1117.13, in which students in higher grades read faster than students in the lower grade (Ms= gr1= 53.72s; gr2= 22.03s; gr4= 16.77s; adults= 11.34s), and for repetition, F(5,700)= 55.49, MSe= 49.73 , in which repeated targets were read faster than were new targets (Ms= 0 repsb= 31.34s, 0 repsw= 31.31, 1 repb= 25.18s, 1 repw= 24.38s, 2 repb= 22.25s, 2repw= 21.34s). A grade x repetition interaction was found significant F(3,700)= 17.88, MSe= 49.73. Taking match of format into consideration, a 4(grade: 1,2,4, adult) x 2(repetitions: 0 and 2) x 2(mismatch or match of format) was also run for the rebus targets. The main effect for grade was maintained F(3,3)=68.74, MSe= 55598.73 (Ms= gr1= 55.29, gr2=22.43; gr4=17.06; adult=11.55) as well as for repetition F(1,3)= 141.07, MSe=12944.56 (Ms= 0reps= 32.32; 2 reps= 21.84). The grade x repetition interaction remained significant F(3,3)=46.13, MSe= 4232.40. No main effect was found for match of format, nor were any interactions between match of format and other factors found.

The next set of ANOVAS investigated the key factors within each grade. A 2 (Format: rebus vs. text) x 4 (Repetition: 0 repms, 0repm, 2 repms, 2 repm) x 2 (Format match:

mismatch, match) ANOVA was run for each grade. These analyses included 0 repetitions and 2 repetitions only, since the 1 repetition conditions were not significantly different from 2 repetitions, and these analyses would provide a clearer distinction between repetitions. Table 10 charts main effects for format, repetitions and format x repetition interactions.

When investigating the differences in format within each grade, there were no significant differences between reading text targets and rebus targets for first, second and fourth graders. Only the adult data showed a significant difference between processing text and rebus targets, with an advantage going to processing text targets, a difference of 1.54 seconds. Figure 5 depicts these differences. All grades showed significant effects of repetitions. The greater the number of repetitions of a passage, the faster the readers read the subsequent target passage. The format x repetition interactions for grades 1,2, and 4 were not significant, whereas the interaction was significant for the adult college sample.

Table 10. Experiment 2: analyses within each grade.

Main effects for FORMAT (text targets vs. rebus targets)

Grade	F	p	MSe	Difference in reading time Text	Rebus
1	(1,70) = .002	NS	5216.48	55.73	56.11
2	(1,70) = 2.16	NS	535.76	25.79	22.03
4	(1,70) = .266	NS	151.03	15.99	16.77
MSU	(1,70) = 35.66	.000	5.93	9.80	11.34

Main effects for REPETITION (0 repms, 0repm, 2 repms, 2repm)

Grade	F	p	MSe	Difference in reading time (0 reps to 2 reps)			
1	(1,70) = 61.69	.000	840.49	69.88	68.80	41.55	43.02
2	(1,70) = 46.76	.000	115.12	28.71	29.47	20.69	19.33
4	(1,70) = 51.90	.000	22.18	18.61	19.00	14.73	14.58
MSU	(1,70) = 62.73	.000	1.18	11.24	11.23	10.25	10.11

Main effects for Match/ Mismatch of Format

Grade	F	p	MSe	Difference in reading time Mismatch	Match
1	(1,70) = .815	NS	224.67	56.72	55.12
2	(1,70) = .869	NS	48.96	24.82	24.83
4	(1,70) = .289	NS	17.63	16.67	16.79
MSU	(1,70) = .378	NS	1.29	10.75	10.67

Format x Repetition Interactions

Grade	F	p	MSe
1	(1,70) =.793	NS	840.49
2	(1,70) = 2.34	NS	115.12
4	(1,70) = .475	NS	22.18
MSU	(1,70) = 9.76	.003	1.18

Table 10. (con't)

Repetition x Match of Format Interactions

Grade	F	p	MSe
1	(1,70) =2.58	NS	199.18
2	(1,70) = 1.93	NS	28.31
4	(1,70) = .299	NS	17.95
MSU	(1,70) = .990	NS	1.28

Figure 6 shows the convergence of repetitions, between 0 and 2 repeated readings, as well as the increase in reading speed for each grade. The ANOVA also revealed no significant differences for the main effect of match of format between target and filler passages. For all grades, it did not matter whether the preceding filler passages matched or mismatched the target reading; they benefited regardless. None of the interactions between match of format and format were found significant, and neither were any of the interactions between repetition and match of format. To further analyze specific differences between grades, ANOVA analyses for grade x repetition were run within each format, giving comparisons between each grade. The differences between each grade within each format were found significant at $p < .01$, showing that there are distinct differences in reading times between each and every grade.

The analyses presented thus far increasingly become more specific to each grade. Delving further into the influences of repetition and match of format for each grade, a final set of 2 (Repetition: 0, 2) x 2 (Match of format: mismatch, match) ANOVAs were run. Table 11 reveals the results from these analyses.

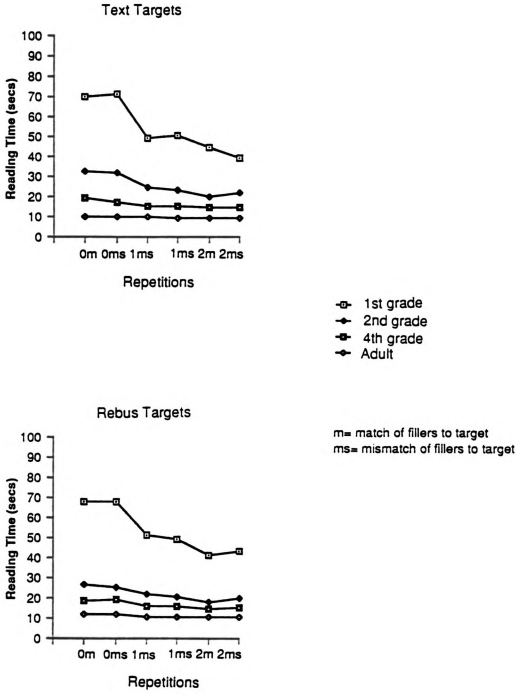


Figure 5. Comparison of all grades within each target format

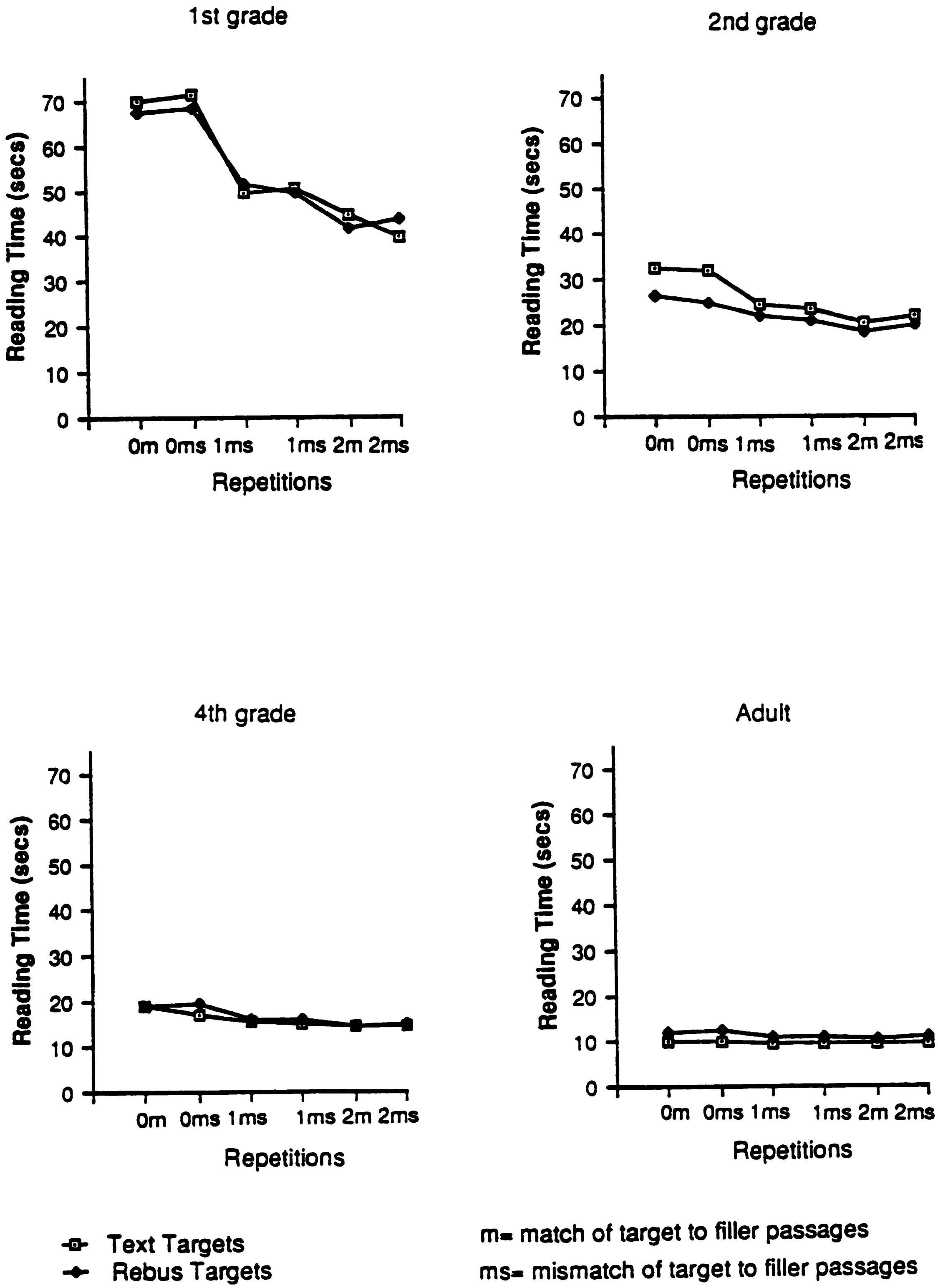


Figure 6. Comparison of all grades for text target vs. rebus target reading times

Table 11. Experiment 2: analyses within each format, within each grade.

TEXT TARGETS

Main effects for REPETITION (0 repetitions, 2 repetitions)

Grade	F	p	MSe	Difference in reading time	
				0 reps	2 reps
1	(1,35) = 24.27	.000	1220.02	70.67	41.99
2	(1,35) = 19.38	.000	234.51	32.39	21.15
4	(1,35) = 22.09	.000	25.10	18.37	14.44
MSU	(1,35) = 46.46	.000	.377	10.22	9.52

Main effects for MATCH/MISMATCH of Format

Grade	F	p	MSe	Difference in reading time	
				Mismatch	Match
1	(1,35) = .384	NS	235.85	55.53	57.12
2	(1,35) = .267	NS	53.07	27.09	26.46
4	(1,35) = .754	NS	28.26	16.02	16.79
MSU	(1,35) = .060	NS	.902	9.85	9.89

Repetition x Match of Format Interactions

Grade	F	p	MSe
1	(1,35) = 1.43	NS	259.24
2	(1,35) = 2.27	NS	16.85
4	(1,35) = .532	NS	27.14
MSU	(1,35) = .044	NS	.513

Table 11. (con't)

REBUS TARGETS

Main effects for REPETITION (0 repetitions, 2 repetitions)

Grade	F	p	MSe	Difference in reading time	
				0 reps	2 reps
1	(1,35) = 73.66	.000	315.72	68.00	42.59
2	(1,35) = 46.89	.000	34.61	25.79	19.08
4	(1,35) = 45.72	.000	15.11	19.25	14.87
MSU	(1,35) = 45.08	.000	1.60	12.26	10.84

Main effects for Match/ Mismatch of Format

Grade	F	p	MSe	Difference in reading time	
				Mismatch	Match
1	(1,35) = .423	NS	120.75	55.89	54.70
2	(1,35) = .094	NS	24.48	22.56	22.31
4	(1,35) = 1.87	NS	5.36	17.32	16.79
MSU	(1,35) = .746	NS	1.74	11.65	11.46

Repetition x Match of Format Interactions

Grade	F	p	MSe
1	(1,35) = .111	NS	140.21
2	(1,35) = 4.42	.043	15.27
4	(1,35) = .033	NS	8.52
MSU	(1,35) = .247	NS	1.59

The results from this set of analyses reveal that repetition as a main effect was maintained and match of format made no difference for any of the grades. Neuman-Keuls simple effects tests were performed on the repetition x match of format interactions. The results of these analyses revealed that repetition remained the only factor responsible for reading differences, and these results are charted in Figures 7 and 8.

Discussion

Experiment 2 yielded basic developmental results, confirming those of Experiment 1. Younger readers read at a slower rate than older readers. A developmental trend was also found for repetitions, although this experiment obtained surprising results concerning cross-modality transfer. Having read a rebus text provided just as much repetition benefit to reading a regular text as did having read exactly the same regular text. The college students showed the pattern observed among adults by Potter et al. (1986) but in ordinary oral reading rather than under the special circumstances of RSVP reading. They exhibited complete conceptual transfer between regular and rebus texts, showing that rebus texts produced just as much repetition benefit as did regular texts in reading a target regular text. The data reveal that for the college sample, there was a significant difference between processing text targets and rebus targets, where the readings of text targets were faster than rebus targets. Adults appear to have quite different experiences with texts as opposed to pictures. Perhaps the younger children were more accustomed to rebus-type reading, a situation they are more comfortable with, since rebus reading is a method used for beginning readers. Perhaps the rebus passages were too out of the ordinary for the

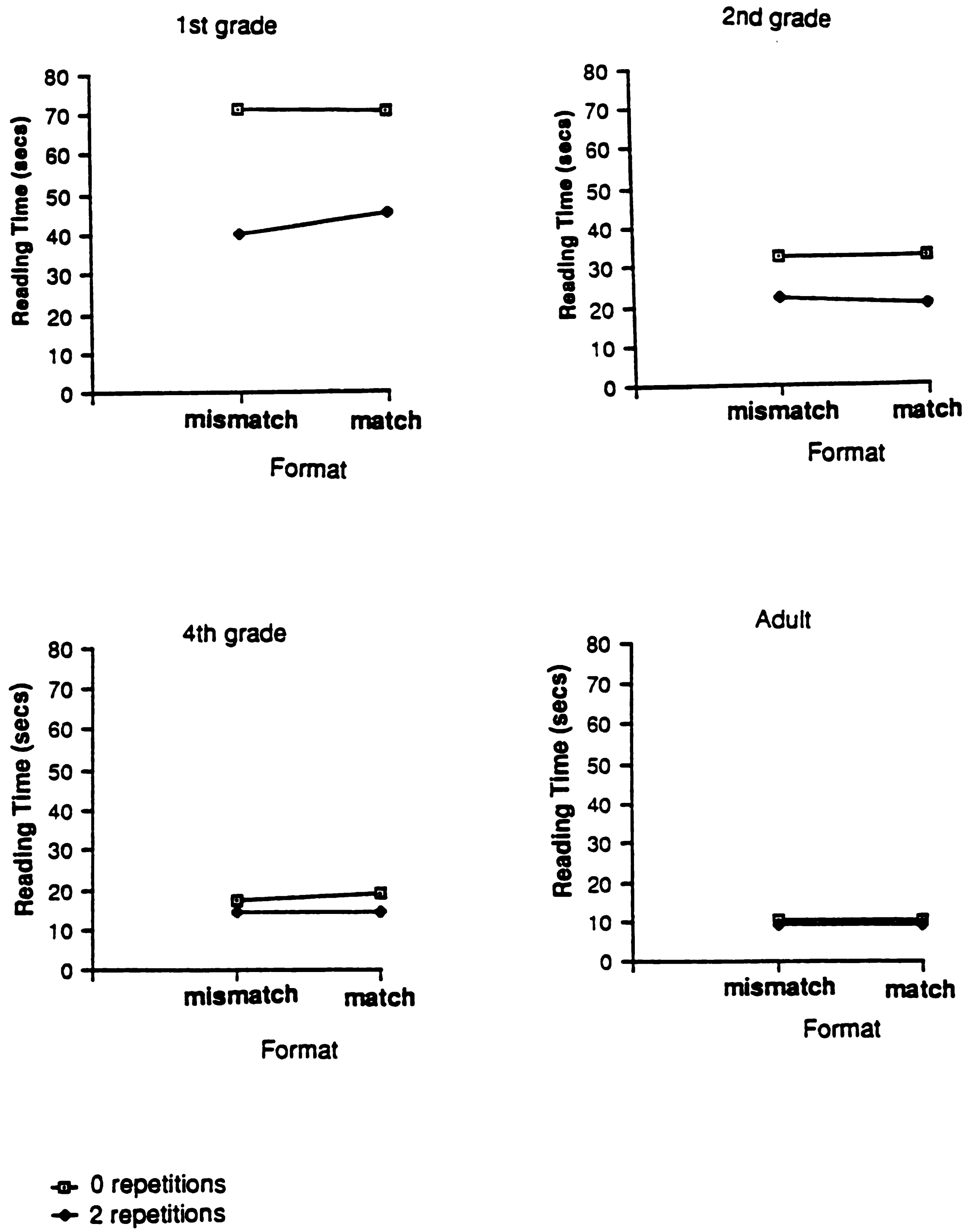


Figure 7. Developmental trends in processing all-word text targets

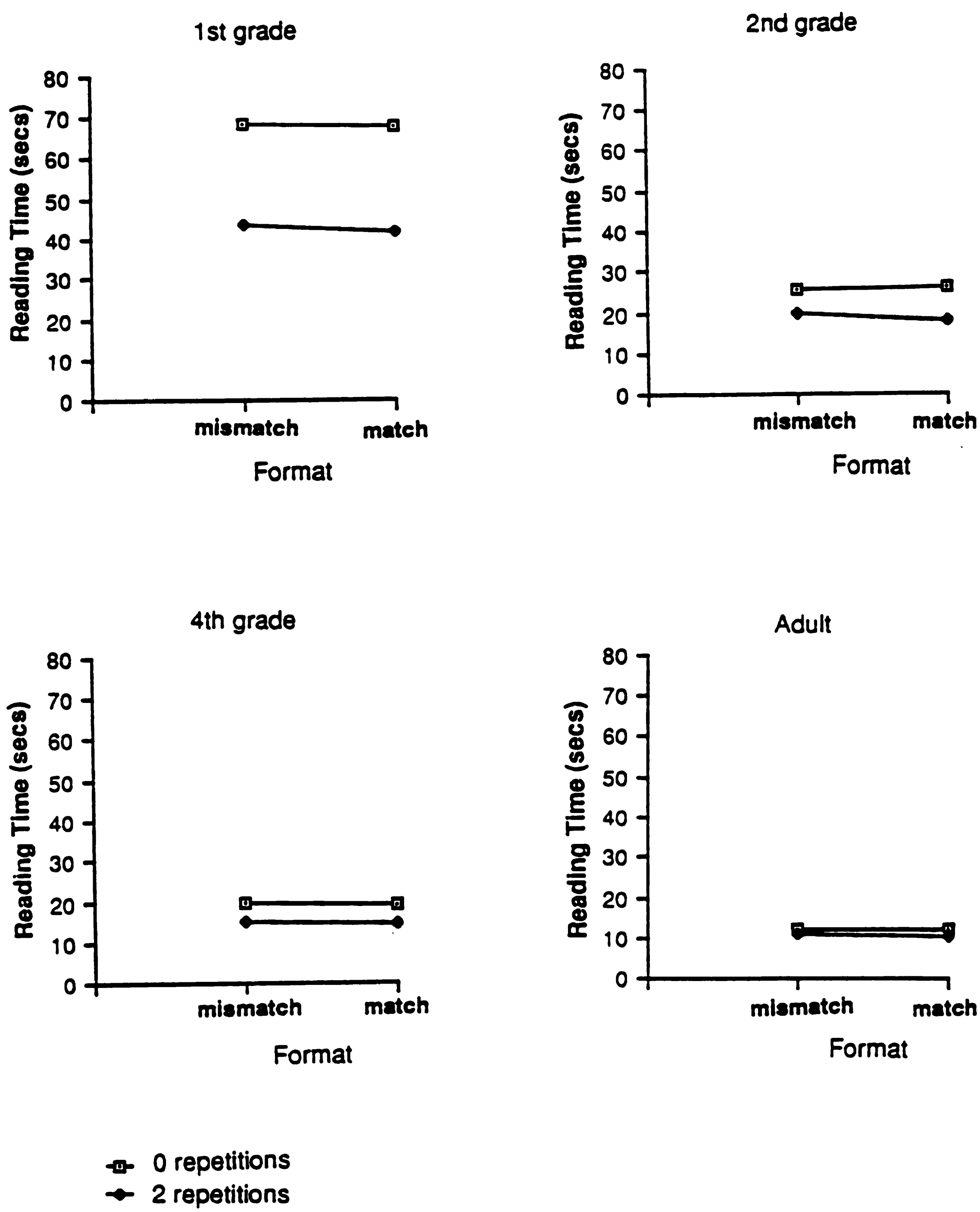


Figure 8. Developmental trends in processing rebus targets

adult readers. Adults are also less often called upon to read aloud, as children are in the school setting, and this may have had some minor influence on the requirements of the task. Perhaps adults call up more referents from memory than children, when labeling pictures. More than one name comes to mind when an adult sees a picture of a bird-- a large variety of names comes to mind, thus forcing the adult to choose a name with which to label the picture, hence slowing down their reading times for the rebus passages.

Referring back to Figure 5, the first and second graders were much slower overall than the fourth graders or the adults, and they do not yet show the signature of firmly established perceptual encoding operations for print in which regular texts are read faster than rebus texts. Nevertheless, the first and second graders show complete conceptual-referential transfer of repetition benefits from rebus reading to regular text reading, and this is clearly evident in Figure 6. This finding is contradictory to the supposition that such transfer should emerge once perceptual encoding operations are firmly established. Levy (1983) noted that contextual knowledge is needed to comprehend text, and beginning readers have little experience with contextual knowledge. Beginning readers are forced to do word by word reading because they are still learning letter-to-word correspondences. The data do not appear to support her supposition. These data show that contextual knowledge appears to be present as early as first grade.

Thus hypothesis #3, which predicted that younger children's information processing systems would treat words and pictures as different entities was not confirmed. Children's text and rebus processing appear to be commensurate as far as the production of repetition benefit is concerned, even for the youngest readers, where words and their picture referents represent the same concept. The match/mismatch analyses confirmed that the size of the benefit accrued from same formats (match) equaled the size of the benefit between formats (mismatch) for all grades. For example, it did not matter whether the readers were presented text target passages that were preceded by text filler passages or rebus filler passages; they still gained benefit. These results provide confirmation that conceptual-referential transfer is possible between text and rebus formats for the youngest beginning readers.

Figures 7 and 8 present developmental trends in processing all-word text targets and rebus targets, and perhaps best illustrate the culmination of the several ANOVAs that were conducted. Within Figure 7, we can see the increasing speed in reading as the reader matures. We can also see the convergence of lines between repetitions from first grade to adult, where the lines seem to overlap. Thus, by the time we become mature skilled readers, the difference between reading a passage once or twice is largely decreased but remains significantly different. Also within Figure 7, we can observe the lack of difference between matched and mismatched formats. We clearly see almost completely horizontal lines between the two. Roughly the same pattern is found in Figure 8 for the processing of rebus passage targets.

The results from Experiment 2 also provide evidence for hypothesis #4, that even during the early points of development, children process words and pictures according to the conceptual coding theory. Children as young as six have conceptual/ amodal memory stores that become more readily accessible by verbal material as reading experience and skill increase. The theory that children begin as dual coders and then develop a third conceptual store is not supported by these data, due to the fact that there were no differences between the matched and mismatched formats across all of the grades. Children were able to deal with words equally as well as with pictures and were able to benefit from repetitions even if the formats were of a different type. In summary, it appears that at all grades, an abstract conceptual level of processing leaves an enduring representation of its activities that can guide subsequent rereading, even when the rereading requires new perceptual operations and overlaps with past reading experience only at an abstract, conceptual level.

CHAPTER V.

EXPERIMENT THREE

Investigating lexical vs. text level effects. At which level does benefit accrue?

Since only eight words were replaced with pictures in each text to create rebus stimuli, it may bring some doubt to mind as to the results of Experiment 2 and the abstraction found between the two text formats. Roughly, eight words of the total of 42 words were substituted, 23 of which were content words. The substitutions were 19% of the total number of words and 35% of the content words. Before drawing firm conclusions, it was necessary to run an additional experiment to show that this paradigm can detect the difference between picture-word and word-word repetition benefits that is commonly observed in single-stimulus processing. To do this, a third experiment was conducted, except that in this manipulation, the words of the paragraphs were randomly scrambled to destroy grammaticality and textual coherence.

Scrambling the word order of the paragraphs eliminated the influence of attention to the entire text as a strategy for reading the text. Scrambling destroys the grammatical structure and coherence of the text, creating stimuli consisting of lists of random words. Text scrambling not only changes the local context of each word but also changes the levels of linguistic analysis that can be easily applied to processing the text (Whittlesea, 1990). This manipulation then discourages a repetition effect dependent solely on the presence of linguistic organization. Using the very same type of scrambling manipulation, Carlson, Alejano, and Carr (1991) found that when attention is devoted to processing the entire text, repetition benefits were sensitive to word scrambling and disrupted the higher propositional, syntactic and thematic levels of text processing. The hope for Experiment 3 is that with scrambling, the reading system should be less able to control the level of analysis that creates an enduring text-based representation of a text or that makes use of an already stored text-level representation. How this affects a developing reading system will be assessed.

Predictions:

Prior to the conclusions drawn in Carlson, Alejano, and Carr (1991) involving the issue of focal attention, Carr, Brown, and Charalambous (1989) began the investigation of repetition benefits, by suggesting that orthographic, phonological and lexical processes involved in word perception are the levels at which repetition benefit accrue. Carr et al. (1989) approached this issue by scrambling words in the first presentation of a passage and then presented a coherent version of the passages as the second, or target, passage. Benefit was accrued from the scrambled version, providing evidence that a level smaller than the sentence level was responsible for improvement. To address this issue once again, the scrambling manipulation in Experiment 3 will also attempt to get at the level at which benefit is accrued. Yet in this manipulation, all target passages are also scrambled, to measure benefits from exactly the same type of incoherent passages.

5. If subjects benefit from repetitions of scrambled passages, it will provide evidence that benefit accrues at the level of individual words. If benefit does not accrue with the scrambled passages, a higher level of processing is responsible for benefit, perhaps at a semantic, syntactic, or thematic processing level. Grade differences in speed should be maintained; large differences in reading times between grades are not expected.

As in experiment 2, conceptual-referential transfer will be assessed by comparing the benefit of repetition to target reading times between matched and mismatched conditions. Matched formats are those with repetitions of the same type (both rebus or both text), whereas mismatched formats have cross-modal repetitions. One goal of Experiment 3 is to replicate the reduction in benefit usually found with cross-modal repetition in the non-text literature. The point is to see whether or not the paradigm of using pictures embedded in text supports the standard finding that for adults, format mismatch reduces repetition benefit. To test this prediction in the most direct way possible, two separate analyses of adult data will be conducted, one in which match of format effects is sought in reading scrambled all-word texts, and a second in which match of format effects is sought in reading scrambled rebus texts. The outcome of the first of these analyses will be a particular point of focus. This is because improvement with practice text is ultimately what is really important to explain. The locus of repetition benefits for coherent text targets thus is the most critical question.

6. First graders who are beginning to read ought to be at a level where they are forced to read word by word because they are still mastering letter-to-sound correspondences. It is plausible that they are not yet highly skilled at whole text processing.

Prior to Experiment 2, one would have expected that younger children initially should show processing primarily at the level of orthographic and lexical processing, later bringing higher level processes into play as they get older. This expectation is based on prior findings that in learning to read, children initially focus on word level processing, decoding individual words and then integrating higher level experiences to the reading task. For younger children, the locus of repetition benefit should have arisen from processes that support lexical recognition and articulation. The results of Experiment 2 proved this to be false for coherent passages. For the younger readers, repetition benefit during text reading appeared to be based on meaningful text-level representations. What can be said about children's performance with scrambled text?

When looking at benefit across repetitions of scrambled text, younger children may show greater benefit from one passage/ list to the next because they do not yet completely rely on sentence and idea structure. On the other hand, older readers may have more difficulty benefiting from repeated scrambled texts because they are accustomed to reading intact, coherent stories. It is possible that when comparing the data from Experiment 3 with those from Experiment 2, first graders should show no differences between reading normal and scrambled targets, if they are truly at a stage where word-by-word processing of text is predominant. Students with greater experience with texts should not show this equivalence between Experiment 2 and 3 data.

If these analyses indicate that young readers are indeed reading word by word, then interest will focus on whether or not they still show transfer of repetition benefit across a mismatch in format. If transfer occurs, it will suggest that benefit is controlled by an abstract level of lexical processing, not by an abstract text representation.

Method

Subjects. Subjects were sixty four undergraduates enrolled in introductory psychology classes at Michigan State University, thirty-two fourth graders, thirty-two second graders, and sixteen first graders. The first- and second-graders attended the same Lansing area and Port Huron Elementary schools as in Experiments 1 and 2. All subjects were native English speakers.

Design. Within this design, the main focus of interest is on no repetition and 2 repetitions. This was because the differences between 1 repetition and 2 repetitions were minimal for good readers in Experiment 1. The readers who had not yet been tested by the end of the school year were generally rated as good readers by their teachers.

Table 12 summarizes the design of Experiment 3. The basic design is a combination of the design of experiments 1 and 2. The difference was that all passages were scrambled. Each child was given twelve passages containing four sets of three passages. Each set of three passages is represented in one cell of the repetition design. The first two passages are either regular texts or rebus texts, and they consist either of two brand new texts and zero repetitions of the target, one repetition followed by a new text, or two repetitions. Four different manipulations occurred. T represents target paragraphs, and A,B,C, and D represent filler paragraphs.

Table 12. Experiment 3: Design.

Cross Modal Scrambled Repetition Scheme: Text or Rebus Targets
All target paragraphs (denoted T) are all-text or rebus passages.

				Text targets	Rebus targets
A	B	T1	No repetitions: two rebus fillers	mismatch	match
C	D	T2	No repetitions: two word fillers	match	mismatch
T4	T4	T4	2 repetitions: two rebus fillers	mismatch	match
T6	T6	T6	2 repetitions: two word fillers	match	mismatch

All four targets were counterbalanced across repetition schemes, and order within the repetition scheme was also counterbalanced, creating a total of 16 different schemes. In Experiment 2, the sequences that consist entirely of regular texts are the "matched" format sequences. These, again, will provide a baseline estimate of the benefits of exact repetition, whereas the "mismatched" format sequences, which pair rebus fillers with the target texts, estimate the extent of conceptual-referential transfer.

Materials. The materials were the same as in Experiment 2, except that all regular and rebus texts were completely scrambled. There were four targets (instead of six as in Experiment 2) to balance the counterbalancing scheme. In addition, the materials were scrambled versions of the coherent passages presented in Experiment 2. An example of a scrambled all-text passage is shown in Figure 9 and an example of a scrambled rebus passage is shown in Figure 10, both reduced to 70% in order to meet margin requirements. Scrambled passages consisted of the same words, rearranged in a random order subject to the constraint that every word be preceded and followed by a different word than it was in the normal version in Experiment 2. For the all-text samples, scrambled passages were created by retyping, and the rebus samples were created by cutting and pasting.

Procedure. The same procedure as explained in Experiment 2 was followed. Each subject was tested individually, and each passage was taped and timed.

Results

The results are summarized in Table 13, Figures 11 and 12. Comparisons can be shown between grades (1,2,4 and adult), with the exception of first graders and the second half of the design involving rebus targets. There were not enough first graders to complete the design due to lack of interest of some of the parents. Repetitions and formats can also be compared within Table 13. The table is divided into reading times for word targets and rebus targets. The means of the first reading are provided as a comparison from which to measure benefit.

went swing chicken the oats she the

stopped see she small the around smell to

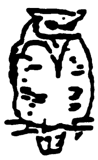
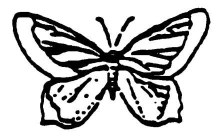
the barn the fed to saw chase both pig

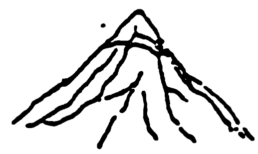
some duck the flowers milked she a cow

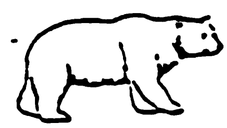
they the at well to Joy some old also

horse

Figure 9. Example of scrambled all-text passage

 the a an in he  sleeping the

flew went big wanted  when past

the brown passed meet  to smelly tall

over pretty the  the  yellow him

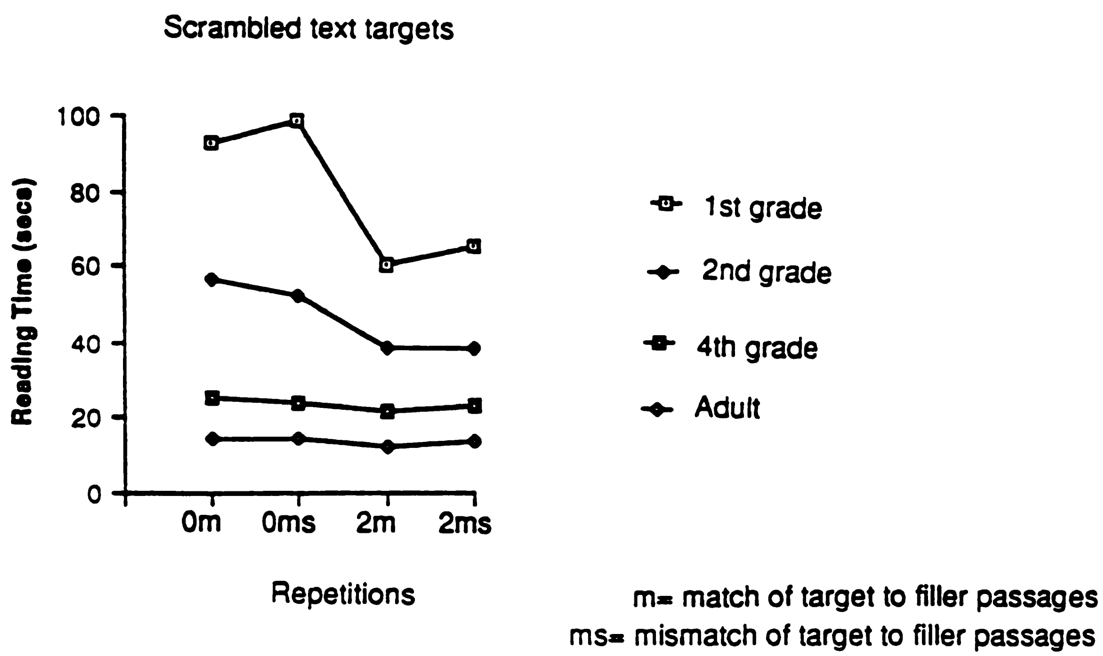
the pond to  by swim watch a with 

Figure 10. Example of scrambled rebus passage

The difference between word and rebus targets is also provided to show whether there is an advantage of reading scrambled regular texts over scrambled rebus texts. The table also includes repetition benefit from 0 repetitions to 2 repetitions for target preceded by matched fillers and targets preceded by mismatched fillers.

Table 13. Experiment 3: mean reading times for word and rebus targets.

GRADE	REPETITION	WORD TARGETS 1st reading	Rep	REBUS TARGETS 1st reading	Rep	WORD over REBUS Advantage	p<
1	0	86.03	98.80				
	0	56.89	92.86				
	2	94.91	64.86				
	2	81.69	59.89				
Overall repetition benefit match			33.94				
Overall repetition benefit mismatch			33.07				
2	0	51.78	56.83	40.65	43.95	-12.88	NS
	0	42.59	52.26	46.08	43.61	- 8.65	NS
	2	55.76	38.70	47.62	37.24	-1.46	NS
	2	48.24	38.13	20.89	38.87	.74	NS
Overall repetition benefit match			18.13		6.71		
Overall repetition benefit mismatch			14.13		4.74		
4	0	24.26	25.24	29.15	31.81	6.57	.01
	0	29.29	24.16	28.37	30.24	6.08	.01
	2	24.36	21.39	30.03	24.14	2.75	.01
	2	28.53	23.32	31.14	24.72	1.4	NS
Overall repetition benefit match			3.85		7.67		
Overall repetition benefit mismatch			.84		5.52		
MSU Undergrads							
	0	14.27	14.44	19.17	18.38	3.94	.01
	0	17.47	14.53	15.94	18.12	3.59	.01
	2	14.47	12.60	18.33	15.85	3.25	.01
	2	16.60	13.96	16.06	15.70	1.74	.01
Overall repetition benefit match			1.84		2.53		
Overall repetition benefit mismatch			.57		2.42		



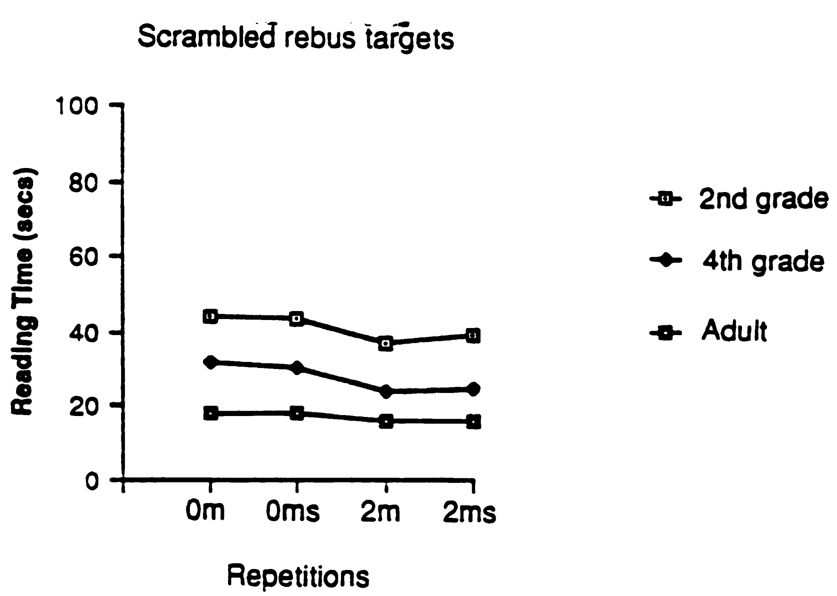


Figure 11. Comparison of all grades within each format: scrambled text targets vs. scrambled rebus targets

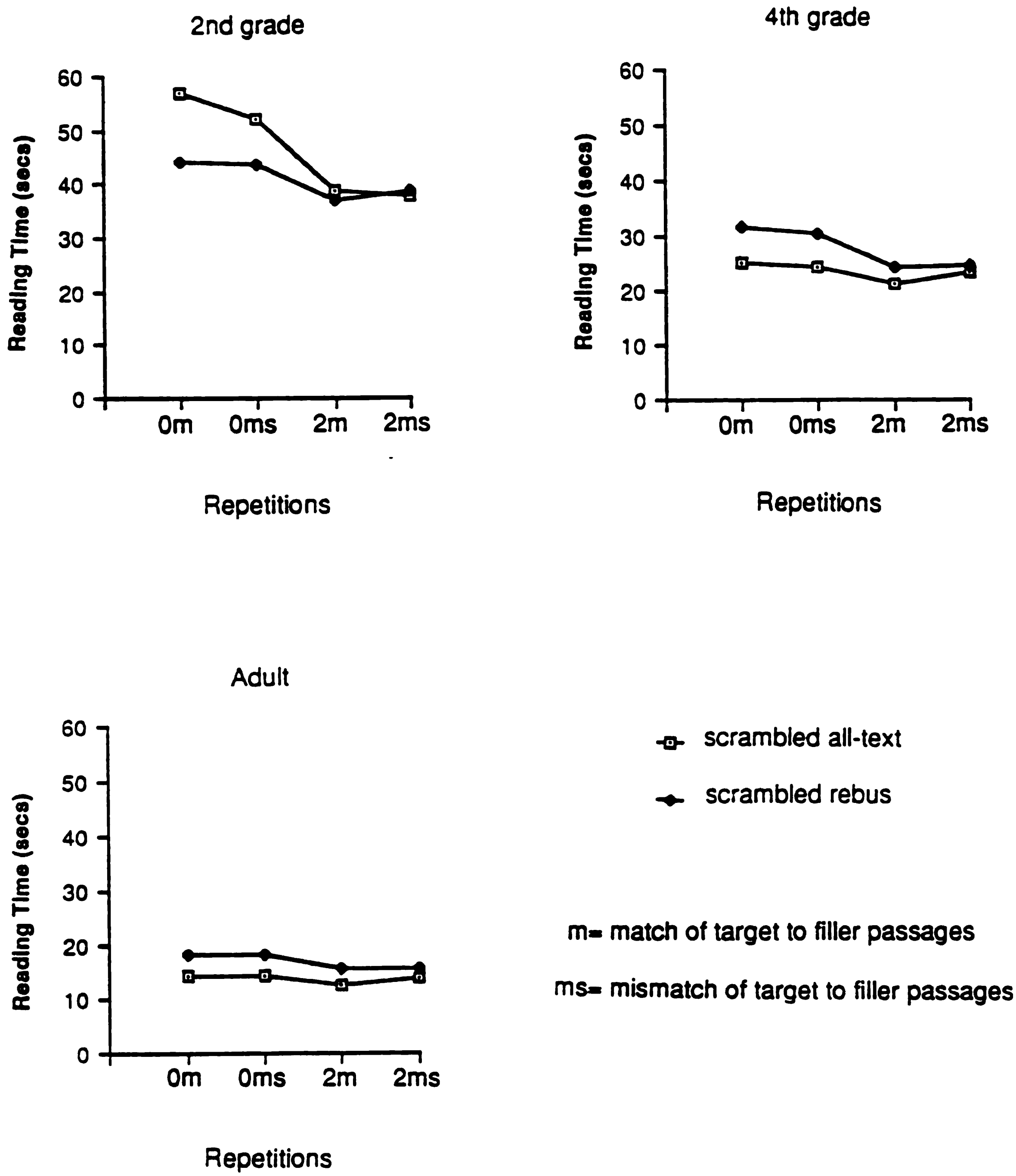


Figure 12. Comparison of target readings: Scrambled text vs. scrambled rebus

Basic results from Experiment 3 show the developmental progression from reading scrambled word and scrambled rebus texts. As seen in Experiment 2, as the grade increases, children have an increasingly easier time dealing with word and rebus targets. Differences between word and rebus targets were found for the fourth graders and adults, with the advantage leaning towards word targets.

Several analyses were conducted to investigate the primary variables: grade, format, repetition, and match of format between target paragraphs and filler paragraphs. The following analyses are organized to look at:

1. Grades 2 and college in both scrambled text and scrambled rebus formats in an omnibus ANOVA. Although this analysis employs all the data and will expose major trends, it is subject to dilution from the noise introduced by the tremendous overall changes in reading speed that occur across grade levels. Therefore, a second set of analyses was conducted to test the specific predictions of the experiment. These analyses involved:

2. Influences of repetition and match of format within each format for each grade. Specifically for hypothesis #5, one would expect significant interactions between repetition and match of format to support the notion that format mismatch should decrease benefit for adults as well as for younger readers. If rebus and text conditions are truly similar as found in Experiment 2, the same results should be found for rebus passages.

The first analysis was restricted to grades 2, 4, and MSU undergraduates so that both formats could be included and directly compared. A 3 x 2 x 2 x 2 ANOVA whose factors were grade (2,4, adult), format (rebus targets and text targets), repetition (0 and 2 repetitions), and match of formats (matched and mismatched) was run.

"Match" represents the relationship between the format of filler paragraphs and target paragraphs. A sequence consisting of 2 regular text fillers and 1 text target is "matched" in format, while a sequence consisting of 2 rebus fillers and 1 text target is "mismatched" in format. In this division of the data, main effects were significant for repetition $F(1,130)= 90.20$, $MSe= 39.30$, in which repeated targets were read faster than were new targets (Ms= 0rep= 29.42; 2reps= 23.94), and for grade $F(2,130)=137.81$, $MSe=311.03$, in which older students read faster than the younger students (Ms= gr2=43.70s; gr4=25.63s; adults=15.45s). No significant main effect for format or match of format was found. Three significant interactions were found. A grade x repetition interaction was significant at $F(2,130)=25.12$, $MSe=39.30$. A repetition x match of format interaction was significant at $F(2,130)=4.31$, $MSe= 22.43$, and finally, a format x grade x repetition interaction was found significant at $F(2,130)=14.62$, $MSe=39.30$.

The second set of analyses looked at the influences of repetition and match of format within each format, for each grade. A 2 (Repetition: 0,2) x 2 (Match of format: mismatch/match) ANOVA was run for each grade. Table 14 displays the results of these analyses.

Table 14. Experiment 3: analyses within each grade for each format.

SCRAMBLED TEXT TARGETS

Main effects for REPETITION (0 repetitions, 2 repetitions)

Grade	F	p	MSe	Difference in reading time 0 reps	2 reps
1	(1,15) = 21.6	.000	823.13	95.83	62.37
2	(1,15) = 17.23	.000	241.66	54.54	38.41
4	(1,15) = 13.41	.000	6.57	24.70	22.36
MSU	(1,31) = 68.85	.000	.673	14.49	13.28

Main effects for MATCH/MISMATCH of format

Grade	F	p	MSe	Difference in reading time Match	Mismatch
1	(1,15) =.717	NS	664.66	81.83	76.37
2	(1,15) = .556	NS	190.00	47.76	45.19
4	(1,15) = .461	NS	6.18	23.32	23.74
MSU	(1,31) = 8.00	NS	2.10	13.52	14.25

Repetition X Match of Format Interactions

Grade	F	p	MSe
1	(1,15) = .022	NS	169.05
2	(1,15) = .601	NS	105.82
4	(1,15) = 4.85	.044	7.45
MSU	(1,31) = 8.99	.005	1.43

Table 14. (con't)

SCRAMBLED REBUS TARGETS

Main effects for REPETITION (0 repetitions, 2 repetitions)

Grade	F	p	MSe	Difference in reading time	
				0 reps	2 reps
2	(1,15) = 8.48	.01	61.88	43.78	38.05
4	(1,15) = 26.90	.000	25.88	31.03	24.43
MSU	(1,31) = 54.71	.000	3.57	28.19	25.03

Main effects for MATCH/MISMATCH of format

Grade	F	p	MSe	Difference in reading time	
				Match	Mismatch
2	(1,15) = .100	NS	15.38	40.59	41.24
4	(1,15) = .161	NS	24.53	27.98	27.48
MSU	(1,31) = .231	NS	5.90	17.12	16.91

Repetition X Match of Format Interactions

Grade	F	p	MSe
2	(1,15) = .239	NS	65.19
4	(1,15) = 1.69	NS	11.01
MSU	(1,31) = .025	NS	4.09

The results from these analyses reveal that repetition as a main effect was maintained and that match of format made no difference for any of the grades or formats, with the critical exception of adults and fourth graders in the scrambled text target condition. In both instances, the interaction of repetition and match of format was significant [$F(1,31)= 8.99$, $p<.005$, and $F(1,15)=4.85$, $p<.05$, respectively]. Newman Keuls simple effects tests were performed on the repetition x match of format interactions, and Figures 13 and 14 depict the results. Comparing Figures 13 and 14 to Figures 7 and 8 indicates just how similarly the two types of text are processed. The subtle differences between the two experiments will be analyzed in the next section.

Experiment 2 vs. Experiment 3 Analyses: Comparing scrambled text to coherent text.

To look at the effects of context coherence on repetition benefit, additional analyses were necessary to compare these data to the baseline data on normal passages from Experiment 2. By comparing these two sets of data, one can clearly see the effects of coherence of a paragraph on repetition benefit. As in Experiment 3, two analyses were conducted, an omnibus ANOVA and then a series of separate ANOVA's for each format at each grade in order to eliminate the noise created by dramatic changes in overall reading speed. Hypothesis #6 would predict a nonsignificant coherence x repetition x match of format interaction for the beginning readers.

The first analysis included a 2 (Format: text vs. rebus) x 3 (Grade= 2,4, adult) x 2(Coherence/ Experiment: normal vs. scrambled) x 2 (Repetition: 0,2) x 2 (Match of format: mismatch, match) ANOVA. A main effect was found for grade, $F(2,332)=166.73$, $MSe= 269.52$, in which subjects in the higher grades read faster

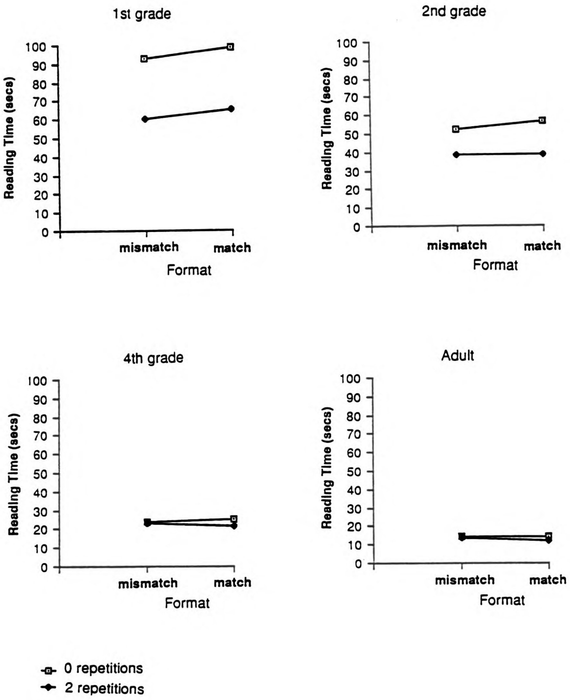


Figure 13. Developmental trends in processing scrambled all-word text targets

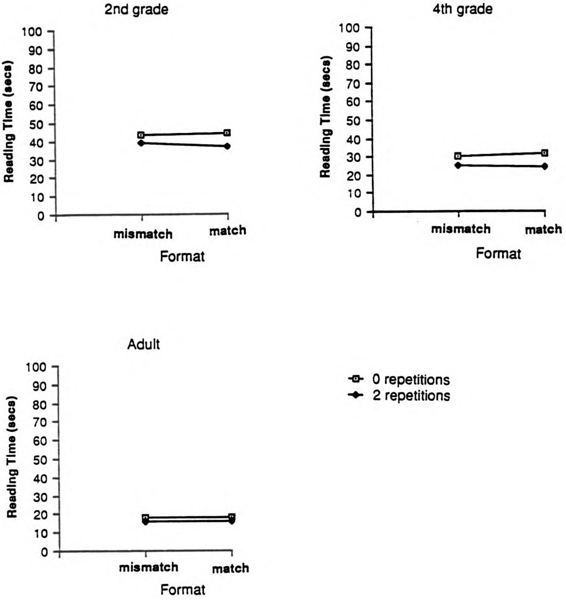


Figure 14. Developmental trends in processing scrambled rebus targets

than the younger readers (Ms= g2= 343.07s; g4= 21.16; ad= 13.07). Main effects were also found for coherence (Experiment), $F(1,332)= 134.59$, $MSe=269.52$, in which subjects read coherent paragraphs at a faster rate than scrambled paragraphs (Ms= coherent= 17.27s; scrambled= 28.26s), and for repetition, $F(1,332)= 177.97$, $MSe=44.77$, in which repeated targets were read faster than new targets (Ms= 0reps=25.34, 2reps=20.19). No main effect was found for format (text= 22.75 s, rebus= 22.78 s) or match of format (mismatch= 22.78, match= 22.75). This ANOVA yielded several significant interactions. A format x grade interaction was significant at $F(2,332)=6.48$, $MSe=269.52$, a grade x coherence interaction at $F(2,332)=20.71$, $MSe=269.52$, a grade x repetition interaction at $F(2,332)=40.51$, $MSe=44.77$, a format x grade x repetition interaction at $F(2,332)=15.09$, $MSe=44.77$, and finally a format x grade x coherence x repetition interaction at $F(2,332)=3.70$, $MSe=44.77$.

To illuminate in detail the developmental changes suggested by this four factor interaction, the second set of ANOVAs was run for each individual grade within each format. Match of format was added to investigate transfer of benefit across match/mismatch of format. For each grade, a 2 (Coherence: normal vs. scrambled) x 2 (Repetition: 0,2) x 2 (Match of format: mismatch, match) ANOVA was run for text targets and rebus targets. Table 15 plots the results for the main effects for coherence, repetition, and match within each format.

The results from this set of analyses revealed no significant coherence x repetition x match of format interactions. However, such an interaction would have been expected solely for the oldest readers and among MSU students reading text targets. A trend toward significance did occur at $p< .10$.

Table 15. Experiment 3: analyses comparing Experiments 2 and 3.

TEXT TARGETS

Coherence x Repetition x Match of Format Interactions

Grade	F	p	MSe
1	(1,50) = 1.14	NS (.291)	231.18
2	(1,50) = .48	NS (.492)	60.69
4	(1,50) = .25	NS (.617)	21.41
MSU	(1,66) = 3.19	NS (.079)	1.91

REBUS TARGETS

Coherence x Repetition x Match of Format Interactions

Grade	F	p	MSe
2	(1,50) = .05	NS (.818)	30.24
4	(1,50) = 1.63	NS (.108)	9.27
MSU	(1,66) = .01	NS (.905)	2.77

Discussion

Experiment 3 used a priori ANOVA analyses to provide a more powerful test of the hypotheses, unlike Experiments 1 and 2, which were exploratory in nature. Post hoc analyses may have yielded different results, but in the interest of power, an a priori approach was better suited to this experiment. Experiment 3 continued to produce developmental trends as found in Experiments 1 and 2, where younger readers read at a slower rate for both formats, and subjects continued to benefit from repetitions, even though paragraph coherence was destroyed. When higher-order linguistic organization was removed from the stimuli, creating word and rebus lists rather than texts, repetition benefits from the words and rebus stimuli were no longer equal.

The two sets of analyses of variances were conducted to provide an omnibus analysis and then to systematically narrow the focus on match and mismatch of format between target passages to filler passages and repetition for each grade within each format. With each set of analyses, repetition remained a main effect throughout. The first four-factor (grade x format x repetition x match of format) ANOVA found that the scrambling manipulation influenced benefits from repeated readings. Significant differences were found between grades and between repetitions, and although format as a single factor was not significant, its interactions with grade and repetition were significant. One critical result was the significant repetition x match of format interaction, which indicated that perhaps the match between targets and fillers was necessary for readers to benefit from repeated readings. This interaction appeared although match of format as a single factor was not significant.

The second set of analyses were run to determine how each grade behaved within each format, and they yielded very different results within each format. Once again, repetition remained a main effect for each grade within each format. Within the scrambled text target condition, match of format was significant for adults, and repetition x match of format interactions were found for fourth graders and adults. These results were not found for scrambled rebus targets, which would indicate that older readers are somehow processing the two types of text very differently. The results support past single-stimulus studies, since these data yield similar patterns. The paradigm appears to detect differences between picture-word and word-word repetition benefit commonly observed in single-stimulus processing.

Figures 15 and 16 depict the developmental trends in processing scrambled texts and scrambled rebuses. The figure compares repetition x match interactions for each of the grades in each format. When subjects read the text "lists", it appeared that match of previous fillers and target passage made no difference in each repetition for the younger grades, but by grade 4 and for the adults, match influenced benefit. For the older readers, exact repetitions of the same format led to benefit from repetitions. If the formats were mismatched, repetition made less difference in reading time of the target paragraphs. This is more clearly evident with the adults and the two repetition conditions. Mismatched formats accrued less benefit than those that were matched in format. The reverse trends appeared when subjects read rebus "lists". The second graders needed exact matches of format in order to benefit from repetitions, whereas the match of format made no difference for the older subjects.

With the evidence from Experiment 2 on how each format is read by each of the grades, the format with which subjects have an easier time processing makes a difference in how much benefit is accrued, but it is important to note that this finding

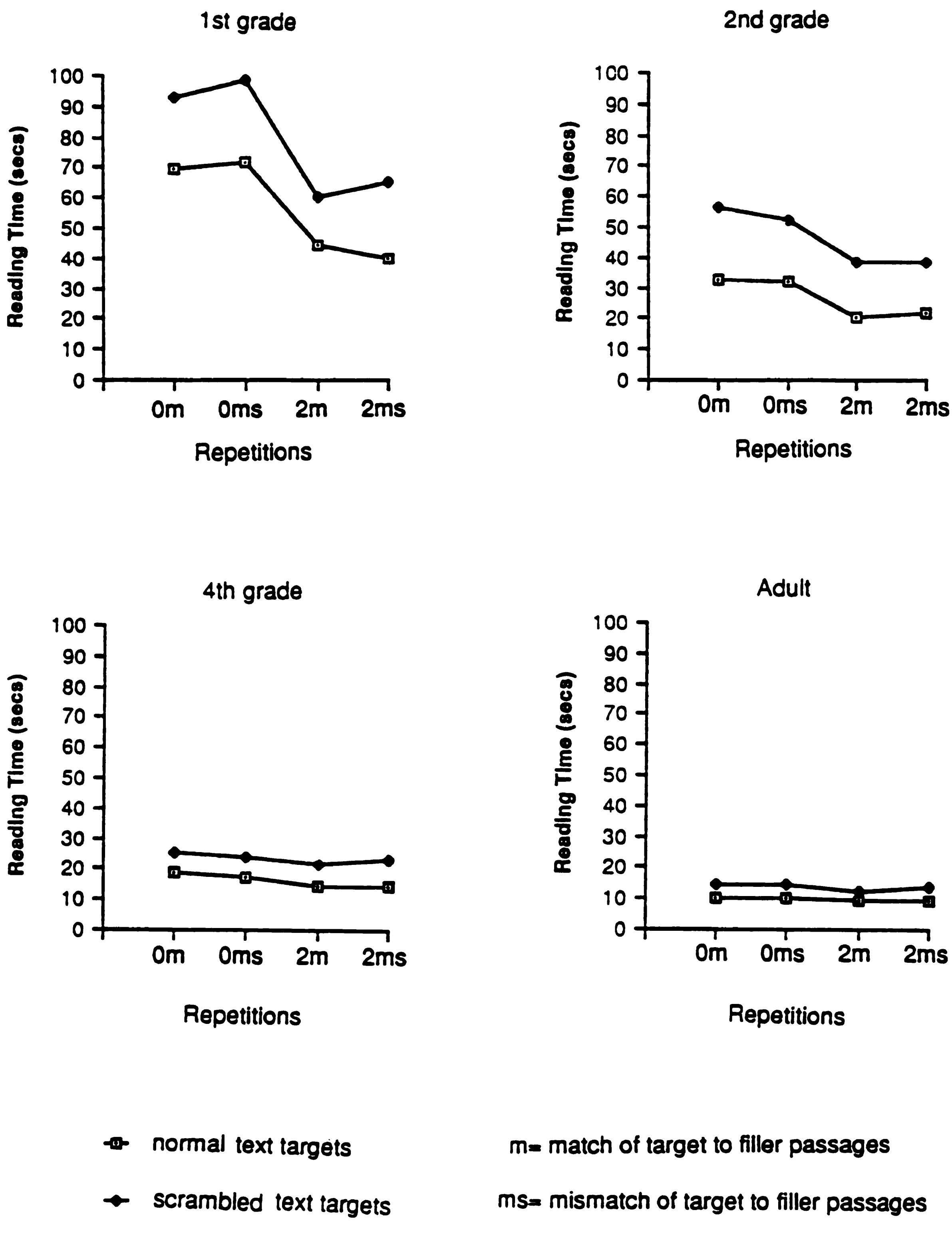


Figure 15. Comparison of normal vs. scrambled text targets within each grade

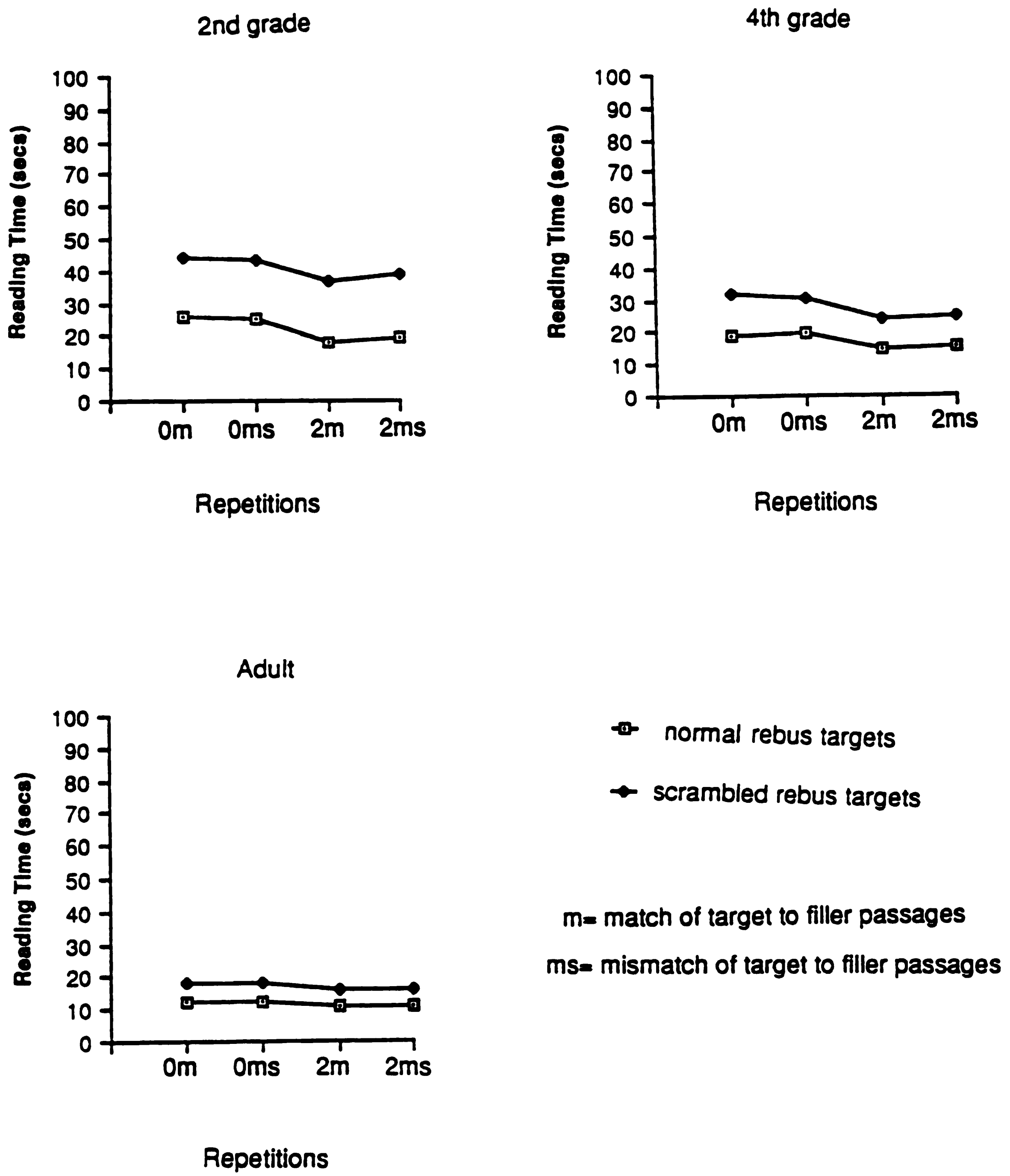


Figure 16. Comparison of normal vs. scrambled rebus targets within each grade

applies only in the case of scrambled all-word texts. For example, fourth graders and adults have more facility with reading texts. They would need exact repetitions of the same format from which to benefit. Older readers have less experience with rebuses. For these readers, it does not matter whether preceding paragraphs match or mismatch the target paragraphs--benefit still results. The reverse is true for second graders who have an easier time processing rebus texts. They need exact matches of repeated passages in order to benefit, but for texts, they are still at the level of word-by-word processing and match or mismatch of preceding texts does not influence how much they benefit to read the target paragraph. They benefit regardless of match of format between fillers and targets.

Hypothesis #6 noted that younger readers should show greater benefit from one list to another because they are accustomed to reading word-by-word. The results support this prediction, but benefit depends on format. Adults appear to be disrupted when they read scrambled text because they cannot build a whole-text representation, to which they are accustomed. Younger children continue to benefit from lists because they are at a reading level at which text-level representations are absent. For younger readers, word level representations appear to support the transfer.

These data also support Carlson, Alejano, and Carr's focal attention hypothesis, which noted that when attention is devoted to processing the entire text, repetition benefits are sensitive to word scrambling, which disrupts higher levels of text processing, at least among adults. This result supports hypothesis #5. By using the scrambling manipulation in this experiment, readers were forced to process the words individually, and this benefit accrued at the level of individual words only. The reading systems for these children appeared to be less able to control the level of analyses that creates a representation of a text.

Experiment 2 vs. Experiment 3: the effects of context on repetition benefit

Comparing the data between Experiments 2 and 3 provides evidence for the way context coherence influences repetition benefit, the way context influences the way pictures are processed, and how context influences the processing of text. Hypothesis #6 predicted that younger readers should show no differences between Experiments 2 and 3 if they process text at a word-by-word level. If there is a difference between experiments, readers are using top-down processing at a young age. The prediction stated that older readers should show differences between processing scrambled and normal text.

In the five factor analysis including all grades, format, coherence (Experiment 2 or 3), repetitions and match of format, coherence, grade and repetition emerged as significant main effects. The following interactions were also found significant: format x grade, coherence x grade and grade x repetition. Finally, a four way interaction between format, grade, experiment, and repetition was also found in this overall analysis. The data were then analyzed separately for each grade within each format, to look further into the differences between experiments and to focus specifically on the predictions made about match of format.

Within both all-text and rebus conditions, the second set of ANOVAs was performed to specifically target the coherence x repetition x match of format interactions. None of the three-factor interactions were significant, which indicated that grade was the cause of the significant four factor interaction yielded from the first ANOVA. If one ignores the planned tests in the results of Experiment 3 and the trend toward the three-factor interaction among adults reading text targets, then one would conclude from this overall analysis that transfer occurred equally, regardless of match/mismatch of format, for all grades. In turn, this would suggest that benefit is controlled by an abstract level of lexical processing rather than that text representations drive benefit.

Taking account of evidence of match/mismatch effects, rather than ignoring them, leads to a different conclusion. Figures 15 and 16 summarize and illustrate the effects of context on repetition for all grades for each of the types of text. It is easy to see the advantage processing normal text has over processing scrambled text, but the effect of match has greater impact on the adults' reading lists of words. For adults to benefit from repetitive readings of lists, the same list has to be presented prior to the target list. This was not true of adults reading lists including pictures. The difference in naming times, as proposed by Potter and Faulconer (1976), shows that picture-word equivalence is not evident here. They are processed differently, as in single stimulus studies.

The data show developmental trends that indicate the transition from bottom-up processing having an influence on repeated readings to top-down processing influences. For older readers, context is needed for readers to benefit from multiple readings in which format mismatches. Experiment 3 showed that there is a progression from benefit from word level that develops into benefit that accrues from text level processing. As the child gets older, top-down processing increasingly comes into play.

In summary, the results from Experiment 3 support the idea that abstraction across changes in surface form is greater when text is being read by advanced readers than when single words are being read. The increased scope of transfer results from the higher levels of semantic, syntactic, and thematic processing that are engaged by text.

CHAPTER VI.

GENERAL DISCUSSION

Results from the experiments may be summarized as follows: First, the use of rebus passages and text passages is a useful tool to examine picture-word transfer, and to examine transfer of repetition benefit at the semantic-referential level of processing. It can be used as a way to document developmental trends in reading speed, reading accuracy, and magnitude of repetition benefits for the two types of text. First graders read rebus texts much faster than regular texts. This is consistent with the idea that object and picture recognition are already well established and interfaced with oral language skills among beginning readers. Both types of texts, however, benefited from repetition. As grade level increased, absolute reading times and the magnitude of repetition effects decreased, consistent with much other work on improvement of cognitive skills with development and practice. By fourth grade, regular texts were being read somewhat faster than rebus texts. This is consistent with the adult pattern found by Potter and colleagues in their oral reading data. It is also consistent with a large number of studies of naming single words and pictures.

Second, Experiment 2 put these tools to use to assess conceptual-referential transfer between the two types of text. As expected, adults and fourth graders showed complete semantic-referential transfer between pictures and words. Rebus texts produced just as much repetition benefit as did regular texts. Surprisingly, however, the same pattern was observed with the two youngest groups of readers. Although the first graders were much slower overall than the fourth graders or adults, they showed complete conceptual-referential transfer of repetition benefits from rebus to regular text reading. Thus even at a quite early stage in the acquisition of reading skill, when print-specific encoding operations are still relatively immature and unpracticed, an abstract conceptual level of processing leaves an enduring representation of its activities that can guide subsequent rereading. These abstract processes guide repetition-based learning, allowing connections to be made across perceptually different experiences even during a period of reading development when perceptual properties are a primary object of learning. This guidance is effective even when the rereading requires new perceptual operations to deal with radically different visual surface forms and therefore overlaps with past reading experience only at the abstract, conceptual level. One may conclude that mastery of print-specific encoding operations takes place in the context of a larger system whose goal is to comprehend current experience and integrate it with past experience at the level of underlying meaning, not simply at the level of surface form. This larger system can guide the operation of the reading system, apparently from the very beginning of the reading system's development.

Third, Experiment 3 provided evidence to show that this paradigm can detect the difference between picture-word and word-word repetition benefit that is commonly observed in single-stimulus processing. When higher-order linguistic organization was removed from the stimuli, creating word and rebus lists rather than texts, repetition benefits from word and rebus stimuli were no longer equal for all subjects. The results show that for adults, abstraction across changes in surface form is greater when text is being read than when single words are being read. Perhaps the increased scope of transfer results from higher levels of semantic, syntactic and thematic processing that are engaged by text.

Returning to the key question--the nature of memory representations that help drive reading as a skill that improves with time-- this section will pull together the major theories to provide a picture of reading as a developing skill.

The experiments add to the literature on the storage of pictures and words; the question was addressed as to how people represent verbal and imaginal concepts in memory, and when children can abstract meaning from print and extract the same meaning from a picture. Evidently, development begins as early as first grade. The results from these experiments offer support for Potter's (1979, 1986) conceptual store theory regarding mechanisms involved in the abstract similarity of meaning and reference that exists between a picture of an object and the object's printed name.

With these developmental data, adding to the already-established adult data, one can speculate about the way words and pictures are processed within this model. The data fit with the conceptual store theory (Potter, 1979; Potter, Kroll, Yachzel, Carpenter, & Sherman, 1986) from the onset--where meaning is available only in a common conceptual system and both verbal and imaginal stores have direct access to an amodal store. Advanced readers named pictures more slowly because it required an extra step to activate the verbal/lexical store. Pictures accessed meaning as rapidly as words because both are connected to the conceptual representation. Children as young as six have amodal memory stores that become more readily accessible by verbal material as reading experience and skill increase, and an abstract conceptual level of processing enabled the reader to benefit from multiple readings. The names given to words and pictures, even for the youngest readers, may be processed differently, but once a meaning is activated, the reader can process a word integrated into a sentence as well as he/she can process a picture integrated into a sentence or text level representation.

In line with the existing theories of concept acquisition, the data have the characteristics of how children's representations of pictures and words change as they mature. One can see the growth of children's ability to understand the cultural symbols of speech and written language. As they mature, they learn to use different symbols for the same referent, as their lexicons gain more information about sound orthography and articulation. This was supported by the trends in Experiment 2, where younger children had better facility at processing pictures, and as they got older, understood that words represented concepts and objects. This was seen with older, more experienced readers who were better able to read all-text passages. The modes of representation evolve from concrete objects to more abstract representations. Since benefit was observed, the results showed that pictures of objects and their names were equivalents--their shared meaning drove benefit.

With this series of experiments, a picture emerges on reading skill, where we gradually come to store pictures and words according to the conceptual model by the time we are adults. So how does our experience with pictures and words get placed into storage? What is the nature of our representation in memory and how does it drive reading as a developing skill? The experiments introduced the use of repetition benefit to assess developing reading skill. By looking at the improvement as the result of repeated perceptual, cognitive and motor tasks, one can see what components or levels of processing increase the accuracy of reading performance (Fitts & Posner, 1967, Logan, 1979, Newell & Rosenbloom, Schneider, & Shiffrin, 1977). The results from the experiments support the abstractionist viewpoint, where the memory storage that supports a skill like reading is categorical and highly generalizable. One could see in Experiment 2 that exact repetition in every detail is not necessary for the developing reading system to apply a past encounter to a present one in an efficient manner. The rebus passages provided a drastic change in surface form, where the meaning was preserved, and yet even the youngest readers were able to benefit from mismatched series of passages, for example, a word target preceded by rebus fillers. The results from these experiments support Carr, Brown, and Charalambous' (1989), finding that repetition benefit shows insensitivity to typographical manipulation. Experiment 2 showed that benefit was insensitive to pictures replacing words, and Experiment 3 provided evidence that benefit was insensitive to contextual variation--even random lists gain benefit from repetitions. Subjects were able to benefit from repetition regardless of any of these manipulations, providing support from the abstractionist view. The question then remains as to what levels of processing are responsible for benefit.

As noted in the literature review, the experiments by Carr et al. (1989) and Levy and Burns (1990) concluded that repetition benefit does not arise solely at the word level; nor does it arise solely from retrieval of processing records by cues from higher levels of linguistic organization. Carlson, Alejano, and Carr (1991) provided a compromise , suggesting that certain reading strategies influence the locus of repetition benefit. Subjects in Experiment 3 were forced to focus their attention on word level processing, reading random lists, and the locus of repetition benefit was found in the processes that supported lexical recognition and articulation. The repetition of individual words was enough to facilitate subsequent reading for all grades, and for the youngest children, relatively complete abstraction across changes in surface form still occurred at this level. However, among adults, abstraction across changes in surface form was greater when text was read than when single words were read.

Carlson, Alejano, and Carr's conclusion that the level of focal attention was correct only for coherent texts was supported by these data. For their subjects, the repetition effect was dependent on linguistic organization, where matching organization, in which first reading were scrambled in the same way as the target, resulted in substantial facilitation. Their scrambled targets behaved differently when they were preceded by a coherent text, a manipulation that was not part of the present experiments. For the current data, the linguistic structure of the target appeared to play a large role in determining the nature of repetition benefit, and the level of analysis at which benefit accrued was dependent on the strategic approach and reading skill level of the reader. Fourth graders and adults demonstrated greater ease in processing scrambled texts over processing scrambled rebuses, and they needed exact repetitions of the same format to benefit from repeated readings of scrambled text targets. If the formats mismatched, the number of repetitions made no difference in target reading times. The data from Experiments 2 and 3 showed that word recognition skills had to be above a certain level in order for the reader to process texts at higher contextual levels. This was seen with first graders who had no difficulty processing scrambled texts or rebuses, since they were at a word-by-word level of reading ability. The results support the suggestion extrapolated from Carlson, Alejano, and Carr's findings with adults that repetition of words might be the primary basis for improvement in rereadings among beginning readers.

This series of studies of developmental changes in reading skill, falls in line with the literature on the general course of children's reading development. One can plot the growth in speed of children's ability to read written language and to understand abstract concepts. Children learn that words represent concepts and objects, learning about the object's conceptual referent, its qualities as an object, and the relation between the two. One can see this in the convergence of lines of reading text and rebuses in Figure # of Experiment 1. With this method of plotting developmental changes, once can see the transition children experience, from paying attention to decoding to extracting meaning from text, and this is shown in the way the scrambled texts were read in Experiment 3. Adults had more difficulty processing scrambled lists because they were well practiced at reading coherent texts, and scrambling interfered with their natural reading. The youngest children were more focused on word-by-word processing, thus scrambling made no difference in how they benefited from repetitions.

Alternatively, the results may suggest that instead of children gaining the ability to transfer from pictures to words as they improve their reading skills, adults lose this ability. Adults may need the support of text to get full transfer, whereas children get it for random lists and texts alike. Children's visual word recognition gains in skills, perhaps getting compartmentalized or modularized, requiring specific text processing to "free" it from its compartment.

This brings us back to the general question of what memory representations are responsible for driving reading as a skill that improves with time. The answer involves issues regarding learning in semantic memory, addressing how repetitions are recognized so that accumulation of episodic experiences can occur. With the understanding that visual stimulus properties might provide crucial retrieval cues to guide such accumulation, we have tried to identify factors that influence the scope of transfer of repetition benefits across variation in visual surface form. The results conclude that one factor is the familiarity of the surface form of the word currently being processed, and another is whether the current word is part of a text and is participating in higher levels of semantic, syntactic, and thematic processing. A third factor may be the already accumulated semantic familiarity of the word itself, with surface form specificity being more pronounced early in lexical learning but giving way to greater abstraction as codes in semantic memory become better established. In the case of scrambled lists, the opposite was found true. Surface form specificity became more pronounced as the reader became more skillful at integrating words or pictures into text. The adults needed specificity of surface form in order to benefit from repeated readings when those reading lacked higher-order textual organization.

The experiments explained in this thesis have provided an array of tools with which to analyze the inner workings of repetition benefit for developing readers. Additional questions can be raised and answered using this paradigm that includes rebus manipulations. Two such experiments have been proposed to add to the basic results found in these exploratory experiments. A brief review of the ensuing experiments will follow, some of which are currently in progress.

It is possible that the results for Experiments 2 and 3 were due to memory aided guessing on the part of the subjects. It is possible that the subjects used top-down processing of the stories that enabled them to improve with each repeated reading. In order to further assess the level of processing responsible for benefit, a cloze task could be incorporated into the basic design for Experiments 2 and 3. Cloze tasks are used to measure strategies used during on-line reading, where readers are instructed to fill in blanks in a story with appropriate words. To fill in the missing words, subjects need to look forward and backward in the text and make inferences from the semantic and syntactic context. The use of context in cloze tasks has been found to be positively related to comprehension, but not necessarily to other aspects of reading, such as word recognition (Stanovich, 1982b). For this proposed experiment, the cloze task will investigate whether or not conceptual representations are at work in a top-down fashion when stories are repeatedly read.

In this experiment, the use of context in constructing meaningful text will be assessed with a standard cloze task, where the key words/ "rebus' terms are replaced with blanks. The subjects will be instructed to read the passages aloud as quickly and clearly as they can, and to fill in the missing blanks with appropriate words. Text and cloze passages will serve as target readings, with rebus and texts as first passages. All conditions will be single repetitions, and responses to the cloze task will be scored as right or wrong based on the match between the original words and the responses given. Only exact matches will be counted as correct. With these results, one can hope to assess facilitation from memory driven processes. One can see whether or not the different types of text (rebus or all-words) yield the same benefit, or provide more benefit to filling in the cloze blanks.

Alternatively, one might challenge the use of rebus texts as a feasible text manipulation. Some may argue that the drastic change in surface form is responsible for benefit, for it stands out so much more clearly than the rest of the text. It is possible that subjects paid special attention to the pictures within the text, which enabled them to improve with each repeated reading. To see whether this special text manipulation was responsible for benefit, another comparable change in surface form could be used: replacing rebus pictures with words enlarged to roughly the size of the pictures, in all capital bold-faced letters. This would provide a way to make the target words stand out without changing their status as printed words. The basic design would follow that of the cloze task, except that the so-called "bold" texts would replace rebus texts in the previous design. Comparisons between rebus texts and bold text could be made. If the two types of text behave the same, then the drastic change in surface form may be a factor in subjects' processing of the text, functioning to call extra attention to the altered or highlighted lexical item. If the two texts behave differently, then rebus texts remain a viable alternative manipulation of text surface form that preserves meaning and reference of words. Both of these proposed extensions are currently underway, with the adult sample recruited from Introductory psychology students from Michigan State University. By Spring of 1993, additional first and second graders from the Lansing area will be included to provide a developmental profile to these experiments.

These extensions will hope to provide more pieces to the complex puzzle of reading development, to further assess what the child brings to the reading experience, and how knowledge and performance are affected as reading skill develops and matures. The series of experiments offered in this thesis has attempted to provide an alternative method of assessing the acquisition of reading skill, tracing the young reader's ability to generalize from one individual experience to another. This is quite an accomplishment of the young child, to master reading of a language that he/she has only heard and spoken, learning to extract linguistic information from a line of squiggles.

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