response items which were high, medium, and low in codibility, i.e., letters, geometric shapes, and abstract shapes. Three sets of fifteen paired associates were presented to each subject in one of six counterbalanced orders. Subjects were tested after one study trial of each set. Stimuli were presented individually; the correct response was selected from among three items on a separate response card. Scores were the total number correct on each set. Data were analyzed by a 2 (Reader Group) x 3 (Task) x 6 (Order) repeated measures analysis of variance. Performance of poor readers was significantly lower than that of good readers on all three tasks. These data suggest that poor readers have an associative learning deficit for material presented visually which is unrelated to its codibility. These results support earlier work demonstrating visual perceptual learning difficulties in poor readers; they are not consistent with studies proposing deficits in visual-verbal learning only. However, codibility of material presented initially was found to differentially affect reader groups' scores on subsequent paired associate tasks. This finding is discussed in terms of differential usage of visual and verbal coding strategies for good and poor readers.

To evaluate label production ability, both reader

groups' knowledge of labels and latencies to name visual materials in Experiment I, were assessed. Materials were presented individually in random order to all subjects; labels and latencies to name were recorded. Data were analyzed by a 2 x 2 x 4 repeated measures analysis of variance. Results indicated no significant differences between reader groups on either label knowledge or latencies to name any of the materials. These data suggested equivalent label production ability for both reader groups. Similarly, there were no significant differences between good and poor readers on either observed or reported use of verbal labeling strategies during learning tasks.

Poor readers' ability to use verbal labeling as a mediational strategy in visual paired associate learning was also examined under an instructional condition. Half of each reader group received instruction in verbal labeling while the other halves of each group did not. Subsequent performance on a new set of paired associates was found to be lower for both good and poor readers who received verbal labeling instruction. The data were analyzed by a 2 x 2 x 3 analysis of variance. Since order of task presentation differed for the two groups, results were interpreted as effects of experimental fatigue.

Results of the investigation suggest the existence of a visual associative learning deficiency in poor readers. Poor readers showed no evidence of a label production deficit over a variety of visual materials. These data do not exclude the possibility of verbal mediational deficiencies in poor readers. Implications for remedial education, including the need to attend to both visual perceptual and verbal coding problems are discussed. The importance of recognizing unique learning styles among subgroups of reading disabled children is emphasized.

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Reading disability is consistently cited as a major factor in academic under-achievement. Five to fifteen percent of North American public school children have been estimated to have reading problems (Hallgren, 1950; Rabinovitch, 1968; Gomez, 1972). Research has suggested a large number of variables related to reading difficulties. Such factors include intelligence, cultural disadvantage, sensory deficits, lack of educational opportunity, perceptual factors, and organic brain damage. Each child's reading problem may be related to deficits in one or more of these areas. Furthermore, the deficits may vary from mild to severe in degree. Given the large number of factors which could contribute to reading disability, recent investigators have tried to define relatively homogeneous samples of poor readers. A discussion of definitional problems related to research in reading disability is presented in the Background Section. The present study is concerned with children who fail to read at grade level inspite of average intelligence, adequate home and educational environments, good emotional adjustment, and normal neurological status.

The main purpose of the present study is to investigate the role of verbal factors in visual paired associate learning of such poor readers. The impetus for such a study was provided by a recent controversy between researchers who hold perceptual and/or intersensory deficit views and those who support visual-verbal deficits as characteristic of poor readers. The perceptual deficit hypothesis links poor reading to an inability to adequately process sensory information, particulary visual, required in the process of reading. Studies of perceptual deficits tend to focus on errors of spatial orientation and form perception. Comprehensive reviews of these studies by Benton (1962, 1975) concluded that such visual perceptual deficits do characterize reading retardation in younger school children, especially those below the age of ten years. Benton suggested that in older children, disturbed "form perception" and "directional sense" might be associated with a lack of implicit verbal mediational strategies required for optimal performance.

The intersensory integration hypothesis, proposed by Birch (1962), suggests a general deficiency in translating and equating information from one sensory modality to another. For example Birch (1962) predicted that poor readers would have difficulty translating auditory information to an equivalent visual pattern. Two lines of research have modified this hypothesis. First, as Zigmond (1966) pointed out, it is difficult to know whether the observed dificits in an intersensory paradigm are truly intersensory or are due to a deficit within one sensory modality. Secondly, Blank and Bridger (1966) suggested that covert verbal labeling was used by good readers in the paradigm while poor readers did not use such verbal mediational devices.

For many years, both the visual perceptual and intersensory integration hypotheses were widely accepted as explanations of reading disability in young children. In spite of the fact that investigators had directed attention to the role of verbal factors in these situations, the perceptual nature of the deficit continued to be emphasized.

Recently, two lines of evidence have served to focus more interest on verbal and verbal mediational factors in perceptual paradigms. First, Vellutino and his colleagues (Vellutino, Steger & Kandel, 1972; Vellutino, Pruzek, Steger & Meshoulam, 1973a; Vellutino, Steger & Pruzek, 1973b; Vellutino, Harding, Phillips & Steger, 1975a; Vellutino, Smith, Steger & Kaman, 1975b; Vellutino, Steger, DeSetto & Phillips, 1975c; Vellutino, Steger, Harding & Phillips, 1975d; Vellutino, Steger, Kaman & DeSetto, 1975e) have conducted a series of studies purporting to show that reading disability is characterized by visual-verbal rather than visual-visual or intersensory deficits. Vellutino suggested that children with reading problems perceive letters and words accurately but mislabel them in oral reading because of difficulty associating visual symbols with their verbal responses. It is difficult to compare Vellutino's studies to studies of perceptual and intersensory deficit. In most of his studies, Vellutino used older subjects, usually ten years or more, in spite of Benton's (1962, 1975) conclusion that perceptual deficits occur more commonly in children less than ten years of age. One goal of the present study is to explore the effect of learning verbal versus nonverbal material in younger good and poor readers.

A second research area, critical to this study, is the work on verbal mediation and verbal rehearsal strategies in visual perception, learning, and memory. Although this work has emphasized normal developmental trends, it should have some importance in understanding the problems of poor readers in visual perception paradigms. Another goal of the present study is to investigate verbal mediational factors in the visual paired associate learning of good and poor readers.

Background

The first section of the Background reviews literature aimed at defining reading disability and highlights three variables which must be controlled in the present study: intelligence, age, and sex. The second section deals with traditional, early research on perceptual deficits in poor readers. The third section reviews the work on intersensory integration, especially visual-auditory integration. Special emphasis is given to work by Blank and Bridger (1966) and Blank, Weider and Bridger (1968) on verbal rehearsal strategies in the visual-auditory paradigm.

The final section of the Background reviews studies of Vellutino's (1979) work on visual-verbal deficits in poor readers as well as recent investigations on verbal mediational strategies in visual perception and memory.

Definition of Reading Disability

Although there is general agreement that a high incidence of some form of reading disability exists in the school aged population, there is considerable ambiguity in clearly defining this group of children. Children may be classified as poor readers because they have difficulty on any one of several different kinds of activities required for good reading.

A variety of terms have been used interchangeably to refer to reading problems, even though they are not synonomous (Batemen, 1966; Ingram, 1969; Applebee, 1971). Some of the major ones include: "reading retardation", "reading disability", and "dyslexia".

"Reading retardation", the most broad term, encompasses "any individual who does not score at or above the norm for his age on valid tests of reading" (Gunderson, 1969, p. 544). This definition does not account for etiology but does include children with low intelligence as well as those who are educationally and culturally deprived.

"Reading disability", is a more specific term referring to a smaller group of children who "fail to learn to read with normal proficiency despite conventional instruction, a culturally adequate home, proper motivation, intact senses, normal intelligence and freedom from gross neurological deficit" (Eisenberg, 1966, p. 360). The criterion of one year below grade level is generally required (DeHirsch, 1965; Eisenberg, 1966) although Rabinovitch (1968) suggests a reading delay of at least two years for children above ten years.

The term "dyslexia" has been used interchangeably with "reading disability". The World Foundation of Neurology Research Group on Developmental Dyslexia defines it as follows: "Dyslexia is a disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence, and socio-cultural opportunity" (Critchley, 1970). However, in most cases, dyslexia implies a neurological etiology. Money (1966) defines dyslexia as "imperfectly developed reading skill or deterioration of skill without its total absence (alexia) as a result of brain lesion or dysfunction", (p. 377). Since most diagnoses of dyslexia in children are based on behavioral rather than neurological evidence, the only real difference between the label "dyslexia" and the term "reading disability" is that dyslexia implies an organic etiology. However, the many studies which have attempted to link some form of brain dysfunction to specific reading difficulties, have failed to provide any practical information relevant to educational or remedial practices (Batemen, 1964). In a recent discussion of etiology, Yule (1976) suggests that the label "dyslexia" serves little purpose other than to stress the severity of the problem.

The problem of definition is complicated by the fact that researchers have not been consistent in their use of these terms. Furthermore, many researchers have failed to be explicit about criteria used in defining samples (Lavers, 1972; Torgesen, 1975). Because of these difficulties, it seems essential to choose a specific definition which has been accepted by other researchers. The subjects in the present study will be chosen to fit the definition of reading disability of DeHirsch (1965), Eisenberg (1966) and Vellutino et al. (1973a, 1973b). Reading disabled children in this study are defined as having reading ability at least one year below grade level in spite of normal intelligence, adequate home and school environments, good emotional adjustment, and absence of gross brain damage. It is acknowledged that this definition does not suggest a homogeneous sample of children nor imply a unitary explanation of the disability for all poor readers. However, it is possible to examine general tendencies of such a reading disabled group and to identify variables which might be important contributing factors to poor reading in some children.

Given the definition of reading disability selected for this study, three variables - intelligence, age and sex for subjects require further comment. First, the attempts to control for intelligence in other investigations and the problems which have arisen from these attempts are reviewed. Secondly, there is a discussion of the relationship of age to perceptual factors in reading disability. Finally, studies of sex differences and reading disability are described.

Intelligence

Many of the studies of perceptual deficit have simply failed to control adequately for intelligence. Others have made educated estimates about the IQs of their subjects. Kastner and Rickards (1974) noted that New York State Law prevented access to IQ data; they had teachers indicate that each subject had at least normal learning ability. Morrison, Giordanni and Nagy (1977) stated that their subjects were of average ability but did not report how intelligence was measured. In a series of studies, Vellutino et al. (1972, 1973a, 1973b, 1975a, 1975b, 1975c, 1975d, 1975e) attempted a more rigorous control for intelligence.

Vellutino administered the Wechsler Intelligence Scale for Children (WISC) to all subjects and required that each child earn either a verbal or a performance IQ of 90 or above for inclusion in his studies. Although this procedure is reasonable in view of the definition of reading disability employed in both Vellutino's and the present study, the resulting groups of good and poor readers were not of equivalent intelligence. In most of his studies, the verbal IQs of the good readers were significantly higher than those of the poor readers (Vellutino et al., 1972, 1973b, 1975a, 1975b, 1975c, 1975d). In another study, both the verbal and performance IQs of good readers were significantly higher than the

IQs of the poor reader group (Vellutino et al., 1973a). The relevance of these findings of verbal-performance score differences is discussed in the Methods Section. Vellutino included the resulting group IQ differences in his studies but used statistical techniques to partial out the effects of different intellectual levels.

It would seem more parsimonious to attempt to equate both good and poor reader groups on a measure of intelligence prior to the experimental treatment. Such a procedure will be followed in the present study. To achieve this goal, it seemed reasonable to select subjects on the basis of a global IQ measure rather than following Vellutino's criterion of <u>either</u> an average verbal <u>or</u> performance IQ. An additional rationale for attempting to equate groups on a global IQ measure is given in the Methods Section. This reason is related to the study's goal of investigating verbal factors in perceptual learning paradigms.

<u>Age</u>

One factor infrequently discussed in connection with defining reading disability is age. However, several investigators have noted that factors related to poor reading seem to differ according to the age of the child (Reed, 1968; Sabatino & Hayden, 1970). Birch and Belmont (1965) examined intelligence and reading ability in a large sample of children whose chronological ages ranged from five to twelve years. Their results suggested that in the initial stages of learning to read, factors such as perceptual ability were important, while in later stages, general intellectual ability became more salient. Benton (1962) reviewed a large number of studies relating perceptual deficit to poor reading. He concluded that perceptual deficits characterized reading disabled children less than ten years of age. Later investigations (Benton, 1975) supported the existence of perceptual errors in poor readers from 7½ to 9 years of age. However, there is less agreement about perceptual deficits in older reading disabled children. While Benton (1962) found no evidence to support perceptual deficits in poor readers older than ten years, other investigators have argued that perceptual deficits exist in children as old as twelve years (Morrison et al., 1977).

In terms of the goals of the present study, it would seem reasonable to choose subjects in the 7½ to 9 years old range where there is substantial agreement that perceptual errors and poor reading are related. We can then proceed to investigate the influence of verbal factors on such perceptual problems.

Sex Differences

It has long been noted by clinicians that reading disability is more common in boys than in girls. Many different hypotheses have been raised to account for this fact. These hypotheses include the idea that reading disability is a sex-linked or genetic trait; that biological differences between boys and girls resulting in greater vulnerability to trauma and slower neurological maturation account for the greater frequency of learning disabilities in boys (Bentzen, 1963); and the idea that reading disability is related to higher cultural expectancies for boys. Regardless of which of these hypotheses or combination of hypotheses is finally accepted, the literature is consistent in finding more boys than girls in the poor reader groups. Kopel and Geerded (1933) found that seventy-eight percent of referrals to reading clinics were males. Bender (in Hoch & Zubin, 1958) noted that the number of boys showing reading problems was several times that of girls. Bentzen (1963) cited evidence that learning problems appeared as much as ten times more frequently in boys than in girls. The decision of whether to include boys only or some combination of boys and girls in the poor reader group varies from study to study (Applebee, 1971; Cruickshank, 1972; Vellutino, Smith, Steger & Kaman, 1975b). Since the literature reports the disability to be more common in boys, the present sample was restricted to males.

Visual Perceptual Deficits

Since reading disorder was first described (Morgan, 1896; Hinshelwood, 1917), the major focus has been on a visual perceptual deficits explanation. The perceptual deficits hypothesis suggests that although the child "sees" the visual symbols accurately, a disruption of information processing results in visual and spatial distortions of letters and words. Many etiologies have been postulated to explain such perceptual errors e.g. delayed hemispheric dominance (Orton, 1925, 1937); inherited directional confusion (Hermann, 1959); dysfunction in visual analysis and sequencing (Birch, 1963); perceptual-motor problems (Kephart, 1960; Cruickshank, 1968; Frostig & Maslow, 1973) and optical deficiencies (Getmann, 1962; Anapolle, 1971). The common link has been that reading disability was primarily the result of problems in visual organization and memory. The implication was that the disorder had an organic base.

Many studies have examined the validity of proposed etiological factors. However, more important to the present investigation are those studies which attempt to establish that visual perceptual errors differentiate poor and good readers. The purpose of this section of the review is to determine whether there is empirical support for a deficit in visual perceptual learning in poor readers, and if so what qualifying conditions are related to this deficit.

Clinical observations of poor readers have traditionally focussed on errors of spatial orientation of letters and words as a major difficulty (Bronner, 1917; Orton, 1925, 1937). Such observations have historically played a major role in describing and treating reading disabilities. Their influence is strong, even today. Many remedial educational programmes have been based on the interpretations of these observations. As early as 1925, Orton noted that while reading, poor readers made reversal and sequencing errors. He proposed that such letter and word reversals (e.g. "b/d; was/saw") were the result of delayed hemispheric dominance (Orton, 1937). This explanation was widely accepted for many years (Bender, 1956, 1957, 1975), although empirical attempts to link hemispheric dominance to reading ability by evaluating left-right identification problems in poor readers proved inconclusive (Harris, 1957).

Although the strongest support for perceptual errors comes from such clinical observations, a variety of paradigms has been used to investigate spatial orientation problems in poor readers: e.g. visual-motor visual matching, and visual perceptual learning. The current section reviews studies using such visual paradigms.

The majority of such studies have employed a visual-motor paradigm, requiring the child to copy letters of similar shape but differing orientation (e.g. b/d, p/q, n/u) (Fabian, 1945; Bender, 1957; Lachman, 1960). In general, poor readers reversed or rotated more letters than good readers when symbols were presented either orally (Fabian, 1945) or visually (Bender, 1957). Although some investigators believed that the spatial orientation errors were specific to copying letters (Gates, 1922; Orton, 1925), others had noted visual perceptual errors in the copying of other materials, such as geometric forms, in a wide age range of poor readers, 7 - 14 years (Galifret-Granjon, 1952; Silver & Hagin, 1960). Goins (1958) found pattern copying and discrimination of reversible forms also correlated highly with reading ability in first grade children, while orientation errors were observed in poor readers' copying of numerals and muscial symbols (Hermann, 1959). Such studies suggested that the spatial orientation problem of poor readers was not specific to letter perception but might reflect a more basic deficit in visual form perception.

However, this controversy remains unresolved since many of these early studies can be criticized for definitional and methodological inconsistencies. The common finding over a variety of conditions was that poor readers demonstrated visual perceptual errors. Since the studies reviewed so far employed a visual-motor paradigm, which required a motor response, it is erroneous to conclude that such deficits are a result of visual perceptual problems alone. Many other factors in cross modality paradigms could account for such results. Neilsen and Ringe (1969) further criticized accepting visual-motor errors as a unique characteristic of reading problems in view of their finding that neither type nor distribution of such errors significantly discriminated poor from good readers. In order to support the idea that visual perceptual errors are characteristic of poor readers, studies utilizing other types of paradigms require review.

In spite of the focus on visual perceptual deficits, there are surprisingly few studies utilizing purely visual paradigms. Conclusions regarding visual perceptual errors and reading have been based on widely disparate stimulus-response conditions. Whether perceptual errors exist for poor readers in paradigms other than those requiring motor response has been an issue of considerable debate, although data is sparse. The few studies which have selected purely visual perceptual paradigms have been of two main types: visual matching and visual associative learning. In general, most studies using both paradigms supported clinical observations; when poor readers are required to learn visual material, they have more difficulty than good readers.

In an early study, using a visual letter matching task, Davidson (1935) found that most preschool children (nonreaders) confused letters of similar shape but different orientation. White (1968), using the same letter matching task, found that 7½ - 9 year old children who continued to confuse letters, were poor readers.

Studies utilizing visual perceptual learning paradigms have also demonstrated deficits in poor readers' performance on a variety materials. Both Roberts and Coleman (1958) and Whipple and Kodman (1969) found that poor readers, ages 9 - 12 years had significantly more difficulty than good readers in learning visual nonsense syllables and scribbles. Similarly Otto (1961) found that poor readers ages 7 - 11 years, had short term associative learning deficits for familiar shapes and nonsense syllables. Although this deficit was evident in a variety of learning conditions, the difference was significant for visual-visual learning. Two studies suggested age as a qualifying factor in poor readers' perceptual learning. Lyle and Goyen (1968) and Goyen and Lyle (1971a) determined that performance decrements on the visual recognition of unfamiliar shapes were specific to younger poor readers, 7½ to 8½ years.

Although there has been support in the literature for a relationship between perceptual errors and reading ability, studies can be found to the contrary (Silverman, 1962; Shankweiler, 1963). Silverman (1962) found no evidence of perceptual learning deficits in poor readers ages 9 to 11 years on visual associative learning tasks; Shankweiler (1963) failed to detect significant differences in the tachistoscopic form perception of good and poor readers with a mean age of 10½ years.

Although there is still considerable controversy over accepting a simple form of the perceptual deficits hypothesis, some conclusions do seem warranted. Even after addressing criticisms of methodology and failure to adequately control for intelligence, both individual studies and reviews of such studies suggest that perceptual deficits do characterize poor readers. However, two factors qualify such a statement and require further study. These two factors are age of subjects and verbal factors.

Benton's (1962) review concluded that spatial orientation errors did occur in poor readers, but that they were specific to age. Visual perceptual errors have been more commonly reported in younger children (below nine years). Later studies have confirmed this conclusion (Lyle & Goyen, 1968; Sparrow & Satz, 1970; Goyen & Lyle, 1971a). As well, Goyen and Lyle (1971b) have possibly defined the basal age at which such perceptual errors are important for poor readers. They were unable to find perceptual deficits in the visual associative learning of very young poor readers, 6 - 7 years of age. In an updated review, Benton (1975) concluded that: "The importance of visuo-perceptive and visuo-motor difficulties as determinants of reading failure has been over estimated by some authors." (Benton, 1975, p.15). However, he continued to argue that perceptual errors characterized younger poor readers, 7½ - 9 years. Evidence for perceptual errors in older children was limited.

Both early studies and more recent research suggest that the "perceptual errors" (e.g. orientation and directional confusions) of poor readers may be related to verbal factors (i.e. verbal encoding of letters) rather than to primary perceptual distortions (Liberman, Shankweiler, Orlando & Berti, 1971; Vellutino, Steger & Kandel, 1972). Although the issue of verbal characteristics of the stimulus material had been raised as early as 1917 (Bronner, 1917), it had never been evaluated empirically in visual perceptual learning paradigms. Both Gates (1922) and Orton (1925) suggested that the spatial errors of poor readers were unique to verbal material (letters). Other investigators had observed perceptual learning deficiencies in a variety of "nonverbal" visual materials (Fildes, 1921; Goins, 1958; Hermann, 1959). For example, Fildes (1921) found deficiencies in poor readers' learning of Greek symbols and their spoken associates while Hermann (1959) detected visual perceptual errors in poor readers' copying of both numbers and musical symbols. More recently, Liberman et al. (1971) alluded to the importance of verbal factors in noting that the majority of sequencing, reversal and orientation errors observed in second grade poor readers were of accoustically similar letter pairs ("b/t") rather than of optically reversible pairs ("b/d"). These observations strengthen the conclusion that verbal factors require further investigation if we are to adequately interpret results of "perceptual paradigms". Although the issue of the verbal-nonverbal characteristics of stimulus materials used in paired associate learning paradigms is not new, the controversy continues. These early suggestions about the importance of verbal factors provided impetus for Vellutino and his colleagues to empirically address the verbal-nonverbal issue. In the present investigation, Experiment I is devoted to examining the effects of learning verbal and nonverbal visual materials in good and poor readers.

Verbal mediation has also been mentioned as an important factor in the perceptual learning of older poor readers (Benton, 1962). Such ideas encouraged Vellutino et al. (1972) to question the role of verbal mediation in both older and younger poor readers. However, definitions of verbal mediation in perceptual learning situations have been vague. Systematic attempts to investigate verbal mediational strategies in poor readers are notably lacking. In the current study, both the Labeling Measure and Experiment II are attempts to clarify the role of labeling and verbal mediational strategies in good and poor readers.

Prior to discussing work on verbal factors, the current review will examine studies using intersensory paradigms. Many conclusions about visual perceptual learning and reading have been based on the child's ability to associate material presented to two sensory modalities. Studies of intersensory integration and reading ability are included in this review for several reasons. Historically, the idea of intersensory deficits preceeded the verbal deficits notion and such paradigms were used in many of the earlier studies. Secondly, most of Vellutino's work on verbal factors has used an intersensory paradigm. Thirdly, studies of intersensory integration also highlight the fact that verbal factors may play an important role in intersensory learning.

<u>Intersensory Integration Deficits</u>

Several investigators have proposed that reading disability is related to deficits integrating information between various modalities. Although the idea was first suggested by Bronner (1917), empirical studies were not performed until the 1960's. Research relating the integration of sensory information to the reading process has focussed mainly on visual-auditory integration, an analogue to the oral reading process (Myklebust & Boshes, 1960; Birch, 1962; Birch & Belmont, 1964, 1965; Beery, 1967; Johnson & Myklebust, 1967; Bryden, 1972; Vandevoort & Senf, 1973).

In 1964, Birch and Belmont introduced a paradigm for measuring auditory-visual integration in which subjects were asked to associate auditory rhythmic patterns and corresponding visual dot patterns. These investigators found that normal readers, aged nine and ten years, performed significantly better on such a task than poor readers matched for age and intelligence. Although subsequent studies have suggested that auditory-visual deficits may be most prevelent in younger poor readers (grades one and two) (Birch & Belmont, 1965), there is general support for audiovisual integration deficiencies in poor readers from 7 to 13 years of age (Sterritt & Rudnick, 1966; Beery, 1967).

These results are similar to those reported using paradigms which involved visual perception and/or visual-motor skills. A correlational relationship exists between intersensory integration deficits and poor reading. However, controversy exists regarding the nature of this relationship. For example, several investigators have pointed out that intersensory performance was confounded by within modality deficits in poor readers (Zigmond, 1966; Bryant, 1968; Vandevoort & Senf, 1973; Vellutino, Steger & Pruzek, 1973; Rudel, Denckla & Spalten, 1976). Failure to control for within modality deficits was first suggested by Bryant (1968) on the basis of results of a study of paired associate learning in poor readers which demonstrated deficiencies on several measures of within modality (auditory) functioning (Zigmond, 1966). Similarly, a study minimizing the short term memory factor found poor readers impaired on both auditory-auditory and visual-visual within modality matching tasks as well as cross modality (auditory-visual) matching (Vandevoort & Senf, 1973). Results of these studies suggest that the reader group differences in intersensory functioning reported in the earlier studies may be explained by basic within modality deficits.

Another factor which may be related to auditory-visual integration deficits and possibly to within modality perception as well, is short term memory. Since most intermodal matching tasks involved a consecutive presentation of stimuli, some investigators have suggested that the poor readers' deficient performance on such tasks is due to difficulty in holding onto the separate sets of incoming stimuli rather than to deficiencies in intermodal transfer (Senf, 1969; Senf & Feshbach, 1970; Senf & Freundl, 1971). Other researchers, however, failed to demonstrate any short term memory deficits in dyslexics (Vandevoort, Senf & Benton, 1972).

In this regard, it is of interest to examine another set of variables, verbal factors, which may influence reader groups differentially on auditory-visual tasks (Blank & Bridger, 1966; Sterritt, Camp & Lipman, 1966; Blank, Weider & Bridger, 1968; Kastner & Rickards, 1974).

Blank and Bridger (1966) and Blank, Weider and

Bridger (1968) observed that good readers coded visual information verbally, on a task analogous to Birch and Belmont's (1965) auditory presentation of temporal sequences of tones. Poor readers did not label the visual stimuli; their performance was significantly lower than good readers. Sterritt, Camp and Lipman (1966) also suggested that the ability to apply a verbal label to an overtly nonverbal, visual or auditory stimulus (e.g. "two dots, three dashes") mediates to aid recall. An inability to verbally code visual stimuli was proposed as an explanation for the poor readers' deficient performance on intersensory perceptual tasks.

The idea that the ability to verbally code the visual stimuli employed in perceptual learning tasks is related to reading ability challenges simple forms of both the perceptual and intersensory integration deficit views. Those who propose a relationship between verbal coding ability and reading ability conclude that poor readers' deficiency in employing verbal coding skills contributes to their lower performance on these tasks. The ability to apply or use verbal labels either overtly or covertly, with different types of visual stimuli, may be an important aspect of reading ability in younger readers. It has been suggested by many investigators that both verbal labeling and mediational factors in such perceptual paradigms require further study.

So far, we have reviewed studies which focused on perceptual and intersensory deficits in poor readers. The remaining sections of the review deal more directly with studies which have attempted to elucidate verbal factors in such perceptual paradigms. These studies can be divided into two types. The first group of studies deal with the problem of trying to clarify how the verbal versus nonverbal nature of stimuli affects perception, sensory-integration, learning and/or memory. Recent research in this area is exemplified by the series of studies by Vellutino and his colleagues (Vellutino et al., 1979). These studies are reviewed under the heading visual-verbal hypothesis.

The second group of studies to be reviewed deals with verbal labeling and verbal mediational strategies. In spite of Benton's (1962) review and the work on mediational factors in auditory-visual integration, there has not been extensive study of verbal mediational factors in poor readers. However, new work in the development of verbal mediation and its use in perceptual and memory paradigms in normal children does seem relevant to understanding the deficits shown by poor readers. This work is discussed in the section entitled verbal mediation and labeling. Finally, the few studies which have attempted to look at such variables in poor readers are discussed.

Visual-Verbal Deficits

As previously noted, there is a long standing controversy in the learning disability literature regarding whether poor readers show visual perceptual deficits when learning both verbal and nonverbal material (Fildes, 1921; Goins, 1958; Hermann, 1959) or on verbal material only (Gates, 1922; Orton, 1925). Recently, Vellutino (1979), reported a number of studies which attempt to determine whether poor readers have learning and memory problems which are specific to "visual-verbal" material. Vellutino suggested that poor readers perceive letter and word symbols accurately but mislabel them because of a primary difficulty in associating visual symbols with their verbal responses.

Before reviewing Vellutino's work, it is necessary to clearly define what is meant by visual and verbal stimuli. In some studies, letters and words, presented visually were defined as verbal stimuli and contrasted with various symbols, geometric or abstract forms, which are defined as nonverbal. On the other hand, Vellutino has at times used verbal synonomously with the term spoken or oral responses. Others have defined as verbal, those stimuli which can be named or labeled. Given this definition, a geometric design such as a circle is a verbal stimulus. In the following review, an attempt is made to distinguish between these three definitions of "verbal". The studies in this section of the review are also often confounded by the fact that visual-verbal paradigms may differ in mode of stimulus-response presentation. Visual-verbal may refer to visual-visual or visual-auditory learning. The presentation modes will also be carefully noted. In addition to clearly defining these terms, it is necessary to divide Vellutino's work into two categories: that which deals primarily with rejecting perceptual deficits in poor readers and that which studies the nature of the "verbal" deficit.

In several studies, Vellutino attempted to demonstrate that poor readers do not have visual perceptual deficits. Vellutino, Steger and Pruzek (1973b), using both nonverbal within modality tasks (visual-visual and auditory-auditory) and nonverbal across modality tasks found neither deficient intrasensory nor deficient intersensory functioning in older poor readers, 9½ - 11½ years. These "nonverbal" visual materials were symbols which did not resemble letters; auditory materials were sounds. Since the authors admitted that these findings were specific to older poor readers and that deficits in either intra- or intersensory functioning may characterize young poor readers, this study fails to provide strong evidence for rejecting the perceptual deficit hypothesis.

In another attempt to negate the perceptual deficit hypothesis, Vellutino, Pruzek, Steger and Meshoulam (1973a) required good and poor readers, aged 9½ - 12½ years to recall, by copying, complex, unfamiliar visual stimuli (Hebrew letters) of varying lengths. Both reader groups made the same number of copying errors. It was concluded that poor readers had intact visual perception. However, both the older ages of these subjects and the use of a potential confounding visual-motor response, limit acceptance of this conclusion.

Similarly, Vellutino, Steger and Kandel's (1972) original study, used older poor readers (10-13 years). "Verbal" stimuli were 3, 4, and 5 letter words and scrambled letters. "Nonverbal" stimuli included geometric designs and numbers. Stimuli were presented visually to good and poor readers who were then compared across a number of response modes, including visual recognition, oral pronunciation, spelling, and copying. Although good and poor readers showed no differences on copying most stimuli (shapes, numbers, and 3 and 4 letter words), poor readers pronounced and spelled all of the words less accurately than the good readers. These findings also encouraged Vellutino to reject visual deficits in poor readers. Once again, subject age and the requirement of visual-motor responses, limit accepting Vellutino's interpretation of his results. Since the mean age of poor readers was 11.6 years, the failure to find perceptual deficits is consistent with past research. The finding that poor readers could not pronounce (i.e. read) or spell is not surprising.

In an attempt to address the criticism of age, two studies were conducted (Vellutino, Smith, Steger & Kaman, 1975b Vellutino, Steger, DeSetto & Phillips, 1975c). Vellutino et al. (1975b) reported a modified version of the Vellutino et al. (1972) study, which included a sample of good and poor readers in grade 2 as well as grade 6. The same words and scrambled letters were used as the verbal material; codible geometric shapes and numbers presented visually were defined as nonverbal material. Even at the 7½ year level, poor readers generally performed as well as good readers in copying these stimuli. In contrast, poor readers of all ages did not perform as well as good readers on pronouncing words. Poor readers in the second grade did poorly on correctly naming scrambled letters, 4 and 5 letter words, and numbers. With regard to the perceptual deficits hypothesis, these results are inconsistent with earlier studies which demonstrated visual-motor task differences for young poor readers. As previously indicated, the use of a visual-motor task as a measure of visual perception raises some problems. Similar effects on a purely visual perceptual task remain to be demonstrated. Another explanation may be that performance on perceptual tasks was equalized when poor readers were matched with good readers having average performance IQ scores. In view of these criticisms, the rejection of perceptual deficits in young poor readers is unwarranted. On the other hand, the letter naming difficulty exhibited by the poor readers in grade 2 is an important finding and will be discussed in connection with verbal deficits.

The other study including younger children as subjects (Vellutino et al., 1975c), improved on earlier work by comparing good and poor readers' visual memory for sets of unfamiliar Hebrew letters, one, two, and three items in length. Good and poor readers, grade 2, 4, and 6, were found to be similar in their ability to recognize such nonverbal stimuli in both immediate and short term memory conditions. Although this study has some methodological problems, particularly inadequate equation of verbal IQs in the two reader groups, it does provide some support for visual-perceptual adequacy of poor readers with such stimuli.

In summary, five studies have been reviewed in which Vellutino and his colleagues have sought to refute perceptual deficits in poor readers. Only one of the five studies actually demonstrated adequate visual perception in poor readers 7-10 years (Vellutino et al., 1975c). On the basis of this study some doubts about the visual perceptual deficit hypothesis can be raised. It would seem that well controlled replication of studies showing such deficits is in order. Experiment I of the present investigation attempts to demonstrate performance decrements in poor readers on visual paired associate learning tasks.

In a second series of studies, Vellutino addressed the issue of the nature of verbal deficits in poor readers. He attempted to specify the conditions in which poor readers experience such deficits. Some evidence from his previously reviewed study (Vellutino et al., 1975b) pointed to visual-verbal difficulties, i.e. difficulty in reading or pronouncing words, and difficulty in naming letters, particularly for younger readers.

Vellutino, Harding, Phillips and Steger (1975a) attempted to show that poor readers had deficits unique to a visual-verbal learning condition. As an analogue of the oral reading process, good and poor readers, aged 10 years, were required to learn to associate visual material to "verbal" responses. "Verbal" material included pronouncable, nonsense syllables while visual stimuli were abstract designs with low association value. Oral responses were required for the nonsense syllables and recognition responses for the visual material. The finding that poor readers' performance was significantly lower than good readers' on visual-verbal tasks only, again suggests that poor readers have deficits in visual-oral learning conditions.

In another study, Vellutino, Steger, Harding and Phillips (1975d) suggested that poor readers in the fourth, fifth and sixth grades learned visual-verbal pairs less well than good readers. Various "nonverbal" stimuli, i.e. ambiguous pictures, unfamiliar shapes, and novel script were presented for learning; responses were either oral "verbal", pronouncable nonsense syllables or oral "nonverbal" stimuli (e.g., cough, hum, etc.). Results indicated that poor readers performed poorly in a visual-auditory paradigm when auditory responses were "verbal".

In summary, Vellutino concluded that poor readers make errors only when they must associate spoken, oral responses to visual stimuli. The visual stimuli may be letters, numbers or abstract designs. The salient factor is the oral response. Vellutino further argued that the nature of the oral response may be a factor in the performance of poor readers on learning and memory tasks. He concluded that poor readers are deficient only if the oral response required is "verbal". The "verbal" responses he has defined include letters, words and pronouncable nonsense syllables. Given these conclusions, Vellutino's work provided only a limited basis for a study of the role of verbal mediational factors in perceptual learning.

Aside from Vellutino's work, there are few studies related to the verbal-nonverbal content of stimuli in learning paradigms with poor readers. Since Brewer (1967) used an auditory-visual paradigm, his results are not directly relevant to the present study. Morrison, Giordanni and Nagy (1977) provide the only study using a purely visual recognition paradigm. Morrison et al. (1977) assessed both information processing and short term memory of good and poor readers. Letters and geometric shapes were defined as verbal stimuli.

Abstract shapes were designated as nonverbal stimuli. Poor readers, 12 years of age, were proficient in the early stages of visual information processing, but demonstrated short term visual recognition deficits for both verbal and nonverbal stimuli. Interestingly, this study used subjects who were older than those for whom perceptual deficits are commonly found. The findings support the idea that poor readers have a general perceptual learning deficit which is not limited to letters.

Verbal Mediation and Labeling

Although systematic study of verbal mediation has not been extensive, both Benton (1962) and Vellutino et al. (1972, 1973a, 1973b) have suggested that mediation may be a factor in influencing the perceptual learning of poor readers. Before reviewing studies with either normal or disabled readers, some definitions of terms are presented. As might be expected, there are many definitional inconsistencies in the literature. For the purpose of this review, the following definitions will be used.

In general, mediation implies a "perceptual" or verbal response to aid in learning or memory (Kendler, 1963). Mediational strategies can be visual, verbal, or both. In the present study, mediation refers to the use of verbal codes in visual learning and memory.

The term labeling has two usages in the context of the current study. First, it describes the process by which a child gives labels (names) to visual stimuli. Secondly, it can refer to a type of mediational strategy, i.e. the application of labels to stimulus materials to facilitate learning and memory. In general, use of such a strategy is called verbal rehearsal. Codibility is closely related to labeling and refers to the ease with which verbal codes can be applied to visual materials. In the present investigation, codibility is empirically defined through assessment of whether children can produce labels to specific visual materials and by measurement of the speed with which children are able to generate such labels.

The theory that verbal coding mediates perception was proposed by Brown and Lenneberg (1954) and Lantz and Stefflre (1964) who demonstrated with adults that codibility of a visual stimulus correlated positively with the degree of its recognition. Myklebust and Brutten (1953) in demonstrating that deaf children were deficient in their performance on visual perceptual tasks, both in matching and recognition, suggested that normal performance is dependent on a well established verbal code.

It has been suggested that verbal mediation follows a developmental pattern (Reese, 1962). There are stages during which normal children have not learned to use it. The literature indicates at least three developmental stages. Kendler (1963) defined the earlier phases:

Mediation Deficiency: Children who do not spontaneously show signs of mediation and who fail to use verbal labels even when they are provided. Such deficits would characterize younger children who either do not have certain labels or who do not use the labels they do possess to mediate.

Production Deficiency: Children who fail to label spontaneously but who are able to use verbal labels as mediators when instructed to do so.

The final stage would be mediational ability, characterized by both possession of labels and spontaneous use of such labels to facilitate perceptual learning and memory.

Research supports the idea that the development of spontaneous verbal rehearsal strategies in learning and memory, is age dependent (Reese, 1962; Kendler, Kendler & Carrick, 1966; Flavell, Beach & Chinsky, 1966; Flavell, 1970). Investigators have attempted for some time, using a wide variety of cognitive tasks, to determine the mediational role played by childrens' verbal productions (Stevenson, 1972). Reese (1962) found that four year olds were able to produce verbal responses (labels) to visual stimuli but were unable to use these responses as mediators in a new task. Flavell et al. (1966) determined that five year olds showed little covert verbalizations or labeling on a sequential memory task, using familiar picture as stimuli while ten year old children spontaneously used verbal rehearsal to facilitate recall. Wright and Vliestra (1975) suggested that developmental improvement in memory in older children is related to "mature, logical perceptual search, often dependent on verbal processes or imagery which contribute to effective rehearsal and retrieval" (p. 225).

In general, studies support the developmental stages. Of primary importance for purposes of this review is the developmental progression, rather than specific age levels. While there is some debate over the age at which these strategies develop spontaneously, most of the evidence suggests that children as young as four years are able to produce labels, but may not be able to use them effectively as mediational strategies until ten years or more. Although these age limits are generally accepted, there are exceptions in certain conditions.

There are some examples of studies indicating that very young children can use labels to facilitate learning (Nelson & Kosslyn, 1976; Scarborough, 1977); however, the critical age for occurrence of spontaneous verbal mediation may vary with the experimental situation. Nelson and Kosslyn (1976) demonstrated that children as young as five years of age were able to recognize significantly more pictures and shapes which had been previously labeled than unlabeled ones. This finding seems to provide indirect support for the idea that young children are able to mediate spontaneously. Scarborough (1977) also found that children as young as five to six years were able to spontaneously generate name codes to pictures and that those children who did so, recognized more pictures than children who did not use name codes. Since this finding was not general for all five to six years olds, and was specific to a long term memory condition, it is not inconsistent with developmental trends.

Several studies have examined childrens' ability to use mediational strategies when verbal labels are made available, but specific verbal instruction is not provided. Cramer (1976) found that developmental trends were accounted for by an increasing number of subjects choosing a verbal mediational strategy as a function of age. Using a recognition paradigm to determine the relative dominance of visual and verbal memory organization at two age levels, 6 and 9 years, Cramer found visual coding was the predominant strategy used by six year olds while 9 year olds were as likely to encode visually as verbally. This study also tested the ability of children to use labels to improve their memory for pictures. The fact that provision of labels failed to improve the performance for either age group, is consistent with the developmental progression of mediation and suggests that a clear preference for using verbal strategies effectively may not emerge until after nine years.

Keeney, Cannizo and Flavell (1967) addressed the question of whether specific verbal rehearsal instruction facilitated the memory of children who do not rehearse spontaneously. Keeney et al. (1967) showed that non rehearsers as young as six years could be taught to rehearse by instruction and practice in the use of overt verbalizations; such training also improved their recall. Since these children did not continue to rehearse when instruction was discontinued, they can be said to have production deficits. In a recent review of developmental memory research, Reese (1976) concluded that only with failure for verbal instruction to facilitate childrens' learning or memory can a true mediational deficiency be determined. A production deficiency can be defined when verbal training does improve learning or memory.

Although age levels for the various stages of mediational developmental are not specific even in normal children, the literature suggests that production deficiencies are evident approximately between the ages of 7 and 9 years. Studies indicate this to be an age range in which children are more likely to use labels in learning and memory tasks. It is also the age at which specific verbal training may have a facilitating effect on performance. Research has not yet clarified the conditions under which children of these ages spontaneously select mediational strategies.

There have been relatively few studies, even of normal children, examining verbal mediation with visual materials other than easy to label pictures. One of the main aims of the present study is to examine verbal mediational factors in poor readers' learning of visual materials, both easy and difficult to label, e.g. letters, geometric shapes, and abstract shapes. In many of the previous studies supporting visual perceptual deficits, poor readers were found to be deficient in their learning of such materials. Since studies have not directly assessed the codibility of visual materials, its role in the perceptual learning of poor readers remains unclear. An important question to be asked in the present investigation is whether labels for such materials as letters, geometric shapes, and abstract shapes are equally available to poor readers. Before making assumptions about poor readers' performance in visual learning situations, we must be assured that their verbal code for these stimuli is well established. Several studies of pre and early readers have indicated that letter naming (labeling) is highly related to reading ability (Muehl & Kremenak, 1966; Jansky & deHirsch, 1973).

Investigators have previously suggested that poor readers may experience a deficiency in the use of verbal coding strategies in intersensory paradigms (Sterrit, Camp & Lipman, 1966; Blank & Bridger, 1966; Blank, Weider & Bridger, 1968; Rudel, Denckla & Spalten, 1976). As well, Benton (1962) indicated that implicit verbal mediation may be relevant to visual perceptual problem solving, but specified this for older poor readers, ten years and above. Only a few attempts have been made to link specific verbal mediation (labeling) strategies to reading ability using visual paradigms (White, 1968; Kastner & Rickards, 1974). Both studies suggest that an important variable may be the child's ability to activate appropriate labels in learning paradigms. White (1968), using the Davidson letter matching task (Davidson, 1935) with two instructional conditions, visual matching alone and visual matching with letter names provided, found that poor readers aged 7 - 9½ years made more errors on visual matching alone. Good readers made no errors in either instructional condition. When asked to name the letter and to match it, poor readers knew the letter names and were able to use them to facilitate performance. These results can be interpreted as evidence for a production deficit in poor readers of this age range and stress the importance of labels as mediators in perceptual learning situations.

Only one study attempted to evaluate the effects of codibility of visual stimuli used in perceptual tasks.

Kastner and Rickards (1974) found that the recognition memory of poor readers, nine years of age, was inferior to good readers when stimuli were unfamiliar shapes, low in codibility. There were no significant differences in recognition between good and poor readers when stimuli were highly codible, familiar objects. Covert verbal labeling strategies were assessed by observations of lip movements and inquiry following performance. Children were classified as verbalizers and nonverbalizers. Analysis of rehearsal strategies indicated most good readers maintained a consistent verbal strategy in both high and low codible conditions, while poor readers switched from a verbal to a visual strategy in the low codible condition. These results provide evidence of deficits for poor readers, in this age range, in their tendency to effectively use verbal rehearsal strategies in certain learning conditions.

While there are no other studies directly assessing verbal mediation in the learning and memory of poor readers, many have suggested ineffective verbal rehearsal as a factor (Kleuver, 1971; Samuels & Anderson, 1973; Tarver, Hallahan & Kaufman, 1976; Bauer, 1977; Kagen, 1979). For example, Tant (1979) interpreted her finding that both hyperactive and reading disabled children (8 - 10 years of age) were significantly poorer than normals on solving visual maze learning tasks, even after verbal rehearsal instruction, in terms of mediational deficits. Kagen (1979) reported that teaching verbal rehearsal strategies to reading disabled boys significantly increased their recall for orally presented digits. Since this study used older subjects, 12 years, and an oral learning condition, it is not directly relevant to the study of verbal factors in visual perceptual learning.

In summary, a review of studies of reading disabled children also provides little evidence to clarify the role of labeling, covert verbal rehearsal or effective use of verbal instruction in perceptual learning. Together, these three factors support the idea that verbal mediation may be a variable in good and poor readers' differential performance on visual perceptual learning tasks. Both verbal factors and labeling have been related to reading ability in normal children; however, studies of label production ability and use of mediational strategies are notably sparse for poor readers. The focus of the present study is to examine these variables in more detail in reading disabled children.

Statement of the Problem

The perceptual deficit hypothesis predicts that poor readers will have difficulty on a number of visual perceptual tasks including paired associate learning and recognition memory tasks. According to reviews by Benton (1962, 1975), visual perceptual deficits characterize poor readers, 7½ to 10 years of age. Recently, Vellutino et al. (1972, 1973a, 1973b, 1975a, 1975b, 1975c, 1975d, 1975e) have challenged the perceptual deficit view. These investigators have tried to show that the performance of good and poor readers does not differ in visual perceptual learning, when no oral verbal responses are required. Vellutino's studies can be criticized on several accounts. Most important to the current investigation is that for the most part, Vellutino has utilized subjects older than ten years of age in his studies. Therefore, it is difficult to accept his negation of perceptual deficits in younger poor readers. However, Vellutino's work has raised some doubts about whether perceptual deficits exist in poor readers. Even Benton criticized the methodological deficiencies in many of the early visual perceptual studies. It seems reasonable to investigate the performance of good and poor readers on a visual perceptual learning task when age and intelligence are well controlled variables. One purpose of Experiment I is to determine whether 8 and 9 year old good and poor readers of average general intelligence differ in performing a visual paired associate learning task. On the basis of Benton's reviews (1962, 1975) and the present literature survey, it is predicted that poor readers will do more poorly on such a task than will good readers.

It has also been suggested that poor readers are deficient on visual tasks only when stimuli such as letters or words are involved (Gates, 1922, Orton, 1925). Other investigators have argued that perceptual errors are typical of poor readers with a wide variety of stimuli including geometric designs and abstract shapes (Fildes, 1921, Otto, 1961; Brewer, 1967; Gascon & Goodglass, 1970; Rudel, Denckla & Spalten, 1976; Morrison, Giordanni & Nagy, 1977). Resolution of this controversy has been obstructed by the fact that age, intelligence, and sex of subjects differs from one study to another. Furthermore, many studies have not been limited to visual learning or visual memory paradigms but have included visual motor and intersensory designs. The second purpose of Experiment I is to compare the visual paired associate learning of good and poor readers under three response conditions; letters, geometric shapes and abstract shapes. Familiar pictures are used as stimuli in all three conditions. It is interesting to note that early studies defined letters as verbal stimuli and designated geometric shapes and abstract shapes as nonverbal. According to the definitions of codibility in the present study, both letters and geometric shapes have names and would be classified as verbal stimuli. Abstract shapes are those without a common name. Since the literature lacks consistent evidence to clarify the role of codibility in the perceptual learning of poor readers, no prediction concerning the direction of the effect is made. This part of Experiment I is exploratory.

In addition to asking whether perceptual errors of poor readers are unique to particular stimuli or involve both "verbal" and "nonverbal" stimuli, several other questions related to verbal factors in perceptual learning of poor readers were raised by the literature survey. Several lines of evidence have suggested that the visual perceptual performance of poor readers might be influenced by verbal mediational factors. Benton (1962) suggested mediational deficiencies in poor readers older than ten years. Blank and Bridger (1966) proposed that verbal mediational strategies were used by good but not by poor readers to facilitate visual-auditory integration. Vellutino et al. (1975b) suggested that labeling deficiencies and difficulty in rapidly transforming visual stimuli to covert verbal labels interfered with both copying and naming scrambled letters and numbers in poor readers. Kastner and Rickards (1974) attributed poor readers' visual recognition memory difficulties for novel stimuli or abstract shapes to mediational deficits.

In summary, three aspects of verbal mediation, which could be related to perceptual learning in poor readers, emerge from the literature review. These three aspects: codibility, use of spontaneous mediational strategies, and effects of verbal instruction are also investigated in the present study.

To investigate codibility, poor readers are assessed to determine if they can generate names of letters, geometric shapes, and abstract shapes as well as good readers. Since poor readers have been shown to be deficient in naming letters (Jansky & deHirsch, 1973), it is important to determine whether poor readers have equal access to verbal labels. The latencies to label production of good and poor readers are also compared. It is predicted that poor readers would not be able to name as many stimuli and would take longer to generate names to the stimuli than good readers.

With regard to spontaneous use of verbal strategies, two measures are employed: observations of overt verbal rehearsal during perceptual learning and self reports of strategies used. Procedures are similar to those employed by Flavell et al. (1966) and Kastner & Rickards (1974). The studies reviewed make it reasonable to predict that overt verbal rehearsal strategies should be observed more frequently in good than in poor readers and that good readers should report the use of such strategies more often than poor readers.

Finally, the effect of instructing children to use verbal rehearsal strategies is examined in Experiment II. A review of the literature with normal children indicates that 8 and 9 year olds have labels but may not always use them to facilitate learning or memory. Studies have been inconsistent in clarifying the conditions under which such strategies may have a facilitating effect. Therefore, it is difficult to predict the effect of differential instructions to verbally rehearse for either good or poor readers in the present study. Since it was predicted that good readers would perform better than poor readers on visual paired associate tasks in this study (Experiment I), differential effects of training can be anticipated. For example, a production deficit could be inferred if poor readers' performance on visual-

visual paired associate tasks improved significantly with verbal rehearsal instruction, while good readers showed no such improvement. On the other hand, a mediational deficit could be suggested if, following verbal rehearsal instruction, poor readers did not improve significantly compared to good readers.

Method

Subjects

Screening variables. Reading ability has been found to correlate with intelligence (Leton, 1962). Since many studies of poor readers have been criticized for failing to adequately control for IQ (Vellutino et al., 1972, 1973b, 1975a, 1975d; Kastner & Rickards, 1974; Morrison, Giordanni & Nagy, 1977), a large number of children were screened for intelligence and reading skill prior to experimental procedures. The objective was to clearly define one group of children who were average in intelligence but deficient in oral reading and a second, control group, with average intelligence but with no deficiencies in reading ability.

Children to be screened were drawn from second and third grade classes in three suburban, middle class schools located in the West Island district of Montreal. The age range of all children was 7 years 5 months to 10 years 3 months with a mean age of 8 years 8 months. These children had never repeated a grade, had received all their education in English, and were from English first language homes. Children with known emotional disturbance, visual or hearing problems were not included as subjects. Similarly, children with reported physical or neurological problems were excluded from the study. Since the male:female ratio for specific reading disability is generally reported to exceed four to one (Bentzen, 1963; Critchley, 1964; Eisenberg, 1966), only boys were selected for the present study.

Prior to formal evaluation, teachers were asked to rate each child's reading ability as average, above average, or below average. Teachers were also asked to indicate their method of reading instruction. A copy of the teachers' rating form is found in Appendix I. Teachers' ratings were used to select children for further screening. Method of reading instruction was consistently phonic across the three schools[1]. Several of the poor readers were receiving remedial reading instruction at the time of screening.

Screening Tests

Reading measure. Each child's formal reading level was assessed using the Gray Oral Reading Test - Form A (Gray, 1963). The present study is concerned with those children who fail to recognize single words or to sound them out phonetically. In younger readers, oral reading problems are more meaningful to measure than comprehension deficits. Therefore an oral reading test was used. The Gray Oral Reading Test has been found to have high reliability. For boys, coefficients of intercorrelation of .973 - ..982 among scores on each of the four forms for each grade level have been reported (Gray, 1963). The test has been standardized on a large population, grade one through college level, and has been used as a measure of reading level in other studies of reading disability (Gittelman-Klein & Klein, 1976).

The Gray Oral Reading Test was selected because of the ample range of basal scoring levels for younger readers. There are three primer reading levels, permitting a more accurate assessment of those second grade poor readers who may fall below a grade one reading level.

Poor readers were selected on the basis of identification by their teachers and scoring one grade or more below their current grade placement on the Gray Oral Reading Test. Good readers were selected on the basis of the teachers' rating of children who were average in oral reading and who scored at or above grade level on the Gray Oral Reading Test.

Intelligence measure. Since a positive correlation between reading ability and IQ has been demonstrated (Leton, 1962), it is crucial to attempt to select good and poor readers of equivalent intellectual abilities. Differential performance on experimental measures should be attributable to reading ability rather than intelligence. In the past, many studies have failed to report IQ scores or have used inadequate measures (Torgeson, 1975).

Since one of the goals of the present study was to determine how verbal factors might contribute to perceptual deficits, it seemed important to try to equate the groups on general intelligence. Many studies, examining profiles of the Wechsler Intelligence Scale for Children(WISC) (Wechsler, 1974), have shown that subgroups of poor readers can be differentiated on the basis of verbal-performance IQ differences. Kinsbourne and Warrington (1963) isolated two groups of disabled readers; those with high performance and low verbal scores and those with low performance and high verbal scores. Other investigators (Lyle & Goyen, 1969; Huelsman, 1970) found lower verbal than performance IQs to be typical of poor readers.

Studies which select subjects of average performance IQ (Doehring, 1968), without reference to verbal ability, would not permit conclusions to be drawn regarding the role of verbal factors in perceptual learning. Similarly, Vellutino et al.'s (1972, 1973a, 1973b, 1975a, 1975b, 1975c, 1975d, 1975e) procedure of selecting poor readers who earn an IQ of 90 on <u>either</u> the verbal <u>or</u> the performance scale of the WISC might not result in adequately controlling general intelligence. In fact, poor readers in most of Vellutino's studies tended to have lower verbal IQs than control subjects.

The present study aimed to equate reader groups on general intelligence by requiring an overall IQ score of 90 or more on a short form of the WISC (Silverstein, 1970a, 1970b). This short form, administered individually to each child, included four subtests, two from the Verbal Score: Similarities and Vocabulary and two from the Performance Scale: Picture Arrangement and Block Design. This form has a validity coefficient of .947 with overall IQ (Sattler, 1974). The subtests were administered and scored according to directions (Wechsler, 1974). Deviation quotients were computed for the four subtests using the Tellegan and Briggs (1967) deviation quotient formula.

Final Sample

Of 99 children initially screened, 27 were eliminated from the study; 15 because they did not meet the criterion IQ score of 90 or above, five because English was not their first language, and seven because they did not score a year below grade level on the individual reading measure, in spite of being rated as poor readers by their teachers. The final sample consisted of 72 boys, 36 poor readers and 36 good readers.

The mean ages, reading levels, and IQs for all subjects in the final sample are presented in Table 1. As seen in this table, the mean age of the poor readers was 106.56 months (8 years 9 months) and of the good readers 104.86 months (8 years 7 months). There was no significant difference between the ages of the two groups ($t(70) = 1.283$, p NS). As predicted, there was a difference between the groups on the reading measure, indicating that good readers scored significantly higher on the Gray Oral Reading Test than poor readers ($t(70) = 6.743$, $p < .001$). Although both reader groups included in the final sample earned a prorated IQ of at least 90 on the WISC, there was a statistically significant difference between the two reader groups ($t(70) = 2.825$, $p < .01$). Good readers earned significantly higher IQ scores than poor readers. Because of this difference, the subtests which contributed to the significant IQ differences were examined. As seen in Table 1, only one subtest from each of the Verbal and Performance Scales contributed to the significant difference in IQ. These two subtests were Similarities and Block Design. It is interesting to note that there

Table 1

Summary of Subject Characteristics (n = 72)

Mean Scores	Poor readers (n = 36)	Good readers (n = 36)	t*	p
Age (in months)	106.56	104.86	1.283	NS
Gray Oral Reading Test (grade level)	2.19	3.85	6.743	.001
Reading level difference score[b]	-1.51	+.36		
Prorated overall WISC IQ score	106.86	113.36	2.825	.01
Verbal Subtests (WISC)				
Vocabulary	10.61	11.58	1.821	NS
Similarities	10.97	12.53	3.087	.01
Mean verbal score	10.79[a]	12.06		
Performance Subtests (WISC)				
Block Design	10.25	11.69	2.34	.05
Picture Arrangement	12.39	12.56	.278	NS
Mean performance score	11.32[a]	12.13		

* df = 70

[a] $t(35)$ = 1.443, p N.S. in comparing the mean Verbal and mean performance scores of the Poor readers.

[b] Score = mean grade placement level minus Gray Oral Reading Score (in years).

was no significant difference between good and poor readers on the Vocabulary subtest score, suggesting that the groups were equally matched on an expressive verbal measure.

There was also no significant difference between the mean of the two verbal subtests (10.79) and the mean of the two performance subtests (11.32) for the poor readers ($t(35) = 1.443$, p NS). This finding of equivalent verbal and performance abilities is important in differentiating the poor readers in the present sample from those in Vellutino's (1972, 1973b, 1975a, 1975b) studies, many of whom had significantly lower verbal than performance IQ scores.

The difficulty in attempting to match the overall IQ scores of the two reader groups in this study resulted from an under-representation of poor readers with above average IQs. Many of the good readers had above average IQ scores, resulting in groups with unequal levels of intelligence. This problem was unresolved by further screening of children. Within the restriction of the three school populations available for study, good readers continued to score above average on the intelligence measure. It is probable that the sample difference would be maintained had an even larger number of subjects been available, since all classes were located in upper middle class suburban schools. This pattern of higher overall IQs for good than for poor readers has been found by other researchers (Lyle & Goyen, 1969; Huelsman, 1970) and seemed to represent a real difference between the groups studied here.

Since it was not possible to eliminate good readers with above average IQs, it was decided that covariance adjustments could be made if there were significant correlations between the IQs and the dependent measures (paired associate task scores). In this way, any effects of differing intelligence scores between the two groups could be partialled out.

Experimental Measures

Paired associate tasks. Four sets of paired associates were used. Each set contained fifteen visual stimulus-response pairs. The stimuli for all four sets were pictures with familiar labels. The 60 pictures (e.g. chair, apple, brush, etc.) were selected from the Peabody Picture Vocabulary Test (PPVT) (Dunn, 1965). The pictures were selected from items on the test usually administered to six to eight year old children. The pictures finally selected had been tested in a pilot sample of eight year olds (see Appendix 2) and represented familiar vocabulary to the age group of subjects in the present study.

The response sets varied as follows:

Set 1 consisted of 15 capital letters, some of which were used in the Morrison, Giordanni and Nagy (1977) study (e.g. N, R, T, etc.) as well as other letters familiar to second and third grade readers.

Set 2 was composed of 15 geometric shapes with labels that are generally familiar to children of this age (e.g. circle, square, diamond, etc.), also stimuli selected by Morrison et al. (1977).

Response items in Sets 3 and 4 were 30 abstract line shapes some selected from Vellutino et al.'s (1975a, 1975b, 1975c, 1975d) studies (e.g. ) and some from Gibson, Gibson, Pick and Osser's (1962) study of the development of visual forms. These abstract shapes did not share a common label and were presumed to be more difficult to label than either letters or geometric shapes.

All items which made up the response sets were pilot tested for label availability. The method and results of this preliminary investigation are summarized in Appendix 2. Support was found for a difference in codibility between letters and geometric shapes on one hand, and abstract shapes on the other. Codibility was measured by response latency to label production and by the commonality of labels elicited. Further measurement of codibility in both good and poor readers is part of the design of the present study and is described under Labeling Measure.

The pictures and abstract shapes were drawn as simply as possible so that they were similar in the number of lines and curves to the letters and geometric shapes. The visual complexity of the abstract shapes was first assessed by a group of forty adults who rated each of the designs for complexity on a scale from 1 to 5. Appendix 3 presents a summary of the visual complexity rating data for the abstract shapes used in the current study. Appendix 4 provides an example of the visual complexity rating sheet. Only those designs rated low in visual complexity (i.e. a mean rating of three or less) were used in the response sets.

All stimulus and response pairs were printed on 3 x 5 inch white cards. Pictures, letters, and shapes were drawn to a two inch scale in black and white and were reproduced by Xerox. The pairs to be learned were enclosed in plastic, each one on a separate page, and were presented in looseleaf binders. Copies of the four stimulus-response sets are found in Appendix 5.

Paired associate Sets 1, 2, and 3 were presented in Experiment 1. Set 4 was used in Experiment II. The differences between the Experiments and verbatim instructions for each Experiment are described in the Procedure Section. In both Experiments, each set of paired associates was presented under study and test conditions. During study, each paired associate was presented individually for 5 seconds. After all 15 pairs in a set had been presented for study, the test phase began. In the test phase, each stimulus item was presented in a fixed random order, on one page. On a separate page below the stimulus, three response choices were presented. Subjects were required to point to the correct response previously paired with the stimulus.

Each response card displayed the correct response and two distractor items. Distractor items were drawn from the same category as the correct responses, i.e. letters, geometric shapes, or abstract shapes. Distractors consisted of one item which had already been presented in the study phase and one new item. Positions of both the correct response and distractor items were randomly assigned. All items in the test phase were drawn to the same scale as the original paired associate in the study phase. Copies of the four response choice sets are found in Appendix 6.

Ten abstract shapes, not used in Sets 1, 2, 3, or 4 were randomly paired as responses to ten numbers (1 - 10).

These number-abstract shape pairs, which comprised the Verbal Training Set for Experiment II, are presented in Appendix 5.

Scores for all paired associate learning tasks were: one point for a correct match and zero for an incorrect one. The score for each paired associate task was a maximum of 15 in each of the four sets. The maximum score for the three sets in Experiment I was 45.

Labeling measure. The accessibility of labels for pictures, letters, geometric shapes, and abstract shapes making up the stimulus-response sets of Experiment I were presented, one at a time, to each child for verbal labeling. The 90 stimuli to be labeled were mixed and shuffled for each subject to eliminate order effects. All subjects were given the following instructions:

"I am going to show you some pictures, letters, and shapes one at a time. Tell me its name or names just as quickly as you can. What is it called? What does it look like to you? I will time you as soon as I turn over each card. Ready, set, go!"

Two measures were taken: the response latency in seconds to naming each stimulus and the actual label given to each stimulus. Latencies were measured by digital stop watch, Micronta L.C.D. (Model 63-5003). Verbal labels given by each subject were recorded by the experimenter.

Metamemory questions. Each child was questionned to assess his knowledge of learning or memory strategies used during Experiment I. He was asked the following questions:

For the letters and geometric shapes:

"How did you remember the letters and geometric shapes?"

For the abstract shapes:

"How did you remember these (abstract) shapes?"

For both categories of material:

"What did you do to help yourself remember?"

"Can you tell me how you did it?"

Responses to the Metamemory questions were categorized into visual, verbal or other strategies. Subjects whose responses indicated a clear use of a visual strategy during paired associate learning gave such statements as: "I looked at it.", "I saw a picture of it in my head.". Verbal strategies included statements such as "I said its name", "I said what it was" or "I named it to myself". Responses classified as other, included: "I don't know", "I guessed." etc. Verbatim responses were recorded.

Procedure

All testing was carried out over a period of six months. Each subject was seen for two sessions, a screening session and an experimental session. Each session lasted approximately 50 minutes. Testing was done individually in the same quiet room in each school, during school hours. An attempt was made to create a pleasant, non threatening situation. An effort was also made to have the child relaxed and motivated. No child was tested if he appeared reluctant or anxious. All subjects expressed interest and seemed to enjoy the procedure.

Screening phase. The screening phase was carried out prior to experimental testing. Two female experimenters administered the screening tests. Each experimenter tested half of each reader group. Subjects were told that the experimenter was interested in discovering which tasks second and third grade children find easy and which tasks they find difficult. By trying his best on all tests, the subjects were told that they could help the experimenter find out how children learn to read. Subjects were assured that the tests had nothing to do with either school marks or report cards.

All tests in the screening phase were administered in the same order:

1. The WISC Performance tests of Picture Arrangement and Block Design

2. The WISC Verbal subtests of Vocabulary and Similarities
3. The Gray Oral Reading Test

<u>Experimental phase</u>. The experimental session was conducted on a different day from the screening session. The same female experimenter tested all subjects. The experimental session consisted of four parts:

1. The Paired Associate Tasks of Experiment 1
2. The Labeling Measure
3. The Paired Associate Task of Experiment II
4. The Metamemory questions

Each subject received all four measures, although the order of task presentation was counterbalanced as shown in Appendix 7. A short rest was given between each part. Half of the subjects in each reader group received the Metamemory questions and Labeling measure after Experiment I; the other halves of each reader group performed these tasks after completing both Experiments I and II.

<u>Paired Associate Tasks</u>

<u>Experiment I</u>. Prior to administering the experimental tasks, five paired associates were presented to familiarize all subjects with the testing procedure. Both stimuli and responses were familiar pictures.

After presentation of each pair for 5 seconds of study, each stimulus was presented separately with a choice from among three pictures on a response card. Subjects were asked to point to the correct response which appeared in a randomized position. The practice set is included in Appendix 5. Verbatim instructions for the practice set are identical to those of Experiment I.

Both good and poor readers then received all three sets of paired associates (Sets 1, 2, and 3) in a counterbalanced order to equal 45 trials. Since there were 3 tasks, 6 orders of presentation were possible. Six subjects in each reader group were randomly assigned to one of six presentation orders. For Experiment 1, subjects were given the following verbatim instructions for all paired associate tasks:

Study phase:

"I am going to show you some pictures and (letters or shapes) that go together. I want you to look at them carefully and to try to remember them. We are going to look at them again; I want you to remember which pairs go together on the page."

Test phase:

Immediately after presentation of each set of fifteen pairs, the following instructions were given:

"Here is one picture you saw before, find the letter (or shape) which went with it. Try to remember which one went with it. Point to it."

Intermittent feedback was given to all subjects: "Yes, that's fine. You are doing well.", etc.

Direct observations of Overt Verbal Labeling (OVL) (e.g. the number of whispered or outloud rehearsals of the name of the stimulus items) during paired associate learning of Experiment I were also recorded for both reader groups.

Experiment II. Both good and poor readers were given a second set of 15 picture-abstract shape pairs (Set 4) to learn following two separate instructional conditions. To eliminate task order learning effects, subjects within the good and poor reader groups were randomly assigned to either a Verbal Labeling Instruction Condition or to a No Verbal Labeling Instruction Condition. The only restriction was that subjects from the different task orders of Experiment I were equally represented in the two instructional conditions.

1. The Verbal Instruction group were given explicit instructions in applying verbal labels to the ten number-abstract shape pairs of the Training Set. Verbatim instructions were as follows:

Here are some numbers and shapes which go together. Look at them carefully. Some people remember them better when they say the names for the numbers and the shapes. Like this ... Let's give the shape a name. This shape looks like a "kite"; e.g. the eight and the "kite" go together. What does this next shape look like to you? Let's practice. Look carefully at all the numbers and shapes and say their names outloud. Try to learn and to remember them. We are going to look at them again later.

2. The No Verbal Instruction group were not instructed in the use of verbal labeling but were simply asked to study and to learn the same ten number-abstract shape pairs of Training Set. Verbatim instructions to subjects in this condition were:

"Here are some numbers and shapes which go together. Look carefully at all the numbers and shapes. Try to learn them and to remember them. We are going to look at them again later."

Each of the ten paired associates in the Training Set was presented either for study and labeling (Verbal Instruction Condition) or for study alone (No Verbal Instruction Condition). Although subjects in both conditions were instructed to learn the Training Set, there was no test phase. These instructions had been given to increase attention to task. The length of the Instruction - No Instruction Condition was approximately five minutes.

Immediately after viewing the Training Set, subjects in both instructional conditions were presented with the second set of 15 picture-abstract shape pairs (Set 4). Verbatim instructions for the two groups were as follows: For the Verbal Instruction group:

> I am going to show you one last set of pictures and shapes which go together. I want you to look at them carefully, to learn them and to remember them. Some people remember them better when they say the names for the pictures and the shape ... just as you did before on the last set. Try to remember this new set by saying their names to yourself. We are going to look at them again later.

For the No Verbal Instruction group:

> I am going to show you one last set of pictures and shapes that go together. I want you to look at them carefully, to learn them, and to remember them. We are going to look at them again later.

The test phase for subjects in both conditions followed the presentation of Set 4. Each stimulus was presented separately, with a choice from among three abstract shapes on a response card. Subjects were required to point to the correct response which appeared in a randomized position.

Results

Intelligence-Paired Associate Tasks Correlations

As shown in Table 1 of the preceeding section, the good readers scored significantly higher on the intelligence measure than the poor readers ($t = 2.825$, $p < .01$). Pearson Product Moment Correlation Coefficients (r) were calculated between the WISC IQ scores and both the mean individual paired associate task scores and the mean overall paired associate task score for both reader groups separately and for the combined reader group. As can be seen from Table 2, there were no significant correlations between intelligence and either individual or overall paired associate learning scores for either good or poor readers or for the combined reader group. Although age was not analyzed as a major factor, Pearson Product Moment Correlation Coefficients (r) were also calculated between age and the experimental task scores. None of these correlations were significant[2]. Since neither intelligence nor age correlated significantly with the paired associate task scores, covariance analysis was not indicated.

Paired Associate Tasks: Analysis of Variance for Experiment I

The individual scores for each subject on each of

Table 2

Correlations (Pearson r) between Mean I.Q. Scores and Mean Individual Paired Associate Task Scores (Experiment I)

Good readers

	Mean Prorated I.Q.	Pix-Let.	Pix-G.S.	Pix-A.S.	Mean P.A.L. Score
Mean Prorated I.Q.	1.00	.263	-.130	-.153	-.014[a]
Pix-Letters	.263	1.00	-.162	.180	
Pix-Geometric Shapes	-.130	-.162	1.00	.172	
Pix-Abstract Shapes	-.153	.180	.172	1.00	
Mean P.A.L. Score	-.014				1.00

Poor readers

	Mean Prorated I.Q.	Pix-Let.	Pix-G.S.	Pix-A.S.	Mean P.A.L. Score
Mean Prorated I.Q.	1.00	.077	-.232	.288	.030[a]
Pix-Letters	.077	1.00	.047	.099	
Pix-Geometric Shapes	-.232	.047	1.00	-.093	
Pix-Abstract Shapes	.288	.099	-.093	1.00	
Mean P.A.L. Score	.030				1.00

p N.S. at $df = 35$ for all correlations.

[a] Correlations between Mean prorated I.Q. and Mean P.A.L. score for the Combined Reader Group ($r = .207$, p N.S.)

the three paired associate learning tasks of Experiment I were subjected to an analysis of variance (2 x 3 x 6, Mixed Design), two factors between subjects (Reader Group) and (Order), with repeated measures (Task) on each subject (Myers, 1966). Scores were the total number of pairs correctly learned out of 15 for each paired associate task for each subject.

Table 3 presents the mean scores for each paired associate task for each reader group in each presentation order. Figure 1 presents graphically the mean task scores for each reader group across all orders. Table 4 presents the overall mean paired associate learning score (summed over the three tasks) for each reader group in each presentation order. A summary of the analysis of variance for Experiment I is presented in Table 5.

<u>Main effects</u>. The analysis of variance for Experiment I revealed a significant main effect of Reader Group $\underline{F}(1,60) = 49.38$, $\underline{p} < .00001$ (Table 5), indicating that good readers performed consistently better than poor readers on all visual paired associate learning tasks in all orders. Figure 1 portrays the relationship between reader group and performance on the three tasks. Any difference in the overall intelligence scores of the two groups is unlikely to account for this large performance difference since, as previously reported,

Table 3

Experiment I: Mean Paired Associate Learning (P.A.L.) Scores for Individual Tasks by Reader Group and Order

	Paired associate tasks					
	Letters		Geometric Shapes		Abstract Shapes	
Task Orders	Good readers	Poor readers	Good readers	Poor readers	Good readers	Poor readers
Letters 1st						
L.-G.S.-A.S.*	11.17	6.67	11.17	7.83	11.67	7.00
L.-A.S.-G.S.	8.67	7.67	11.17	7.50	9.83	8.50
Geometric Shapes 1st						
G.S.-A.S.-L.	9.00	8.17	9.83	6.50	11.50	8.67
G.S.-L.-A.S.	9.33	7.17	10.50	7.17	11.67	9.33
Abstract shapes 1st						
A.S.-L.-G.S.	10.33	9.83	10.33	8.67	9.50	9.50
A.S.-G.S.-L.	11.17	7.50	7.50	10.00	9.50	7.83
Mean P.A.L. score across all orders	9.94	7.83	10.08	7.94	10.61	8.47
Mean P.A.L. score for Task	8.89		9.01		9.54	

*L. = Letters
G.S. = Geometric Shapes
A.S. = Abstract Shapes
Note. Maximum score = 15.

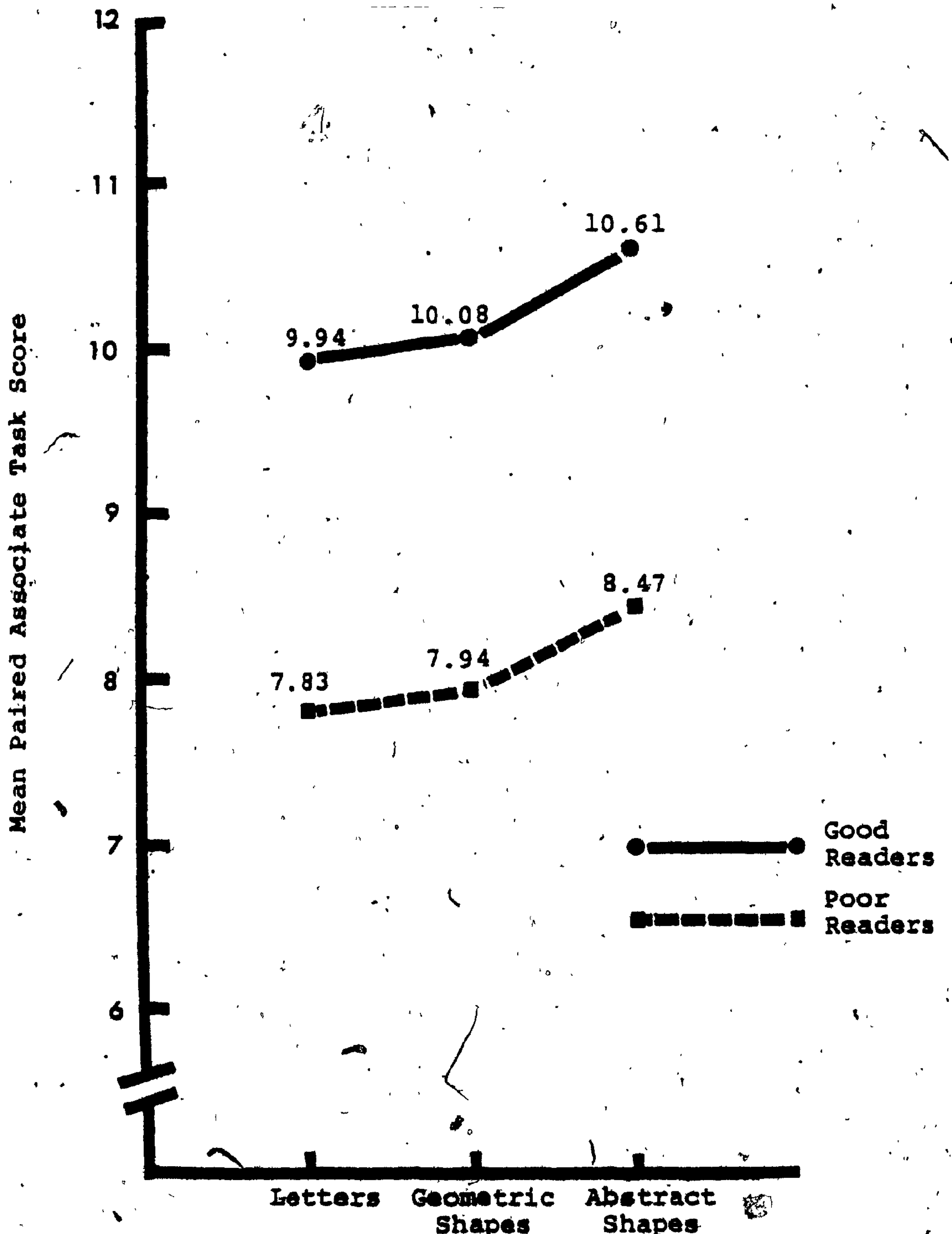

Figure 1. Experiment 1: Mean paired associate task scores for reader group across presentation order.

Table 4

Experiment 1: Mean Paired Associate Learning Score (Summed over task) for Each Presentation Order and Reader Group

Task order	Reader Group: Good readers	Poor readers	Combined readers
Letters first (Mean)	10.61	7.52	9.07
L.-G.S.-A.S.[a]	11.33	7.16	9.25
L.-A.S.-G.S.	9.88	7.88	8.88
Geometric Shapes first (Mean)	10.31	7.83	9.07
G.S.-A.S.-L.	10.11	7.77	8.94
G.S.-L.-A.S.	10.50	7.88	9.19
Abstract Shapes first (Mean)	9.72	8.89	9.31
A.S.-L.-G.S.	10.05	9.33	9.69
A.S.-G.S.-L.	9.38	8.44	8.91
Mean score for group across order	10.21	8.08	9.15

[a] L. = Letters
G.S. = Geometric Shapes
A.S. = Abstract Shapes

Table 5

Summary of the Analysis of Variance for Experiment I (n = 72)

Source	SS	df Num.	df Den.	MS	F
Group	251.337	1	60	251.337	49.38036**
Order	18.634	5	60	3.727	.73220
Group x Order	67.079	5	60	13.4158	2.63581*
S/AB	305.389	60		5.08982	
Task	18.925	1[a]	60[a]	9.4625	2.01052
Group x Task	.038	1[a]	60[a]	0.019	0.00404
Order x Task	53.797	5[a]	60[a]	5.3797	1.14304
Group x Order x Task	101.129	5[a]	60[a]	10.1129	2.14872
C x S/AB	564.778	120		4.70648	
Total	1381.106				

**$p < .000001$

*$p < .05$

[a]The number of degrees of freedom are reduced according to the Greenhouse-Geisser correction (Winer, 1962, p.306) for a repeated measures design. The degrees of freedom for the numerator and denominator of the F ratio are each divided by (r-1) where r = repeated factor. The number of degrees of freedom is reduced since the repeated measures are correlated observations. The resulting F ratio is more conservative.

the Group x Order interaction was that the order of presentation of the visual tasks, under which both good and poor readers received the same visual materials for learning, resulted in differential performances. A strong learning effect was evident for the good readers related to the presentation order of the Abstract Shapes (i.e. either first, or third). Good readers did best on all three paired associate tasks when they received either Letters or Geometric Shapes before the Abstract Shapes. Receiving either Letters or Geometric Shapes (presumed to be highly codible material) first might have facilitated the use of verbal coding strategies on the Abstract Shapes Task for the good readers. It is possible that the good readers had more readily available access to verbal coding strategies for learning visual material. It might have taken more time for the good readers to learn the visual tasks when the Abstract Shape task was presented first, since this material required the generation of labels which were not readily available.

Performance on paired associate tasks was shown to be very different for the poor readers than for the good readers under the same stimulus presentation conditions (Figure 3). When either Letters or Geometric Shapes were presented before Abstract Shapes, poor readers did most poorly on all three paired associate tasks. Poor readers' performance was best over all paired associate tasks when they received Abstract Shapes first.

The poor readers may not have had a readily available verbal coding strategy for performing visual learning tasks and may not have been as distracted by the occurrence of an unfamiliar, less easily labeled task presented first. On the other hand, since the Abstract Shapes are novel material, the poor readers may have focussed their attention more initially, and have done better on subsequent tasks. Poor readers, seemed to do most poorly on all tasks in those orders where the more highly codible material was presented first.

Labeling Measure: Analysis of Variance

The mean latencies to label production for each of the four types of visual material used in Experiment I (Pictures, Letters, Geometric Shapes, and Abstract Shapes) were subjected to an analysis of variance (2 x 2 x 4 Mixed Design); two factors between subjects (Reader Group) and (Presentation Order: third or fourth in the experimental sequence), with repeated measures (Task) on each subject (Myers, 1966). Scores were the mean reaction times to labeling for each subject on each of the four different types of visual material.

There were the same number of subjects on all measures (n = 72), 18 subjects in each cell. Mean reaction times to label production for both reader groups and all stimulus materials in each presentation order, are presented in Table 7. A summary of the analysis of variance of the labeling data can be found in Table 8.

Main effects. There was no significant main effect of Reader Group $F(1,68) = .18$, p. N.S. (Table 8). Good and poor readers were not significantly different on Reaction Time measures to labeling the visual stimuli employed in Experiment I; both reader groups were able to generate verbal labels with equivalent latencies.

There was also no significant main effect of Presentation Order indicating that whether the labeling task was presented third or fourth in the experimental sequence had no overall effect on the labeling scores, $F(1,60) = 1.01$, p. N.S. It is important to note that neither reader group had received any verbal training at the time the Labeling Measure was given (Appendix 7). Given the finding that presentation order did not affect overall labeling scores, it is difficult to argue that experimental fatigue was a factor in labeling performance.

The main effect of Task was highly significant $F(3,204) = 258.63$, $p < .00001$ indicating the four

Table 7

Label Production Measure: Mean Latencies (in seconds) for Label Production by Reader Group, Task, and Presentation Order

Reader Group	Pictures			Letters			Geometric Shapes			Abstract Shapes		
	Task Order			Task Order			Task Order			Task Order		
	3rd	4th	Combined	3rd	4th	Combined	3rd	4th	Combined	3rd	4th	Combined
Good readers	1.09	1.04	1.06	.66	.65	.65	2.02	1.93	1.97	4.62	4.31	4.46
Poor readers	1.12	1.14	1.13	.70	.75	.72	2.15	2.58	2.37	3.66	4.59	4.13
Combined readers	1.11	1.09	1.095	.68	.70	.686	2.09	2.26	2.222	4.14	4.45	4.297

Table 8

Summary of the Analysis of Variance for Labeling Times

(n = 72)

Source	SS	df Num.	df Den.	MS	F
Group	0.1795	1	68	0.1795	0.175982
Presentation Order	1.0284	1	68	1.0284	1.008261
Task	564.0777	3	204	188.0259	258.63071**
Group x Order	4.0588	1	68	4.0588	3.97932*
Group x Task	4.72068	3	204	1.5735	2.16444
Order x Task	1.21118	3	204	0.40372	0.55532
Group x Order x Task	4.23982	3	204	1.41327	1.94396
S/AB	69.3593			1.01999	
S/ABC	217.668			0.80025	
CxS/AB	148.3090			0.72700	
Total	1224.8363				

**p<.00001

*p<.05

types of visual material to be significantly different from each other in length of time required to generate labels to them. As can be seen from Table 7, the orders, from shortest to longest Reaction Time are as follows: Letters, Pictures, Geometric Shapes, and Abstract Shapes.

Scheffé tests were applied to the following pairs of means to determine which tasks were significantly different from each other:

1. Letters vs. Geometric Shapes
2. Letters vs. Abstract Shapes
3. Geometric Shapes vs. Abstract Shapes

Since Pictures were stimulus materials, which remained constant over tasks, no post hoc comparisons were made between the Pictures alone and any other visual materials. Table 9 presents the means, *F* ratios and degrees of freedom for these Scheffé comparisons.

All of the comparisons in Table 9 reached significance indicating that each task was significantly different from the others in latency to label generation. These response latencies provided an empirical definition for the codibility level of the visual materials as had been previously hypothesized: e.g. Letters, with the shortest latencies can now be defined as highly codible material; Geometric Shapes, with the second shortest

Table 9

Means and F Ratios for Scheffé Comparisons for Reaction Times (in secs) to Labeling for Task

Comparisons			F*(3,204)	p
1. Letters	vs	Geometric Shapes	83.356	.001
.686		2.222		
2. Letters	vs	Abstract Shapes	460.742	.001
.686		4.297		
3. Geometric Shapes	vs	Abstract Shapes	152.054	.001
2.222		4.297		

* F value of 16.26 is critical for alpha of .001.

latencies can be defined as medium codible material; and Abstract Shapes, with the longest latencies can now be defined as low codible material.

As well, a comparison of the mean of the three highly codible tasks (Pictures + Letters + Geometric Shapes) versus the mean of the low codible task (Abstract Shapes) by Scheffé test revealed that all highly codible tasks were performed significantly faster than the task low in codibility (1.334 versus 4.297, $\underline{F}(3,204) = 155.11$, $\underline{p} < .0001$).

Interaction. There was a significant interaction between Group and Presentation Order, $\underline{F}(1,170) = 3.98$, $\underline{p} < .05$ indicating that the order in which the Labeling Measure was presented, affected the reader groups' reaction time scores differentially. Figure 4 presents the mean reaction time scores to label production (summed over task) for both reader groups in the two presentation orders. Inspection of Figure 4 indicates that the good readers labeled faster in comparison to the poor readers when the labeling measure was the fourth task. Increasing the number of experimental tasks accelerated labeling time for the good readers in comparison to the poor readers in the same condition. Poor readers who labeled later in the experimental sequence, showed the slowest reaction times.

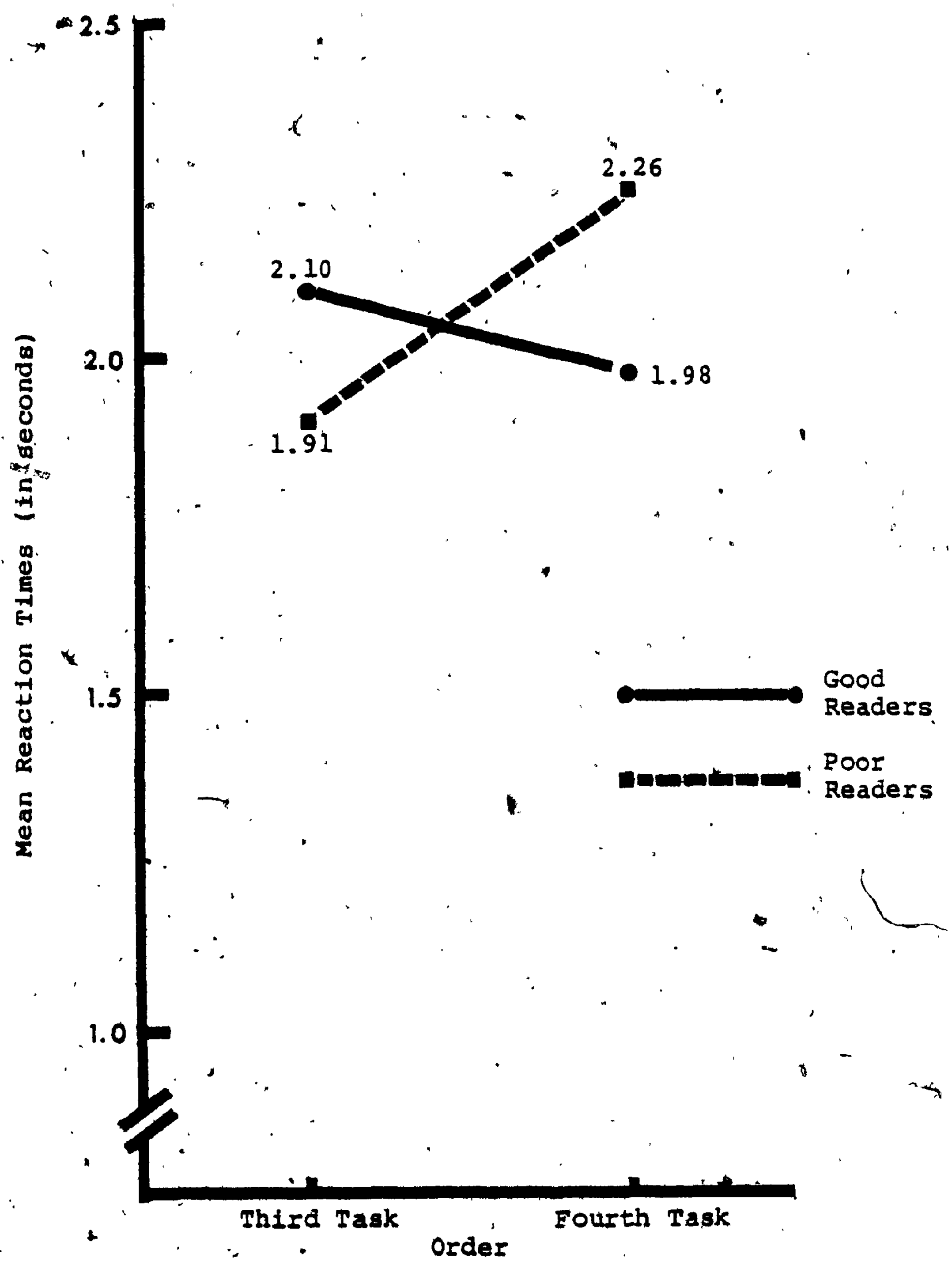

Figure 4. Overall mean reaction times to label production (summed across tasks) for each reader group in each presentation order.

Performing the labeling task earlier in the sequence, resulted in faster labeling times for the poor readers in comparison to the good readers.

The differences between the mean reaction times of the good readers in both task presentation orders (2.0975 versus 1.9825) and the mean reaction times of the poor readers in the same two orders (1.9075 versus 2.2650) were compared using Scheffé tests. Due to the conservative nature of the test, there were no significant differences for either the good readers ($\underline{F}(1,68) = 1.0148$) or the poor readers ($\underline{F}(1,68) = 1.1277$) when the groups were compared separately.

In summary, the most important result of the 2 x 2 x 4 analysis of variance, in terms of the hypotheses of the current study is that there were no differences between the reader groups in their ability to generate verbal labels to visual materials. Both good and poor readers in this study could produce labels with equal facility.

Paired Associate Task: Analysis of Variance for Experiment II

The individual scores of each subject on a second set of Picture-Abstract Shape pairs (Set 4), presented visually for learning after either a Verbal Instruction or No Verbal Instruction condition, were subjected to an analysis of variance (2 x 2 x 3 Factorial Design): three factors between subjects (Reader Group), (Instructional Condition: Verbal Instruction versus No Verbal Instruction) and (Task Order for Experiment I: Abstract Shapes first, second, or third).

Order was included as a factor in this analysis even though all subjects received the experimental measure directly following one of the two instructional conditions. The original six task presentation orders of Experiment I were not selected since this would have resulted in too small an n (i.e. three subjects per cell) to satisfy requirements of an analysis of variance (Winer, 1962). The measures for Experiment II were taken on the same subjects who had performed Experiment I. Since the significant Group x Order interaction in Experiment I (Table 5) had been accounted for, through post hoc analyses, by the presentation order of the Abstract Shape task (i.e. first, second, or third) (Table 6), this order was used in the analysis of variance for Experiment II.

Scores for each cell were the mean number correct out of 15 on the paired associate task for each subject. Due to an unequal assignment to treatment conditions, there was an uneven number of subjects in each cell, although the proportions for each cell were balanced.

The analysis of variance was calculated with unweighted means (Winer, 1962).

Table 10 outlines the mean scores for the paired associate task (Set 4) for each reader group, order of presentation for Experiment I, and instructional condition. A summary of the analysis of variance for Experiment II is presented in Table 11.

Main effects. The analysis showed a significant main effect of Group $F(1,60) = 5.86$, $p<.05$. As shown in Table 10, the good readers did better than the poor readers on learning the paired associate task, regardless of presentation order or instructional condition. This finding is consistent with the performance of the good readers on the three sets of paired associates in Experiment I (Table 5) and with the expectation that good readers perform better than poor readers on a variety of visual paired associate tasks.

There was also a significant effect of Instructional condition $F(1,60) = 7.02$, $p<.05$ indicating that Verbal Rehearsal Instruction tended to lower the performance of both the good and the poor readers on learning the paired associate task. Contrary to hypothesis, both reader groups performed best under the No Verbal Instruction condition (Scheffé $F(1,60) = 7.2978$, $p<.10$)[5]. Failure

Table 10

Experiment II: Mean Paired Associate Learning (P.A.L.) Scores for Set 4 for Order, Reader Group and Instructional Condition

Order of Task for Experiment I		Good readers (n=36)				Poor readers (n=36)			
		Verbal Instr.		No Verbal Instr.		Verbal Instr.		No Verbal Instr.	
Abstract Shapes	1st	(n=5)	9.00	(n=7)	11.00	(n=5)	8.60	(n=7)	9.29
Abstract Shapes	2nd	(n=5)	9.00	(n=7)	11.14	(n=7)	8.29	(n=5)	11.40
Abstract Shapes	3rd	(n=8)	10.38	(n=4)	12.25	(n=6)	7.00	(n=6)	8.17
Total mean P.A.L. score for reader group and condition			9.46		11.46		7.96		9.61
Mean P.A.L. score for Set 4 for reader group				10.46				8.78	

Table 11

Summary of the Analysis of Variance for Experiment II (n = 72)

Source	SS	df Num.	df Den.	MS	F
Group	48.3626	1	60	48.36	5.855*
Instructional Condition	58.0222	1	60	58.02	7.024*
Order	3.81466	2	60	1.907	0.2308
Group x Condition	0.53115	1	60	.53	0.064
Group x Order	38.61936	2	60	19.31	2.3378
Condition x Order	5.59823	2	60	2.80	0.339
Group x Condition x Order	4.04246	2	60	2.02	0.2445
S/ABC	495.57262		60	8.26	

* p = <.025

of Verbal Instruction to facilitate paired associate learning is difficult to interpret because task presentation order is confounded with the Verbal Instruction condition. As can be seen in Appendix 7, both reader groups who received the Verbal Rehearsal Instruction were tested on Set 4 after receiving the three other experimental measures. The reader groups in the No Verbal Instruction condition performed Set 4 second. Because subjects in the two Instructional conditions received the paired associate task at different times in the experimental procedure, test fatigue might have influenced subjects' performance in the Verbal Instruction condition.

Metamemory Questions and Observations of Overt Verbal Labeling

Table 12 presents results of the Metamemory Questions which are relevant for discussion, including the number and percentages of subject's direct reports of employment of either a visual or a verbal learning strategy in Experiment I. As can be seen from Table 12, there were no significant differences between reader groups in numbers of subjects reporting a verbal strategy for either the high or the low codible material: e.g. 25% of good readers and 25% of poor readers reported such a strategy on Letters and Geometric Shapes, and

Table 12

Matamemory Questions: Self Reports of Learning Strategy

	Tasks high in codibility (Letters & Geometric Shapes)						Tasks low in codibility (Abstract Shapes)					
	Strategy reported						Strategy reported					
	Visual		Verbal		Other		Visual		Verbal		Other	
	No.[b]	%	No.	%	No.	%	No.	%	No.	%	No.	%
Good readers[a]	(19)	53	(9)	25	(8)	22	(8)	22	(12)	33	(16)	45
Poor readers[a]	(18)	50	(9)	25	(9)	25	(14)	39	(13)	36	(9)	25

[a] n = 36 for each Reader group

[b] No.= Number (frequency of reported strategy)

33% of good readers and 36% of poor readers on the Abstract Shapes task. It was interesting to note that for all tasks, both reader groups reported using a Visual strategy more frequently than a Verbal one. Both good and poor readers, of ages studied here, were more likely to report using visual strategies to learn the paired associate tasks. However, the number of subjects reporting Other strategies was high for both reader groups.

Direct observations of Overt Verbal Labeling (OVL) were recorded for each reader group and subjected to a chi square analysis (Ferguson, 1966) (Table 13). Although 22.3% of the good readers and 8.3% of the poor readers were observed to label spontaneously while performing the visual paired associate tasks in Experiment I, this difference was not statistically significant ($\chi^2(1) = 2.6826$, p. N.S.). It was not possible from these data to statistically support Kastner and Rickard's (1974) finding that poor readers verbalized outloud less frequently than good readers while performing visual recognition memory tasks, although the observations in the present study do suggest such a trend.

Table 13

Observed Frequencies of Overt Verbal Labeling (OVL) vs. No Overt Verbal Labeling (No OVL) in Experiment I (Chi Square Analysis)

	Good Readers	Poor Readers	
OVL	8	3	11
No OVL	28	33	61
	36	36	72

χ^2 = 2.6826, N.S.

df = 1

χ^2 = 6.64 at $p<.01$

DISCUSSION

Paired Associate Tasks: Experiment I

The results of Experiment I confirmed the expectation that poor readers would show significantly greater difficulty than good readers in learning visual paired associate tasks. The finding of poorer visual associative learning for young poor readers, aged 7½-9 years, is not surprising since these ages are still within the limits in which the use of visual strategies for learning have been found to be most salient (Benton, 1962). Recent criticism by Fletcher and Satz (1979) challenges Vellutino's (1973a, 1973b, 1975a, 1975b, 1975c, 1975d, 1975e) claims of intact visual perceptual learning for all poor readers. Such criticism, as well as the present results, allow speculation that deficits in visual perceptual learning may be present for subgroups of poor readers, such as those of younger ages in the present study.

This finding contrasts with results of Vellutino (1979) who predict that poor readers would not have deficits on such visual associative learning tasks. As well, present results are somewhat difficult to reconcile with the one study clearly demonstrating adequate visual perceptual learning in poor readers as young as 7 years

(Vellutino et al., 1975c). However, one possible explanation of the difference between Vellutino's results and those of the present study is the differential IQ selection procedures. Poor readers in the present study represent a different sample since they were selected on the basis of average global IQ and had equivalent verbal and performance scores.

As predicted, performance of the poor readers was more deficient than that of the good readers in learning all three types of visual paired associates, regardless of the codibility level. The present data support research which has demonstrated a significantly lower performance in poor readers' associative learning ability compared to good readers (Otto, 1961; Brewer, 1967; Gascon & Goodglass, 1970; Rudel, Denckla & Spalten, 1976). While the present study used 7½-9 year olds, results also support the findings of Morrison et al. (1977) with twelve year olds, that poor readers experience general short term memory deficits, unrelated to the verbal nature of stimuli. Similarly, the present results are in accord with Zigmond (1966), Fletcher and Satz (1979), and others who propose within modality deficits, either visual or auditory, for poor readers. Such deficits have been suggested to explain the cross modality difficulties of poor readers in many of the intersensory integration studies (Birch & Belmont, 1964).

Although results of Experiment I indicated no significant differences in difficulty among the tasks, it could be argued that task difficulty level might still affect performance. If either reader group had scored consistently very high or very low, the tasks' ability to adequately discriminate between the groups could be questioned. Since there were no ceiling or floor effects in overall learning scores for either good or poor readers, it is reasonable to suggest that the tasks adequately discriminated between the groups.

Although reader groups did not differ as a function of task, there were other effects of task. Further analyses revealed that this effect was specific to the experimental context. Initial order of task presentation, high or low codible pairs first, was shown to have a differential effect on reader groups' subsequent learning of other visual pairs.

The performance of both reader groups was most similar when initial material presented was low in codibility i.e., when the first task was the abstract shapes, the same shapes as used in Vellutino's (1975d) visual-nonverbal paradigm. Performance of the reader groups in this condition was consistent with Vellutino's (1975d) finding no difference between good and poor readers in learning these visual (nonverbal) materials. Since there was no control for task order in Vellutino's (1975d) study, it can be argued that his failure to find differences between reader groups may be specific to his experimental procedures.

The results for the differential effect of task order are discussed for the two reader groups separately.

Poor readers. Poor readers learned more pairs and their learning of all visual pairs was higher when low codible abstract shapes were presented before more familiar, highly codible material such as letters. The fact that the first task, abstract shapes, was more novel and did not require the use of a readily available label (Eakin & Douglas, 1971), may have resulted in more focussed attention. A recent investigation compared the performance, on visual tasks, of normal, poor readers, and hyperactive children of the same ages as in the present study (Ain, 1979). She found that poor readers had longer looking times than normal readers for both complex and novel visual stimuli but not for less complex stimuli. In the current study, presentation of the abstract shapes first, a more novel stimulus than either letters of geometric shapes, may have induced poor readers to look longer at all stimuli, resulting in the better performance scores.

Another explanation may be that learning to associate a highly codible picture and a low codible abstract shape, as a first task, is easier for poor readers than trying to associate two highly codible stimuli, e.g., a picture and either a letter or a geometric shape. In the first case, there may be less competing information in trying to associate the pairs in a meaningful way. In the picture-letter condition, some of the poor readers expressed surprise that the pairs did not seem to go together (e.g. CUP-N, was the required pair, instead of CUP-C). Presentation of the picture-abstract shapes first may be simpler for the poor reader who is known to have difficulty on visual tasks when there is too much competing information (Willows, 1974). There was less opportunity to make familiar associations between the pairs in the picture-abstract shapes task (e.g. KITTEN-).

The two highly codible tasks, picture-letters and picture-geometric shapes, had been designed with visual and verbal components in both stimulus and response conditions, although the labeling requirement was not overtly oral as it was in Vellutino's (1973b, 1975d) paradigms. Since the response required in the present experiment was visual recognition, there was no clear way to verify whether or not a subject actually used a verbal coding strategy. Observations of overt verbal labeling during paired associate learning and subjects' self reports of strategies used, attempted to clarify this point. These data indicated that although both good and poor readers reported using verbal as well as visual coding strategies for learning all three types of paired associates, there were no significant differences between the types of strategies reported for either reader group.

Good readers. For the good readers, the effect of this same task order was opposite to that of the poor readers. Good readers' learning was better in those conditions where familiar, highly codible material, letters or geometric shapes, was presented first, before low codible abstract shapes. Good readers responded better in conditions where they could employ highly overlearned and automatic responses to verbal material such as letters and geometric shapes (Eakin & Douglas, 1971). Initially presenting good readers with a task requiring readily available verbal labels may have facilitated their use of verbal coding to learn the picture-abstract shape pairs. Good readers appeared more set to use a verbal strategy on subsequent tasks when either letters or geometric shapes were presented first, even though good readers did not report more use of labels when questioned later on strategies used.

Visual Paired Associate Learning in Poor Readers: A General or Specific Deficit?

In summary, poor readers responded as if they had a general associative deficit for learning visual materials. Poor readers had lower scores, compared to good readers, on learning all tasks, both high and low in codibility. Given the finding that poor readers' performance was deficient on all tasks, difficulty in labeling all stimuli might be predicted. It had also been hypothesized that poor readers would be observed to overtly label less during task performance, and to report the use of verbal labeling strategies less often than good readers. However, these predictions were not confirmed.

Although there were no differences between good and poor readers on the Labeling Measure, observations of spontaneous labeling, or self reports of labeling strategy, the importance of the codibility factor cannot be completely rejected. The finding that the reader groups did not display a similar pattern of learning over all task orders provides some evidence of its importance. When visual material, low in codibility was presented first, poor readers' subsequent learning was significantly improved. Therefore, it can be suggested that poor readers have deficits in visual associative learning which occur only in specific learning contexts and which are related to both the order in which the tasks are presented and to the verbal or nonverbal nature of those materials.

Results of Experiment I indicate that codibility was a factor in the differential performance of good and poor readers in certain task orders. One possible explanation for the fact that poor readers' subsequent learning was deficient when highly codible, familiar material was presented first, followed by low codible, unfamiliar material, is that the use of a verbal strategy may be required in the novel situation. The poor reader may be able to generate a label to the highly codible material but does not transfer this strategy to the unfamiliar condition.

The above interpretation is supported by Kastner and Rickards' (1974) finding deficits in the production of relevant verbal labels by poor readers, 8-9 years, who were presented with novel, less readily codible visual stimuli first in a memory task. In the current study, presentation of highly codible material before low codible material decreased subsequent performance of poor readers. This same order appeared to effect the use of verbal labeling strategies in good readers for learning subsequent low codible abstract shape pairs.

Another explanation for finding differential performance for poor readers in certain task orders may be the fact that both good and poor readers, who are in the transitional stage of production deficiency (Reese, 1976), were capable of either visual or verbal mediational strategies. This was evident from their self reports on the Metamemory Questions. However, selection of one strategy over another may be determined by other factors such as the specific experimental conditions. Those who have defined the production deficiency stage (Keeney et al., 1967), have suggested that training in labeling accounts for strategy selected. Since other more subtle factors may also contribute to the selection of either visual or verbal strategies, the definition of the production deficiency stage should be expanded to include not only the facilitating effects of specific training in verbal rehearsal, but also the codibility of materials and the order in which such material is presented.

The fact that task order differentially affected reader groups' performance, has possible implications for remedial education. These are discussed in a later section. The context in which both highly codible and less codible visual materials are first presented to poor readers may have an important effect on their learning material which follows.

Labeling Ability

On the basis of literature previously reviewed, it was expected that poor readers would have fewer labels and slower reaction times to naming visual stimuli than good readers. This hypothesis was not confirmed. Both number of labels and latencies to label indicated that both reader groups could generate labels with equal facility to all types of stimuli. Since a verbal code for poor readers appeared well established, label production deficiencies could not account for their lower performance scores in Experiment I.

Although poor readers did not have difficulty producing labels, they may have verbal mediational problems related to ineffective use of labels in learning situations. The ability to produce labels to letters or shapes does not mean that a child can effectively use verbal mediational strategies (Fletcher & Satz, 1979).

Labeling Task Difficulty

There was a significant difference in task difficulty for both reader groups. Difficulty level was defined as latency to produce labels. The latencies to label from shortest to longest, were as follows: letters, pictures, geometric shapes, and abstract shapes. These latencies provided an empirical definition for the codibility of visual materials. As previously hypothesized, letters and pictures, with the shortest latencies, could then be defined as highly codible; geometric shapes with the second shortest latencies, could be defined as medium codible material; and abstract shapes, with the longest latencies, could be referred to as low in codibility.

It was interesting to note that letters were the easiest (fastest) to label for both reader groups. It is speculated that for the ages of children in this sample, the letter naming task was overlearned. Given Eakin and Douglas' (1971) finding differences for ten year old poor readers in rapid naming of pictures, and Vellutino et al.'s (1975b) finding letter name difficulty for 7 year olds, it should be expected that poor readers in the present study would demonstrate a reaction time deficit in labeling the more highly codible material. However, poor readers and good readers were equivalent in their ability to produce labels to letters as well as to all other visual stimuli, including abstract shapes. Since the mean age of poor readers in the current study was younger than that of subjects in the Eakin and Douglas (1971) sample and older than that of the children in the Vellutino

(1975b) study, the types of skills impaired in readers at different ages may be different.

Labeling Task and Order of Presentation

The reader groups' reaction times were differentially affected by the presentation order of the task within the experimental procedure:

Good readers. Good readers whose labeling times were measured at the end of the experimental sequence (i.e. the last of the four measures) had faster reaction times to all stimuli than good readers who labeled earlier in the task sequence. The good readers who performed the Labeling Measure last, did not appear to experience test fatigue; they demonstrated faster reaction times than did the reader group who labeled earlier. It could also be suggested that good readers who labeled at the end were bored, so speeded up in order to finish quickly.

Poor readers. On the other hand, poor readers who labeled last had the longest reaction times; having had more test procedures, these poor readers may have become inattentive and hence had slower reaction times. There is evidence that children with reading problems have sustained attentional deficits (Pelham & Ross, 1977). Those poor readers who labeled earlier in the sequence had the shortest reaction times of any group. They may have reacted to the novelty of the task. It was noted during testing, the these poor readers were particularly eager to do well. Those who performed the Labeling Measure early versus late in the test sequence, were observed more often to comment on how fast they were going, how well they were doing, etc.

Verbal Rehearsal

There were no significant differences between reader groups on either frequency of observed overt labeling or on reports of silent naming (verbal rehearsal). Therefore, it cannot be concluded that poor readers were deficient in their use of verbalizations to mediate performance on associative learning tasks. Although there was a trend suggesting that poor readers overtly labeled less often than good readers, only a few children in either reader group were observed to use overt labeling during performance. Results of this phase of the investigation cannot determine whether task performance was mediated by verbal rehearsal although it is speculated that poor readers have verbal mediational deficits.

Research has found that with an increase in age, there is also an increasing use of spontaneous verbal rehearsal (Flavell et al., 1966; Flavell, 1970; Kellas, McCauley & McFarland, 1975) and a facilitation of performance on learning and memory tasks (Flavell et al., 1966; Kellas et al., 1975). It has been recently determined that children as young as four-years use labeling to store and organize visual material in memory (Alegria & Pignot, 1979).

Given these findings, most children in the current study were expected to mediate verbally. However, neither reader group did. Therefore, the conditions for both good and poor readers under which spontaneous mediation occurs require further study. Type of task used in such studies may be of primary importance. The paired associate tasks selected for the present study were designed to elicit the use of verbal strategies. The consistent use of highly codible pictures as stimuli was an attempt to encourage children to select a verbal code. Other researchers have found that pictures facilitated children's performance on paired associate tasks (Reznick, 1977). The implication was that pictures elicited covert labeling of simuli which facilitated performance.

However, both the measures of overt verbal labeling and self reports indicated that only a few children verbally mediated. Either there actually were very few children who used mediation, or the measures of mediation were not direct enough. Although the current study attempted to assess verbal mediation through overt verbal labeling and self reports, the paired associate tasks selected may be criticized for not creating a condition in which only a verbal code would be selected. A more direct method for determining that a verbal strategy was used has yet to be developed.

Results of the present study indicate that even in normal children, the conditions under which verbal mediation occur, are not well understood. Such conditions include the nature of task. Further studies should utilize a procedure in which more children would be induced to select a verbal strategy.

The literature has indicated that another, more direct way to assess verbal mediation is to see whether children who do not use verbal mediation spontaneously can be trained to do so. Experiment II investigated the effects of verbal mediation instruction for poor readers.

Paired Associate Task: Verbal Labeling Instruction, Experiment II

Poor readers were also significantly poorer than good readers, on learning a new set of picture-abstract shape pairs (Set 4), regardless of the instructional condition or the order of task presentation. As might be expected, poor readers in Experiment II improved their performance over Experiment I but were still significantly lower than good readers, who had also increased their performance in Experiment II.

These data indicate that, at least for the poor readers, the instructional condition differentially affected the reader groups' performance on Set 4 in a direction opposite to expectation. Contrary to prediction, subsequent learning of both reader groups in the Verbal Labeling Instruction condition was significantly poorer than the reader groups in the No Verbal Instruction condition.

Before interpreting these findings with reference to verbal mediational ability, it should be pointed out that task presentation order was confounded with the verbal instruction condition. All subjects in the No Verbal Instruction condition performed Set 4 directly following Experiment I. Appendix 7 presents the experimental task orders. Task presentation order had been designed to minimize the effects of verbal labeling cues given before Set 4 was administered. If either the Labeling Measure or the Metamemory Questions had been given prior to Set 4, there would have been a risk of cuing the group to use verbal labeling strategies. The improvement on Set 4 of both reader groups in the No Verbal Instruction condition, may be accounted for by two factors. These factors are either experimental practice and/or the short latency between performing the first set of abstract shape tasks in Experiment I and the second set of abstract shape tasks in Experiment II.

On the other hand, all subjects in the Verbal Instruction condition received Set 4 at the end of the series of four experimental procedures. All subjects in this condition received both the Metamemory Questions and the Labeling Measure prior to the Verbal Labeling Instruction and before attempting Set 4. Several factors may have contributed to the poorer performance of both reader groups under Verbal Instruction:

Experimental fatigue may have affected both reader groups in this condition by decreasing their scores on learning Set 4. It was also observed that good and poor readers found the Verbal Labeling Instruction an amusing and somewhat awkward procedure. It is possible that even if the coding strategy used by some children were primarily verbal, it was highly idiosyncratic. Finally, imposing a general verbal labeling strategy for all children may have interfered with a unique verbal strategy which was already working effectively for some children.

To explain any effects of Verbal Labeling

Instruction on poor readers, two assumptions had been necessary. First, poor readers should have shown deficient performance on visual paired associate learning tasks and secondly, poor readers should have been deficient in generating labels to visual stimuli. Since the requirements of only the first assumption were met, the original hypothesis was not valid.

Although test fatigue confounds scores of the Verbal Instruction versus No Verbal Instruction groups, the performance of poor readers within each instructional condition can be examined. Within each instructional condition, poor readers' scores were lower than good readers'. In spite of an inability to evaluate the overall effects of Verbal Instruction as presented in Experiment II, it can be argued that Verbal Labeling Instruction did not have a differential effect on poor readers since the performance of both reader groups in the Verbal Instruction condition was decreased. The fact that Verbal Instruction failed to differentially effect poor readers' learning, again provided no support for differing mediational abilities. Within the context of the current experimental situation, effects of mediational strategy instructions appeared similar. However, there may still be some children in each reader group who do use such strategies and some who do not.

In summary, results of Experiment II did not support the expectation that the paired associate learning of poor readers would be increased following instruction in verbal labeling.

Summary and Conclusions

It was not the intention of this investigation to limit the interpretation of reading disability to either a visual perceptual deficit view or a verbal encoding deficit view. Both linguistic and perceptual processes are most likely involved to different degrees at different ages. Results of the present study are in agreement with Fletcher and Satz's (1979) criticism of Vellutino's specific visual-verbal deficit view and take exception to any unitary view of reading disability. The results of Experiment I suggest that poor readers, at least for the ages studied here, do experience some form of perceptual learning deficits which are evident only in certain learning contexts.

Although performance of poor readers was significantly lower than good readers for visual paired associate tasks at all levels of codibility, the codibility of material presented initially, differentially affected reader groups' performance on subsequent learning tasks. Good readers' performance was better when highly codible material was presented first, while the performance of poor readers was better when the low codible material was presented initially. This finding is interpreted in terms of differential activation of verbal and visual coding strategies by good and poor readers.

The Labeling Measure clearly indicated that good and poor readers could name all stimuli with equal facility. Therefore, it is concluded that a label production deficiency does not explain poor readers' lower performance on visual associative learning tasks. Explanation for such performance decrements may exist at other levels of cognitive processing, such as differential use of verbal mediational strategies. However, failure to find significant reader group differences on direct measures of verbal mediation, such as observations of overt labeling and self reports, does not exclude the importance of such factors in poor readers' learning and memory. Measures of verbal mediation used in the present study may not have been adequate.

In many of the developmental studies of verbal mediation and perceptual learning, lack of overt verbal responses was taken as evidence of failure to mediate verbally. Such observations do not negate the possibility of covert verbal responses (i.e. subvocal rehearsal) being used to strengthen perceptual learning. Differences in engaging in covert labeling could not be measured directly in the present study. Reliance on observations such as lip movements, whispers, and self reports, also used by other researchers (Flavell et al., 1966; Keeney et al., 1967; Kastner & Rickards, 1974), may not provide a sensitive enough measure of verbal mediation. Future research should concentrate on developing methods for a more valid assessment of verbal label usage.

The present study also points out the need for a visual perceptual task which clearly ensures that a child select a verbal rather than a visual strategy. Only then can the conditions be specified under which both good and poor readers use each strategy.

Although Experiment II was an attempt to use another task to assess differential use of verbal mediation, both good and poor readers failed to demonstrate improvements in learning following verbal training. However, the previously discussed confounding of task order with instructional condition, also indicates this paradigm to be an inadequate test of the use of verbal mediation. In spite of the methodological difficulties in this measure, and others previously discussed, the differential performance of poor readers on perceptual tasks as a function of order, suggests that verbal mediational strategy deficiencies may still characterize poor readers.

In this way, results of the current investigation have contributed some ideas about verbal mediational factors which broaden the concept of the production deficiency stage for both good and poor readers. Previous definitions of production deficiency have been limited to a description of the facilitating effects of verbal mediational training on children's learning and memory (Kendler, 1963; Keeney et al., 1967; Reese, 1976). The differential performance of reader groups in Experiment I as a function of the order in which either high or low codible tasks are presented, suggests that factors other than verbal labeling training alone, may account for children's selection of a particular mediational strategy. This finding provides some evidence that specific learning contexts may determine differential use of mediational strategies by good and poor readers.

Recent elaborations of the theory of the development of rehearsal strategies in children's memory (Flavell, 1970; Wright & Vliestra, 1975; Cramer, 1976; Nelson & Kosslyn, 1976; Scarborough, 1977) may offer a more complete understanding of the availability and use of verbal rehearsal strategies during both visual paired associate learning and visual memory which can than be applied to a study of poor readers. There is a need for a developmental study of the use of verbal rehearsal strategies for both good and poor readers which includes training in the use of verbal labels for learning a variety of materials in both long and short term memory conditions.

Implications for Remedial Education

Research in reading disability can make some limited suggestions about the direction remedial education might take. The finding in the present study of differential associative learning for good and poor readers, related to the order of presentation of both high and low codible visual materials, is one such example. It can be suggested that visual materials initially presented to reading disabled children should be unfamiliar and low in codibility. Since presentation of this type of material first, resulted in better performance of poor readers on more highly codible tasks such as letters, such a strategy may prove effective in the teaching of reading disabled children. However, only further research into the origin of this order effect (i.e. novelty of task or other explanations) can determine whether or not it can be effectively incorporated as a strategy in remedial educational programmes.

As present, the most important contribution any research in reading disability can make, is not to develop specific remedial programmes, but to clarify the dimensions along which the many skills involved in learning to read may vary among children. Only then, can programmes be established which take into account the specific problems of each poor reader. The importance of considering different learning styles i.e., differing uses of cognitive strategies and unique ability patterns among children, is key in any investigation of learning a process as complex as reading.

Footnotes

[1] Reading series used by all children in this study was the Ginn 360.

[2] Pearson Product Moment Correlation Coefficients (r) between age (in months) and mean paired associate task score were: for poor readers .21, for good readers .09 and for the combined reader group .03. When age was calculated in years, the correlations were: for poor readers .14, for good readers .17 and for the combined reader group .04. For df = 34, a correlation coefficient of .325 is critical for $p<.05$.

[3] Scheffé $F(.5,60) = 5.58$ for alpha level of $p<.10$.

[4] Scheffé F of 2.79 is cirtical at $p<.10$.

[5] Scheffé $F = 7.08$ for alpha level of $p<.10$.

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Appendix 1

INDIVIDUAL READING ABILITY SCREENING FORM

INDIVIDUAL READING ABILITY SCREENING FORM

Child's Name: ____________ Date of Screening ____________

Birth Date: ____________ School: ____________

Age: ____________ Class & Teacher: ____________

Maternal Language: ____________

Please estimate this child's reading ability (relative to the class Average) on the following general criteria:

I. ORAL READING SKILLS (Decoding - Word Analysis)	II. COMPREHENSION (Getting the Meaning from context)
Above Average: ______	Above Average: ______
Average : ______	Average : ______
Below Average: ______	Below Average: ______

Reading Series Used: ____________

Level or Book in Series at present: ____________

Other comments you feel one relevant to this child's current reading performance:

____

____

____

Appendix 2

Pilot data: determining codibility

The visual materials selected for use in the paired associate tasks for Experiments I and II were first evaluated for their codibility. Codibility was defined as the ease of producing verbal labels to each category of visual material. Fifteen grade three children (nine boys and six girls), mean age of 8.4 years, rated by their teacher as of at least average intelligence and reading ability, were selected from a middle class suburban school to pretest the experimental materials.

There were four categories of visual materials from which the experimental stimulus-response pairs would be chosen:

1. Pictures (70 items selected from the Peabody Vocabulary Test (PPVT) (Dunn, 1965).
2. Letters (20 capital letters used in the Morrison et al., 1977 study).
3. Geometric shapes (20 geometric shapes and also in the Morrison et al., 1977 study).
4. Abstract shapes (40 unfamiliar abstract forms used by Vellutino et al., 1975a, 1975b, 1975d).

There were 150 items drawn to a two inch scale, Xeroxed in black and white and presented on cards. The pictures and abstract shapes were drawn to be as similar as possible in number of lines and curves to the letters and abstract shapes. Stimuli with a large number of lines and curves were omitted from the sample. To control for order effects, stimuli were shuffled and presented in a random order to each subject. Subjects were tested individually outside the class room.

Each subject was asked to label (name) each item as quickly as possible. Maximum time for responding was 15 seconds. Latencies were recorded by digital stop watch. Two measures related to codibility were recorded for each subject: the latency to labeling each stimulus and the actual label produced by each subject. The accuracy of the labels was not assessed; codibility was defined by the ease of generating labels and the commonality of labels produced.

Each set of stimuli was rank ordered for latency to labeling. The overall mean reaction time scores (in seconds) to label production for each of the four types of visual material were as follows (from shortest to longest):

Letters (.65), pictures (.89), geometric shapes (1.95), and abstract shapes (3.78). Letters, pictures, and geometric shapes produced more commonality of labels. There was more variability in the labels produced to the abstract shapes.

Fifteen of each of the letters and geometric shapes and 30 of the abstract shapes, which were the easiest to label, (i.e. had the shortest reaction times and a high degree of common responses) were selected for use as responses in the paired associate tasks. Sixty pictures which had the shortest reaction times to label production were also selected as the stimulus items. All items chosen as experimental materials are presented in Appendix 5. Items not used in the stimulus-response sets were used as distractors on the response choice cards.

Appendix 3

Pilot Data

Selection of abstract shapes: control for visual complexity

A sample of 40 adults (36 females and 4 males) attending an undergraduate class in education were asked to rate the 30 abstract shapes for visual complexity. An explanation of the rating scale for visual complexity is given on the copy of the questionnaire presented in Appendix 4. Only abstract shapes with a score of three or less were selected for use as response choices. Those abstract shapes not selected for stimulus-response pairs appeared as distractor items on the response choice sheets.

Appendix 4

Rating Scale for Visual Figures

Age ____________

Sex ____________

Date ____________

Please rate the following figures on a scale of visual complexity as follows:

1. How complex visually would you say each figure is if you were presented with it briefly, asked to remember what it looked like and were expected to recognize it later from amongst other similar looking shapes?

Do not compare one figure with another; rate each figure separately. Circle the appropriate number on the scale: e.g.

Very Complex		Quite Complex				Quite Simple		Simple
5	:	4	:	3	:	2	:	1

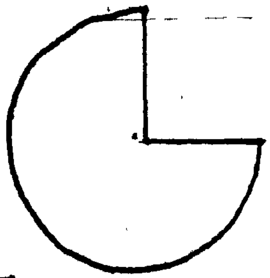
2. Please try to state what criteria you used to judge visual complexity:

____

____

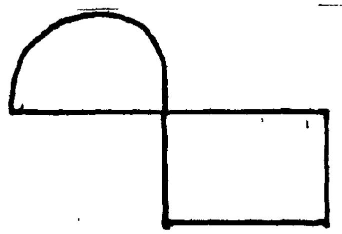
____

A



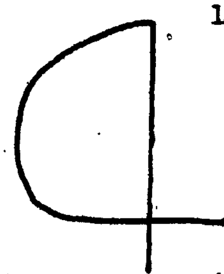
5 4 3 2 1

B



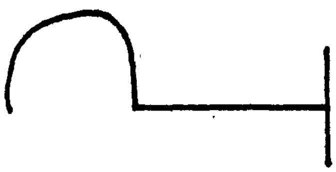
5 4 3 2 1

C



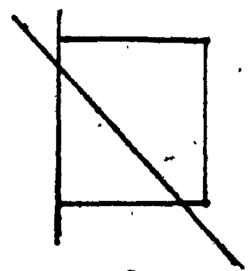
5 4 3 2 1

D



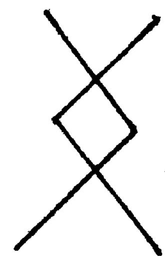
5 4 3 2 1

E



5 4 3 2 1

F



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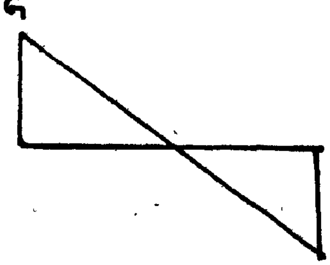

5 4 3 2 1

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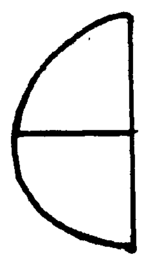

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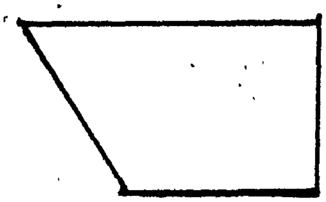

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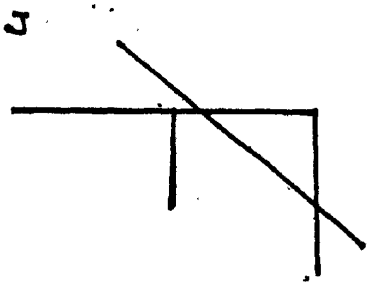

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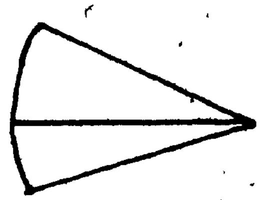

5 4 3 2 1

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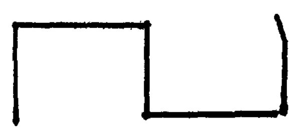

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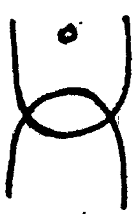

5 4 3 2 1

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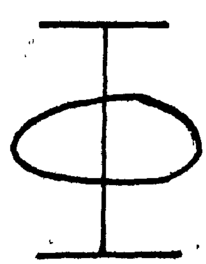
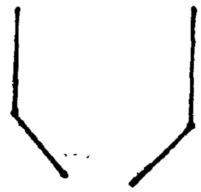


5 4 3 2 1

O

5 4 3 2 1

P



5 4 3 2 1

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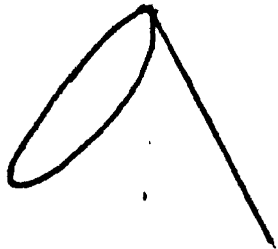

5 4 3 2 1

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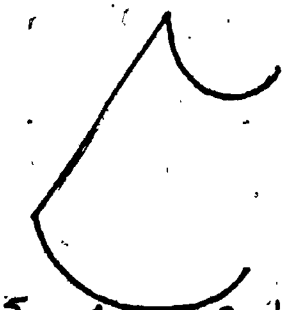
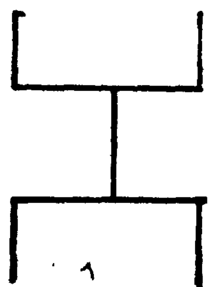


5 4 3 2 1

S

5 4 3 2 1

T



5 4 3 2 1

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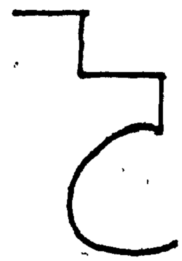

5 4 3 2 1

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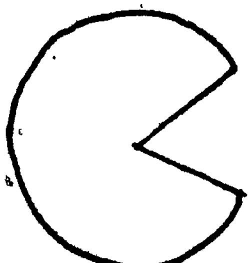

5 4 3 2 1

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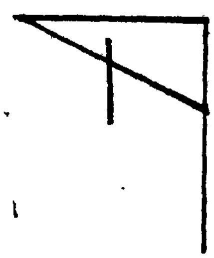

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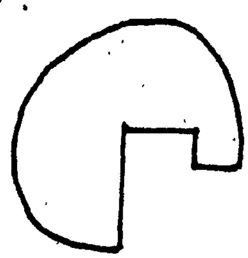

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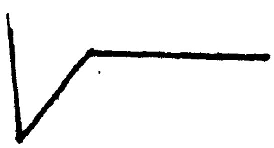

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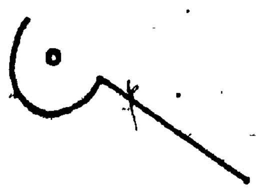

5 4 3 2 1

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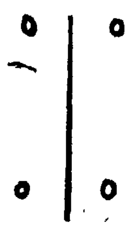
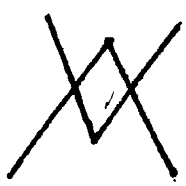


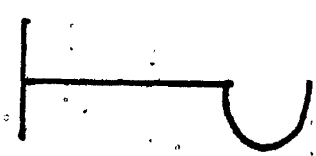
5 4 3 2 1

b



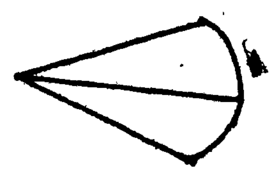
5 4 3 2 1

c



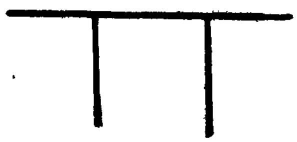
5 4 3 2 1

d



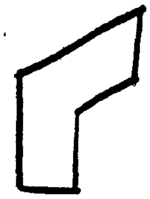
5 4 3 2 1

e



5 4 3 2 1

f



5 4 3 2 1

g

5 4 3 2 1

h

5 4 3 2 1

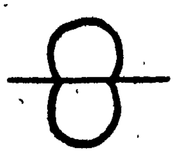
i

5 4 3 2 1

j

5 4 3 2 1

k



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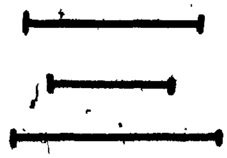
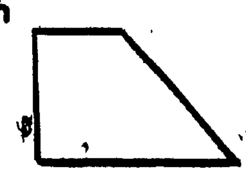


5 4 3 2 1

m



5 4 3 2 1

n

5 4 3 2 1

Appendix 5

Paired Associate Tasks for Experiment I

Set 1

(Pictures - Letters)

	Stimulus	Response
1	Cup	N
2	Jacket	W
3	Fish	B
4	Table	F
5	Banana	S
6	Brush	C
7	Purse	D
8	Guitar	H
9	Sailboat	P
10	Bat	L
11	Ring	E
12	Saw	J
13	Pie	T
14	Gift	A
15	Clown	Q

Appendix 5 (Cont'd)

Set 2

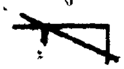
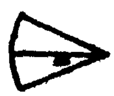
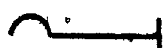
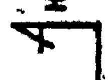
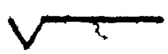
(Pictures - Geometric Shapes)

	Stimulus	Response
1	Mitt	✳
2	Horse	|
3	Chair	◇
4	Apple	+
5	Sock	△
6	Glass	☾
7	Bus	×
8	Umbrella	□
9	Iron	○
10	Leaf	→
11	Mop	$
12	Jug	⬯
13	Can	⌓
14	Fan	¢
15	Pin	▭

Appendix 5 (Cont'd)

Set 3

(Pictures - Abstract Shapes I)

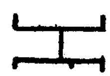
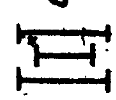
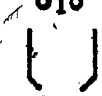
	Stimulus	Response
1	Knife	
2	Skirt	
3	Duck	
4	Bike	
5	Tree	
6	Shoe	
7	Kitten	
8	Tire	
9	Kite	
10	Spoon	
11	Thread	
12	Pail	
13	Snake	
14	Stove	
15	Shovel	

Appendix 5 (Cont'd)

Paired Associate Tasks for Experiment II

Set 4

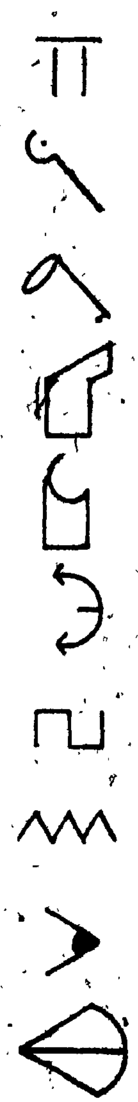
(Pictures - Abstract Shapes II)

	Stimulus	Response
1	Giraffe	
2	Train	
3	Lamp	
4	Net	
5	Watch	
6	Bowl	
7	Cone	
8	Hydrant	
9	Gun	
10	Seal	
11	Nest	
12	Vase	
13	Envelope	
14	Bee	
15	Wheel	

Appendix 5 (Cont'd)

Paired Associate Training Set for Experiment II

Stimulus	Response
5	
7	
2	
6	
1	
9	
3	
4	
10	
8	



Appendix 5 (Cont'd)

Picture-Picture Pairs (Practice Trial) for Experiment I

	Stimulus		Response	Response Choices		
1	Shirt	-	Crib	Crib	Wagon	Flag
2	Door	-	Pear	Clamp	Pear	Earing
3	Drum	-	Nail	Cone	Nail	Sink
4	Wagon	-	Cow	Canoe	Wheel	Cow
5	Axe	-	Bell	Tower	Bell	Horn

Appendix 6

Response Choice Sets for Experiment I

Set 1

	Stimulus	Response Choice		
1	Table	F	C	V
2	Sail boat	P	Q	L
3	Jacket	K	S	W
4	Saw	D	J	R
5	Clown	G	L	Q
6	Cup	H	R	N
7	Purse	D	E	F
8	Fish	D	B	M
9	Gift	A	P	I
10	Guitar	A	W	H
11	Bat	J	L	N
12	Banana	P	G	S
13	Ring	V	S	E
14	Brush	T	C	B
15	Pie	K	T	H

Appendix 6 (Cont'd)

Set 2

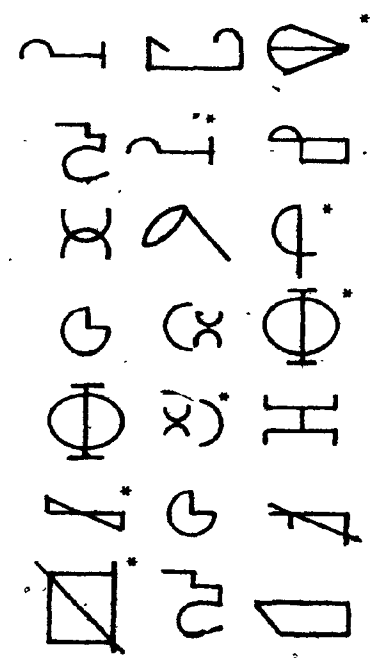
	Stimulus	Response Choice				Stimulus	Response Choice		
1	Chair	▭	◇*	→	9	Sock	◠	✕	△*
2	Mitt	✳*	$	○	10	Glass	▭	☾*	→
3	Bus	◠	|	✕*	11	Mop	☾	$*	→
4	Jug	0*	∼	▭	12	Iron	○*	¢	+
5	Apple	∼	+*	◊	13	Fan	¢*	△	○
6	Umbrella	$	□*	✳	14	Can	✕	◇	◠*
7	Horse	0	□	|*	15	Leaf	▭	✕	→*
8	Pin	|	▭*	+					

* = Correct response

Appendix 6 (Cont'd)

Set 3

	Stimulus	Response Choice
1	Duck	
2	Snake	
3	Knife	
4	Shovel	
5	Skirt	
6	Thread	
7	Bicycle	
8	Pail	

	Stimulus	Response Choice
9	Kitten	
10	Kite	
11	Tree	
12	Spoon	
13	Shoe	
14	Tire	
15	Stove	

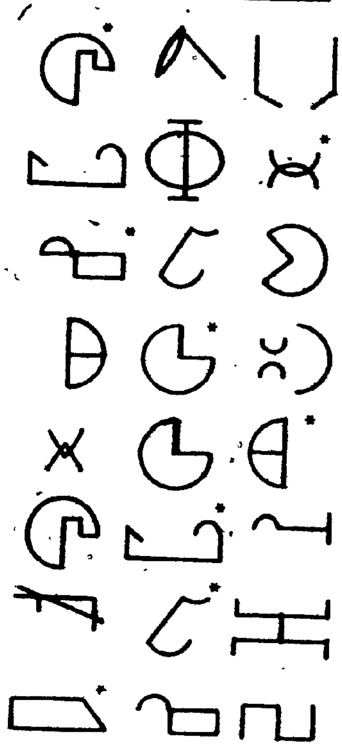
* = Correct response

Appendix 6 (Cont'd)

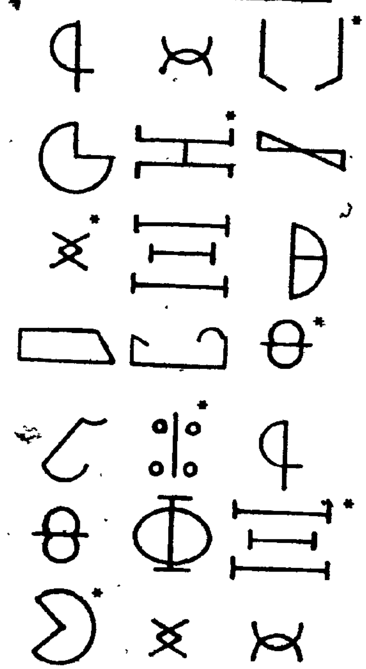
Response Choice Set for Experiment II

Set 4

Stimulus	Response Choice
1 Train	
2 Net	
3 Hydrant	
4 Giraffe	
5 Seal	
6 Cone	
7 Lamp	
8 Watch	



Stimulus	Response Choice
9 Bee	
10 Bowl	
11 Wheel	
12 Gun	
13 Envelope	
14 Nest	
15 Vase	



* = Correct response

Appendix 7

Order of Task Presentation for all Experimental Procedures

Order of Presentation	Verbal Labeling Instruction Group (n = 36) Good Readers n = 18 Poor Readers n = 18	No Verbal Labeling Instruction Group (n = 36) Good Readers n = 18 Poor Readers n = 18
I.	Experiment I (PAL Tasks)* Set 1. (High Codible) Pic/Letters Set 2. (Med. Codible) Pic/Geom. Shapes Set 3. (Low Codible) Pic/Abstr. Shapes	Experiment I (PAL Tasks)* Set 1. (High Codible) Pic/Letters Set 2. (Med. Codible) Pic/Geom. Shapes Set 3. (Low Codible) Pic/Abstr. Shapes
II.	Metamemory Questions	Experiment II (PAL Task) Training Set: 10 Abstract Shapes with No Verbal Labeling Instruction Set 4 (Test) Pic/Abstr. Shapes (II)