VISUAL FORM PERCEPTION: POSSIBLE DEFICITS IN CHILDREN WITH SPECIFIC READING DISABILITIES

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A Thesis
Presented for the
Master of Arts
Degree
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Teresa Logan Fryer
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DEDICATION

This thesis is dedicated in loving memory of
my brother, Randy Logan,
whose influence has steered my life.

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ABSTRACT

Various studies have found that children with specific reading disabilities (SRDs) suffer more than the average reader from interference factors when asked to perceive stimuli which are contained within visually confusing backgrounds. In addition, these children have been shown to have difficulty on measures of contrast sensitivity lending support to a proposed transient system impairment. To further explore this idea, children with specific reading disabilities and control subjects between the ages of 7 and 10 years were assessed with several visual perceptual tasks. The measures employed were the Frostig Developmental Test of Motor-Reduced Visual Perception, a reduced-contrast letter acuity test, and a computer generated texture-defined form test. The texture-defined form test failed to demonstrate differences between the two groups, however, a significant difference between groups was found for the contrast sensitivity test and the visual perception test. These results offer additional evidence to support the hypothesis that individuals with SRDs have a transient system deficit related to an underlying temporal processing impairment.

TABLE OF CONTENTS

LIST OF FIGURES

FIGURE PAGE

CHAPTER I

INTRODUCTION

The literature which exists on the relationship between reading difficulties and visual dysfunction is voluminous and complicated (Suchoff, 1981). Problems arise when teachers of children with reading disabilities attempt to understand the literature investigating vision and visual dysfunction. Teachers who suspect a possible visual deficit in relation to reading are unlikely to understand the studies and language familiar to vision researchers. Therefore the current study attempts to:

1. propose a working definition of dyslexia and specific reading disability (SRD)
2. review the literature suggesting dyslexia subtypes
3. review the research investigating specific reading disabilities and visual dysfunction, including studies that do and do not fail to find a relationship
4. review studies linking specific reading disabilities and visual dysfunction
5. describe the distinction between the transient and sustained visual systems and examine the evidence linking SRDs with a transient system deficit
6. investigate form perception abilities in children with SRDs
7. investigate the importance of texture segmentation in visual form perception in children with SRDs

Defining Dyslexia and Specific Reading Disabilities

Dyslexia is a term used to describe a severe reading problem that is unrelated to intellectual ability, emotional disturbance, gross sensory or physical handicaps, socio-cultural status, or insufficient schooling (Pavlidis, 1981). Dyslexia is most often operationally defined in terms of a performance discrepancy; that is, despite adequate educational opportunity, the reading ability of a child with dyslexia is significantly lower than that predicted from their age and I.Q. (Critchley, 1970). The process of diagnosing dyslexia usually begins when parents or teachers recognize a reading or comprehension failure (Griesbach, 1993).

Of all human maladies that account for learning disabilities in young and old alike, few are as poorly understood as dyslexia. Dyslexia has become a generic term that refers to an extraordinary difficulty experienced by otherwise normal children in the ability to identify the printed word (Vellutino, 1987). In his book, The Minds Eye, Thomas West describes the many different definitions associated with dyslexia as a "constellation of terms." In 1976 there were "2,400 annotated terms confined to dyslexia, and this was considered less than a complete list" (Rawson, 1988).

In a review article, Griesbach (1993), describes dyslexia as a range of difficulties that are diverse and confusing. Each child with dyslexia may have different symptoms of dysfunction, some being more pronounced while others being subtle and difficult to diagnose. As children progress through school, the difficulty of learning to read and reading orally may be noted. There may be a persistent difficulty learning and applying the rules of capitalization and punctuation even into adulthood. Children as well as adults with dyslexia often have difficulty with handwriting, and their efforts are described as labored and heavy-handed. The problems connected with dyslexia are complex and confusing. Not every symptom will be found in every child with dyslexia. Researchers have been interested in the etiology of reading disabilities for a long time, but a current agreed upon conclusion is that dyslexia probably arises from a variety of causes, some of which may be interrelated (Whyte, 1994).

In 1979 a list of fourteen indications of dyslexia was presented by Wheeler and Watkins: (1) directional confusion (left/right), (2) writing and spelling impairment, (3) finger differentiation problems, (4) visual perception deficiencies, (5) handedness and cerebral dominance abnormalities, (6) weakness in memory storage, (7) negative maternal and natal factors, (8) motor dysfunctions, (9) delayed maturation, (10) delayed speech development, (11) minimal neurological dysfunctions, (12) familial or inherited disability, (13) sex differences (prevalence), (14) language delays. One problem with this list is the lack of criteria defining symptoms necessary to present a diagnosis of dyslexia.

Many people with dyslexia have learned to compensate for their disabilities, and so if one looks at their ability to read the written language, no abnormalities may be observed. However, their problems will surface under other circumstances, such as in the reading of nonwords and unknown words. Research has shown a strong relationship between the ability to sound out words (phonological awareness) and progress in learning to read (Tallal, 1980; Tonnessen, 1995).

Because definitions of dyslexia generate more controversy than clarity, some working definition is necessary to be able to compare studies performed in different laboratories. An initial step towards a definition was made by Rutter and Yule (1975), who make a distinction between children who are specifically reading retarded and the generally backward reader. They state that general backwardness is present in both boys and girls and is usually determined by one or more of a wide range of neurological dysfunctions or low intelligence. These children are more commonly found in large, low socio-economic status families. Specific reading retardation, more commonly referred to as specific reading disabilities (SRDs), is more specifically associated with delay in development of speech and language and much more common in boys (a ratio of approximately 3:1). It is also more common in large families. In addition, Rutter and Yule found that children with specific reading disabilities made less progress in reading and spelling than backward readers over a four- to five-year period, even though they had higher intelligence quotients. At the same time, however, they did make more progress in mathematics as reviewed in Rutter & Yule (1975).

In attempts to provide a working definition of dyslexia, the subjects identified for the present study are referred to as children with specific-reading-disabilities (SRDs). The use of the term SRD may not be strictly equivalent to Rutter and Yule's (1975) term "specific reading retardation," but no differentiation is made between the two. School-age children who fall in this category are estimated to range from 4% to 15% of the school age population making reading difficulties a substantial problem in our society.

The prevalence of dyslexia is also controversial. Some researchers maintain that there are groups of children with specific disabilities and research should always take into account the existence of visual and auditory subtypes (Reddington & Cameron, 1991). Others have suggested that dyslexia merely represents the lower end of a normal distribution of reading performance (Shaywitz, Fletcher, & Shaywitz, 1995). While still others argue that we are finding severe degrees of reading retardation at a rate above that predicted on a statistical curve, suggesting a "hump" at the lower end of the normal distribution (Rutter & Yule, 1975). However, this analysis could be misleading. Shaywitz et al. argue against a "hump", that these individuals represent a normal distribution. Thus, failing to find a dip would mean that dyslexia cannot be characterized as discrete and must be a condition that can vary in degree, some people being more dyslexic than others. Abelson (1995) argues that the Shaywitz et al. data and conclusions arise from a hidden problem of measurement error. The diagnostic scores used in their research consisted of the difference between an overall IQ score and the score on a reading test. Abelson adds that although a gap or dip in a distribution implies a mixture of underlying processes, the failure to find a dip could be caused by the effects of measurement error.

Investigating Dyslexia Subtypes

Some of the defining characteristics of dyslexia are not found in all individuals with this diagnosis. Lovegrove, Martin, and Slaghuis (1986) found approximately 75% of children with SRDs suffered from a visual pathway deficit, suggesting a significant number do not suffer from a deficient visual pathway. Borsting, Ridder, Dudeck, Matsui, and, Motoyama (1995) suggest that studies investigating processing deficits in specific reading disabilities that find negative results could be biased in favor of subjects without a visual processing deficit. Neurological studies of specific reading disabilities support the idea of distinctive subtypes by identifying different areas of the brain that affect reading ability (Borsting et al., 1995). The type of dyslexia may determine whether visual perceptual losses are found. Borsting et al. found that the relationship between a visual pathway deficit and the language components of reading is not clear. In their study they identified characteristics of students with dyslexic language errors using an approach advocated by Boder (1971). Boder identified three subtypes of dyslexia: dyseidesia, dysphonesia, and dysphoneidesia. She defined dyseidesia as a deficit in the ability to perceive whole words as visual gestalts and match those words with auditory gestalts. For example, phonetically regular words like "stop" and "did" present no problem for correct decoding, but phonetically irregular words like "laugh" and "does" may not be decoded correctly. The prevalence of dyseidesia is estimated to be from 10 to 30% of children with dyslexia. The second type, dysphonesia, is a deficit in word analysis and synthesis skills. Children presenting with dysphonesia have difficulty using grapheme-phoneme relationships when encountering unfamiliar words and sometimes make semantic substitutions during reading. An example of dysphonesia is substituting the word home for house. Additionally, their spelling errors are not adequate phonetic equivalents. The range of estimated prevalence of dysphonesia is from 55% to 70%. The third type of dyslexia is a combination of the previous two types of deficits. This type is given the name dysphoneidesia. The prevalence of this third type of dyslexia is approximately 10% of children with dyslexia. The study concluded that the presence of a visual pathway deficit appears to vary by the type of dyslexia with the subgroup dysphonesia making up the largest deficit group. Therefore, future investigation may profit from subtyping specific skill deficits prior to studying the capabilities of poor readers. This method would ensure more homogeneous groups and make it easier to link specific skill deficits with special subgroups.

Research Failing to Link Specific Reading Disabilities and Visual Dysfunction

Many researchers interested in reading disabilities adopt the view that disordered language processing is the main reason for children's reading difficulties and that visual problems are rarely causal (Eden, Stein, Wood, & Wood, 1995; Reddington & Cameron, 1991; Tallal, 1980). A great deal of evidence has been collected showing that specifically disabled readers frequently have varying forms of language deficiency (Hulme, 1981; Vellutino, Pruzek, Steger, & Meshoulam, 1973). Areas of difficulties include phonological coding deficits, phonemic segmentation deficits, poor vocabulary development, and difficulty in discriminating grammatical and syntactic differences among words and sentences (Patterson & Marcel, 1977; Snowling, 1980;). These results led to the "no visual deficit hypothesis" of reading disability (Jorm, 1983 & Vellutino, 1987). Vellutino conducted a series of studies in which children were instructed to reproduce, from visual memory, words from an unfamiliar Hebrew writing system. After short exposure to the Hebrew symbols, children with dyslexia and normal readers were requested to print Hebrew words and letters in the correct sequence and orientation. Children with dyslexia performed as well as the normal readers on the task. Vellutino concluded that when complex, wordlike symbols had no meaning and no sound, the ability to visually recall those symbols was no different for the poor readers than it was for the normal readers. Vellutino deduced that visual memory for symbols representing words is determined by the linguistic associations of those words including their meanings and sounds. An inference that Vellutino makes is that the dyslexic readers could hold a memory trace in their sensory memory for just as long as the normal reader. Visual form perception appeared to be similar in both groups. Although studies by Vellutino have been criticized on methodological grounds, they are widely accepted. However, these studies only investigated one aspect of visual perception.

Other supporters of the no visual deficit theory base their hypotheses on the unsuccessful programmatic application of visual perceptual therapy (a non-scientific effort to treat the deficit) with reading disabilities. Hammill (1972), reviewed the literature on the effectiveness of visual perceptual therapy on subsequent reading performance and concluded that visual perceptual training had no consistent positive effects on reading performance. Recent studies have shown that previous investigations failed to find a visual deficit, not because they do not exist, but because we lacked knowledge about the visual processes and mechanisms involved in normal reading (Lovegrove et al., 1986). Much more is known today about such processes.

<u>Research Linking Specific Reading Disabilities and Visual Dysfunction: Evidence For a Transient/Magnocellular System Impairment</u>

Visual deficits have been proposed to be at least partially responsible for the inability to read ever since the first recorded reports of dyslexia appeared around the end of the last century. Since then numerous studies have found visual deficits associated with dyslexia, including Evans, Drasdo, and Richards (1994); Lovegrove, Garzia, and, Nicholson (1990); Lovegrove et al. (1986); Stanley and Hall (1973); Williams and LeCluyse (1990). Their results lend support for the hypothesis that a reading disability is accompanied by a visual dysfunction. It is not always clear how these deficits relate to the reading process, however.

One theory that has gained wide attention and acceptance is that SRD is related to a functional deficit in one of the two parallel subsystems that operate from the retina to the visual cortex (Lovegrove et al. 1986). Physiological and anatomical studies of the primate visual system have found similar separate processing systems. In primates, separate visual channels, called the magnocellular and parvocellular systems, are responsible for perception of form, color, movement, and depth (Livingston & Hubel, 1987). The magnocellular and parvocellular pathways have physiological properties that result in them being called the transient and sustained systems, respectively (Williams & LeCluyse, 1990). For the remainder of the present study, these two pathways will be referred to as the transient and sustained systems.

The transient system controls the perception of motion and depth, brightness discrimination, eye movement and targeting objects in space, and the ability to quickly analyze a global visual scene (Williams & LeCluyse, 1990). The transient system is primarily a flicker or motion detecting system and is more sensitive to low spatial frequencies (Lovegrove et al., 1990).

The sustained system is very sensitive to high spatial frequencies, transmits detailed information about the visual stimulus, and plays an important role in pattern detection. The sustained system earns this name because it responds throughout the duration of stimulus presentation and continues for a brief time after the stimulus is removed, causing a visible persistence (Lovegrove et al., 1990).

These two systems mutually inhibit each other. The most common operation being transient-on-sustained inhibition (Breitmeyer & Ganz, 1976). It is believed that the transient system operates preattentively functioning as a warning system and directing the sustained system to areas where it might need to perform a more detailed analysis of an object. The function of the sustained system would then depend upon the earlier performance of the transient system (Williams & LeCluyse, 1990). The transient system naturally inhibits the continuing sustained system response, lessening the duration of the stimulus persistence. Termination of the sustained response enables the visual system to separate the information at each visual fixation. The results would be stable, flowing visual input resulting in smooth fluid reading. In a series of studies with specifically reading disabled readers age 8 and 15 years, a significant increase of visual persistence was found with increasing spatial frequency when compared to normal readers (Lovegrove et al., 1990).

Visual persistence is defined as the continuation of a response after the removal of a stimulus. Laboratory studies have shown that following a visual presentation, the stimulus continues to be "seen" for a brief period of time (Bowling & Lovegrove, 1981). In a series of experiments, Lovegrove and others (1990) measured visible persistence in children with SRDs and normal readers. The SRD group had a significantly smaller increase in visible persistence duration with increasing spatial frequency than did the control group. Visual persistence may cause a reader to continue seeing information from one fixation while concentrating on the next fixation. This could cause an overlapping of text when reading (see Figure 1). This would not happen for most readers.

Williams and LeCluyse (1990), concluded from their visual persistence studies that if children with SRDs have weak transient systems causing successive superimposed fixations, reading would be terribly confusing. From this information, they deduced that children with SRDs would perform better on reading tasks that required no eye movement. Williams and LeCluyse also demonstrated how comprehension is affected by eye movements. Their subjects consisted of children reading at least 1 year below grade level

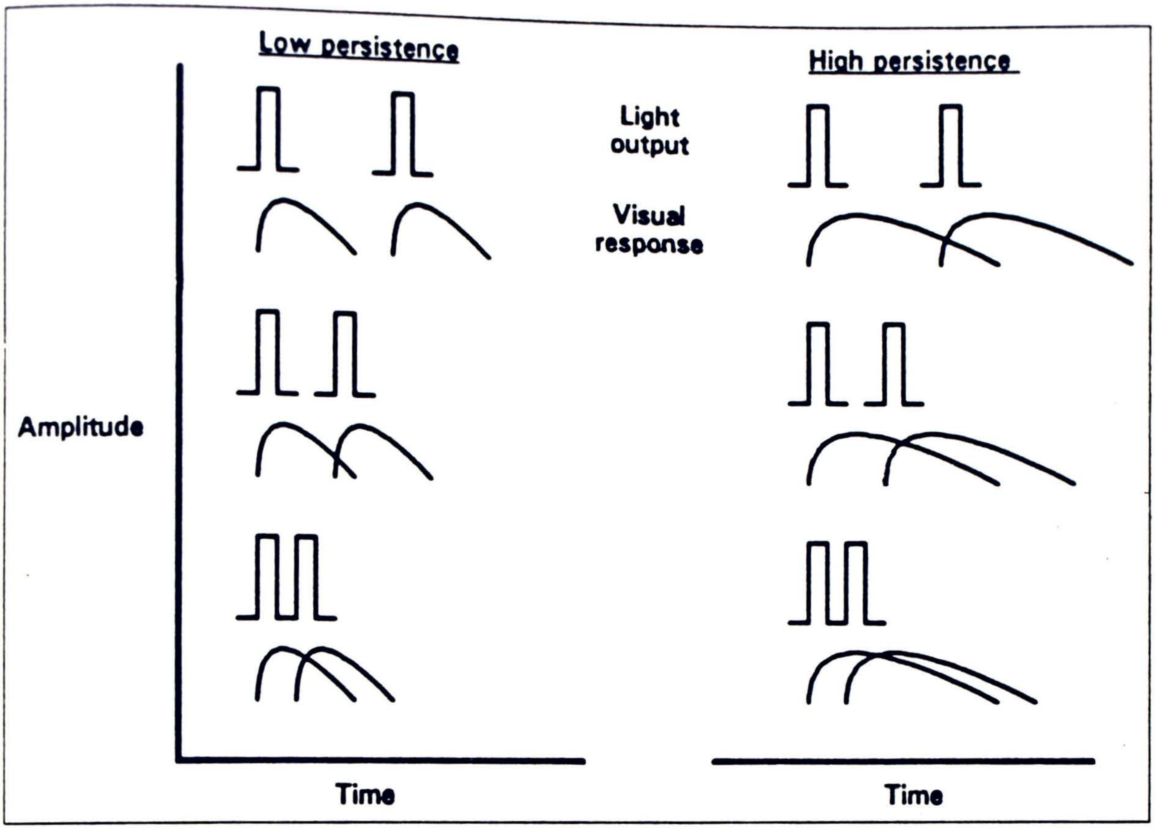


Figure 1. Visual Persistence. Readers continue seeing information from one fixation while concentrating on the next fixation causing an overlapping of text when reading.

and children reading at or above grade level. By using a video display, passages of text were displayed in two ways; line by line and single word. Reading comprehension of reading disabled children was reduced with the line by line method. These results show that demanding eye movement in the reading process has a detrimental effect on reading comprehension in children with SRDs.

Of interest currently is the transient and sustained systems' response to color when metacontrast masking is part of the model. Meta contrast is a measure used to investigate the transient system's suppression of the sustained system responses. A target stimulus is presented briefly followed by a surrounding mask. The visibility of the target is suppressed when the rapid transient system's response to the mask is briefly superimposed on the slower sustained system's response to the target. The metacontrast function reflects the effects of transient system inhibition of sustained system responses. Edwards, Hogben, Clark, and Pratt (1996) conducted studies of metacontrast function in adults, average reading adolescents and adolescents with SRDs to examine the magno system response. Results showed that a red background field compared to a white background field lessened metacontrast magnitude in all groups. Also, the adolescents with SRDs exhibited weaker metacontrast that the average adolescent readers. These results indicate a continuing transient system deficit in people with SRDs beyond their childhood years.

Another large body of evidence for a transient system deficit in specific reading disabilities can be found in studies of contrast sensitivity. Lovegrove et al. (1986), reported that 75% of children with reading disabilities demonstrated poor performance on a measure of contrast sensitivity. Lovegrove describes contrast sensitivity as the minimum amount of contrast necessary to perceive a grating pattern. Lovegrove et al. compared the luminance contrast sensitivities of children with dyslexia and controls. Children with specific reading disabilities showed a small but consistent sensitivity loss at low spatial frequencies (see Figure 2). Although there was a reduction in the sensitivity for certain frequencies, it is not clear how these deficits would be directly related to reading difficulties.

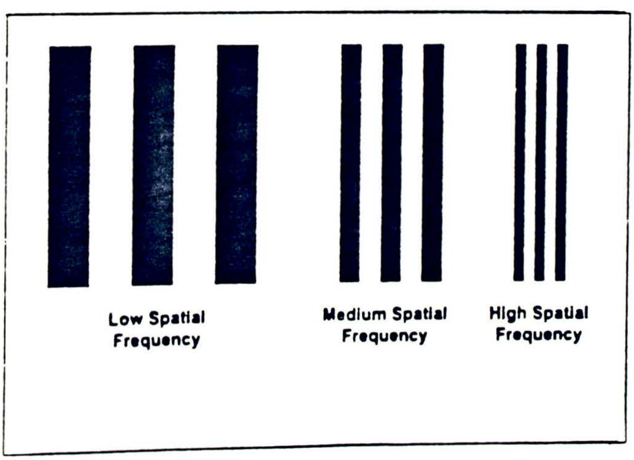


Figure 2. Spatial Frequency

A transient system deficit may also effect reading performance in an additional way. When reading, visual attention is first directed to the foveal area to retrieve information from the fixation point. After a period of time necessary to process the information, attention is then allocated to the parafoveal areas to the right of the point of fixation. This attention shift occurs before the actual eye movement. A dysfunctional oculomotor pattern has been found in children with SRDs. With increased fixation durations and smaller saccade lengths, the ability to shift attention forward in reading is affected (Henderson, Pollatsek, & Rayner, 1989). Studies have shown that disabled readers are not able to allocate visual attention across visual space (Bouma & Legein, 1977; Eden, Stein, Wood, & Wood, 1995). Readers with SRDs were not able to accurately determine information to the right of the fixation point. The normal reader looks ahead in the line of print to the right of the foveal area when reading. The ability to "see beyond" aids in fluency and comprehension. The ability to allocate visual attention is critical for processing information in reading. This inability could be related to a transient system deficit in peripheral vision.

Studies have also shown evidence of impaired critical flicker frequency (CFF) in children with SRDs. CFF is the rate at which a flickering light is seen as continuous. Chase and Jenner (1993) found CFF to be lower in individuals with dyslexia. By manipulating contrast and spatial frequency, Martin and Lovegrove (1987) found SRDs had reduced visibility to rapidly moving or rapidly flickering stimuli. These findings are consistent with a transient system deficit.

Another line of evidence for the proposed transient deficit was carried out through anatomical studies. Livingstone, Rosen, Drislane, and Galaburda (1991) compared the brains of five normal readers with the brains of five dyslexic readers. They found that the ventral, magnocellular (transient) layers of the lateral geniculate nucleus (LGN) in the brains of the dyslexic readers contained fewer and smaller cells than the magnocellular layers of the brains of the normal readers. The two groups did not differ in the cell sizes of the parvocellular (sustained) layers of the LGN.

Just recently the literature has provided a study of visual motion processing (Eden et al. 1996). Using functional magnetic resonance imaging (fMRI) while viewing moving dots, this study revealed a physiological anomaly in the dyslexic brain. The viewing of randomly moving dots failed to activate an area of the brain at the junction of the occipital and temporal lobes. Striking differences were found between the volunteers with dyslexia and control volunteers. Not only was a physiological difference discovered, but the volunteers with dyslexia had a significant impairment in detecting visual motion. Eden and others present these findings as further evidence for a transient deficit in people with dyslexia.

Much evidence has been presented for a proposed transient system deficit in children with SRDs. These lines of evidence include luminance contrast sensitivity studies (brightness discrimination), visual persistence and visual masking studies (eye movement), flicker sensitivity (temporal processing), and just recently, motion processing.

<u>Research Linking Form Perception and Reading</u>

Reading is a learned skill which does not occur without an ability to first identify and focus on certain stimuli, separating figure from ground. (Whyte, 1994). In 1977, Bouma and Legein found that children with specific reading disabilities scored significantly worse on an embedded figures task. The children had difficulty recognizing lower case letters embedded between two letters (xax) and words placed slightly left or right of the central area of greatest visual acuity, the parafoveal area, when presented for 100 msec. However, no difference was found between groups identifying single letters. This finding led to the suggestion that the difficulty of recognizing words was due to a problem with visually recognizing letters embedded within words (Fisher & Frankfurter, 1978). Engel (1974), also found that single isolated stimuli are easily found in parafoveal vision, since they are free from interference effects.

In another experiment, Snowling (1980), found that children with reading disabilities may be less certain than nonreaders (i.e. younger children or peers with no reading ability) as to whether embedded letters in words are the same or different. Pairs of nonwords were presented to the disabled reader at four reading age levels (7, 8, 9 & 10) so that the middle letters in each word were transposed (e.g., sond-snod). She found that the disabled reader's performance in visual matching did not significantly increase with reading age as did normal readers. She therefore deduced the possibility of a "visual form constancy" difficulty in dyslexia.

Visual Form Constancy and Figure-Ground are two subtests of the Frostig DTVP mentioned earlier in this paper. According to Hammill, Pearson, and Voress (1993), form constancy involves "the recognition of the dominant features of certain figures or shapes when they appear in different sizes, shadings, textures, and positions;" and figure-ground involves "the recognition of figures embedded within a general sensory background" (p.2). On the basis of clinical and classroom observations, Frostig (1967) asserted that problems in discriminating between similar letters and similar words are indicative of form constancy problems. Form constancy refers to a high-order visual discrimination ability that allows people to recognize that a figure is essentially the same regardless of whether it appears in a different size, position, texture, color, or shading.

Feild and Feild (1974) found that poor readers compared to normal readers have difficulty reading four letter words when placed against confusing backgrounds. They found that dyslexics suffer from interference factors when visual stimuli are contained in confusing backgrounds. In the Form Constancy subtest, the subject must decide if various shapes are still the same figures when they are placed in confusing backgrounds or embedded within other figures. Feild and Feild equate this situation to a reader discriminating letters that are embedded within other letters in words when reading. In both of these tasks, the reader is presented with a background interference effect, or visual "noise."

In a double-blind experiment investigating visual and auditory problems, Reddington and Cameron (1991), compared 17 children with dyslexia between the ages of 7.25 to 10.25 years with 17 normal readers matched for chronological age and intellectual ability. A significant negative correlation was found for the dyslexics, but not for the normal readers on the Form Constancy subtest of the Frostig Developmental Test of Visual

Perception (DTVP).

Bouma and Legein (1977) found no differences between the scores of children with reading disabilities and normal readers when tasks involve simple visual stimuli. However, if the visual stimulus is a complex configuration requiring visual analysis, children with SRDs are reported to score lower than the control children in their age group. It is concluded that children with specific reading disabilities have more difficulties than their control peers in distinguishing properly between figure and ground or seeing relations between parts and wholes.

Form Perception Based on Differences in Texture

Bergen (1991), describes textures as smooth or rough, glossy or matte, or having the qualities of sand, wax, velvet, leather, fur or various other substances. Texture information is used to help distinguish objects from their background. We can perceive shapes defined by texture only, although this happens infrequently in the natural world. Normally texture is accompanied by differences in color and brightness. In Figure 3, we easily see an area that is visually different from the background surrounding it. The shape is seen effortlessly, even though the surrounding area is no different in brightness or color. This phenomenon has been described as "texture-based segmentation." Figure 4 shows an example of textures that do not segment easily. Texture segmentation has received much

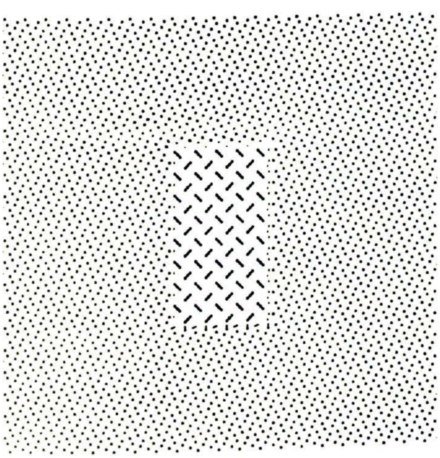


Figure 3. Example of perceptual texture based segmentation.

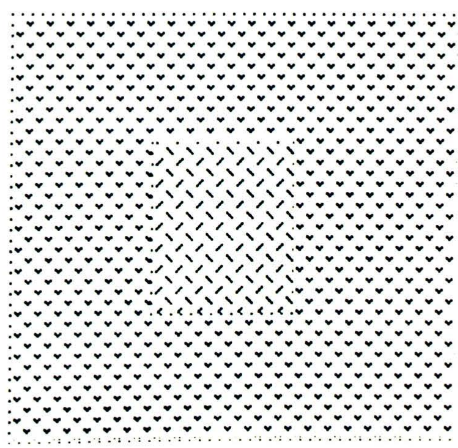


Figure 4. Example of perceptual texture that does not easily yield perceptual segmentation

theoretical attention, although it is still not obvious which textures will segment. The distinction between textures that segment and ones that do not is unclear (Bergen, 1991).

There is a limit to what we are able to process visually at a given instant. Characterizing this limit has been the focus of much research. One strategy is measuring performance on tasks which require simultaneous local analyses throughout the visual field (Bravo & Blake, 1990).

An approach used to evaluate segmentation is called "rapid detection of segmentation." In studies to assess segmentation, one texture is embedded within another. The observer's role is to detect its presence when briefly displayed. Examples of the use of this technique using letter detection are researched by Regan and Hong (1994) and Regan and Simpson (1994). Experiments to test the limits of segmentation have generally used textures made of a single pattern element repeated in a regular array. Two textures made with different elements are juxtaposed. The subject must determine whether or not the textures form separate visual arrays. This perception of groups occurs immediately and therefore, requires a parallel analysis of the texture display. These experiments are able to reveal large differences in the visual system's ability to discriminate between elements (Bravo & Blake, 1990).

Reading involves a visual processing task requiring an analysis of visual patterns and features. Results of studies have found that some disabled readers process information more slowly than normal readers. Williams and Bologna (1985) investigated perceptual grouping, the segmenting of elements into figures and regions. Studies of perceptual grouping specified that elements that are similar to one another, or close in space to one another, group into the same perceptual unit. Williams and Weisstein(1980) suggest that the perceptual distinction between connected and fragmented patterns is linked to transient activity. Their studies found that poor readers were more restricted to the holistic (rather than analytic) processing level. Poor readers show stronger perceptual grouping effects than good readers and may be less able to exert strategic control of their reading behavior. Thus, reading errors would more likely be based on holistic percepts of words.

The Present Study

Research has found visual problems in significant numbers of children with specific reading disabilities. The present study investigates the hypotheses that children with SRDs have impaired contrast sensitivity and an impaired ability to discriminate form (as determined by the visual perception tests) and possibly textured-defined letters. It has been proposed that the transient system is a motion detecting system transmitting information about stimulus change whereas the sustained system is a pattern system transmitting detailed information about stationary stimuli and spatial detail. The texture-defined form test evaluates the ability to detect stationary form within a patterned system. The sustained system has not been shown to be different between individuals with SRDs and controls (Lovegrove et al., (1990); Livingstone et al., (1991). Lovegrove et al. (1990) used studies with sine wave gratings to argue that the SRDs' sustained system appears to show no deficit. However, no research has been found that uses texture-defined "letters" to test for a proposed transient system deficit. If students with SRDs have deficits in the transient system only, then they are not expected to have difficulties on the texture-defined form test. However, if the texture-defined letter test measures global figure/ground abilities, indications are that the results would be affected by a transient deficit. The results from the texture-defined letter test may lend further information about sustained system functioning. The data findings in this study should tell us more about the transient and sustained operations.

Students aged 7 to 10 years with specific reading disabilities selected for the study met the criteria below established by Stanley and Hall (1973). A control group of students was selected based on their ability to read at or above grade level and matched for chronological age and gender. Both groups were administered a contrast sensitivity test, a texture-defined form test, and the motor-reduced visual perception tests.

The criteria used to assign participants to groups were as follows:

Specific reading disability criteria:

1. A reading delay of at least 2.5 years below that expected for grade level as measured by the Wechsler Individual Achievement Test (The Psychological Corporation, 1992)
2. Average or better intelligence as determined by psychological evaluation within 3 years
3. No gross behavioral problems as determined by class placement
4. No organic disorders as determined by medical diagnoses
5. At least normal visual acuity as determined by the Regan visual acuity chart (Regan, 1994)

Control group criteria:

1. A reading placement on or above grade level with average or better performance
2. No gross behavioral problems as determined by class placement
3. At least normal visual acuity as determined by the Regan visual acuity chart (Regan, 1994)

CHAPTER II

METHODS

Participants

The students chosen for the study came from elementary schools in the Clarksville-Montgomery County School System in Clarksville, Tennessee. Students ages ranged from 7.9 years to 11.0 years. Included in the study were 20 students meeting the state criteria (as listed on page 16) for a learning disability in the area of reading including 5 girls and 15 boys with a mean age of 10 years and 2 months. Also included were 19 students without known specific reading disabilities including 5 girls and 14 boys with a mean age of 9 years and 6 months. Permission was secured from the special education supervisor, principals, and teachers. Informed consent was then obtained from the parents and students.

Measures

All students in the study participated in each of the three following measures. If a student did not pass the visual acuity test, no further assessments were obtained and that student was referred to the school system's vision specialist.

Acuity and Contrast Sensitivity

The Regan Low-Contrast Letter Acuity Charts (Regan & Hong, 1994) were developed to provide a clinical test that is simple and inexpensive. The Regan charts test visual acuity at high, intermediate and low luminance contrasts. Visual acuities for letters at 96%, 11% and 4% contrast reveal the smallest letter that can be recognized for each of the contrast levels. The "standard" visual acuity is measured using the 96% contrast chart. Different visual pathways determine visual acuity for high-contrast letters (sustained) and for low-contrast letters (transient) (Livingstone & Hubel, 1987).

Visual Form Perception

The Frostig Developmental Test of Motor-Reduced Visual Perception (DTVP-2)

(Hammill et al., 1993) was used to measure visual form perception. This battery includes four subtests measuring different but interrelated visual perceptual abilities. The results of the DTVP-2 have been shown to be useful in documenting the presence and degree of visual perceptual deficits in children (Hammill et al., 1993). The manual provides standard scores for each motor-reduced visual perceptual skill allowing a comparison to be made between specific abilities. The manual also provides motor-reduced composite quotient scores for comparisons of each subject's motor-reduced visual perceptual ability. The DTVP-2 has value as a research tool, especially for investigators who wish to use standardized instruments to study visual perceptual processes. The four subtests are described as follows:

A) Position in Space. Children are shown a stimulus figure and asked to select the exact figure from a series of similar but different figures. Since the stimulus figure always remains in view, memory is not a factor. This is strictly a matching test (see Figure 5).

B) Figure-Ground. Children are shown a stimulus figure and asked to find it in a series of figures. In the series, the targeted figure will have a different size, position, and/or shade (see Figure 6).

C) Visual Closure. Children are shown a stimulus figure and asked to pick it out from an array of figures that have significant amounts of their outline missing (see Figure 7).

D) Form Constancy. This test involves the recognition of certain geometric figures presented in a variety of sizes, shadings, textures, and positions in space and their discrimination from similar geometric figures. The type of decision a subject will make is whether various shapes are still the same figures when they are situated in confusing backgrounds or are embedded in other figures (see Figure 8).

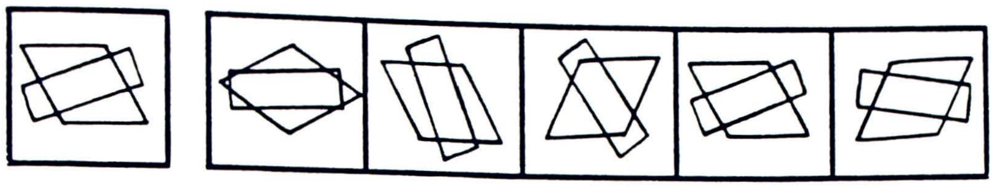


Figure 5. Example of Position in Space. Children are shown a stimulus figure and asked to pick it out from a series of similar but different figures.

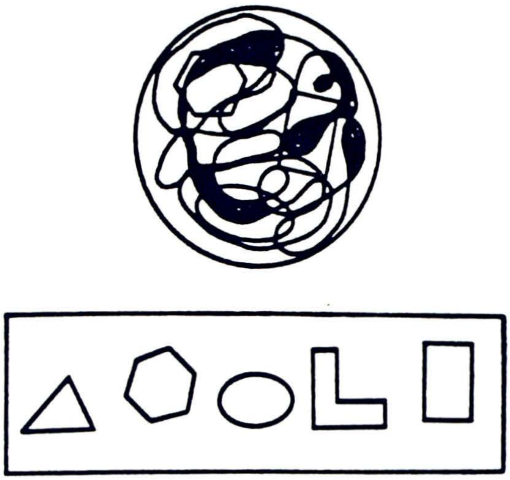


Figure 6. Example of Figure-Ground. Children are shown a stimulus figure and asked to find it in a series of figures having different sizes, positions and/or shades.

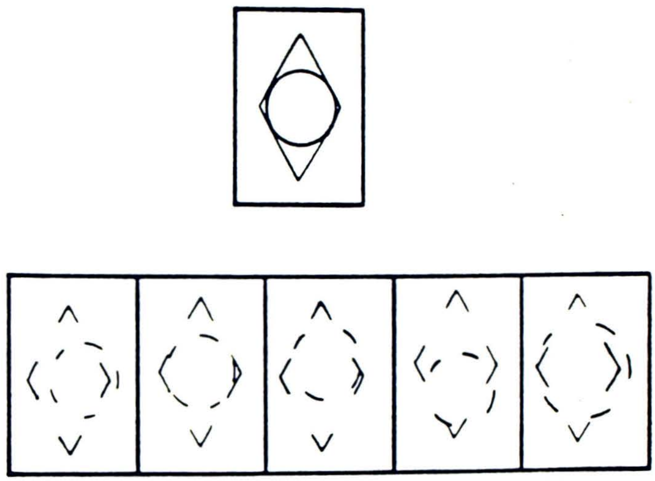


Figure 7. Example of Visual Closure. Children are shown a stimulus figure and asked to pick it out from an array of figures that have significant amounts of their outline missing.

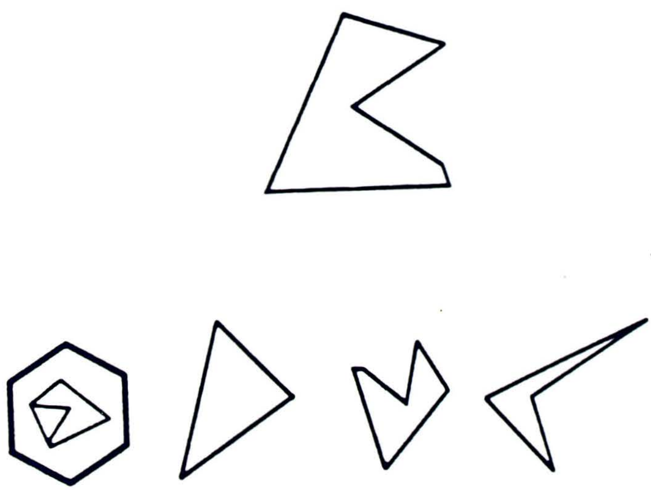


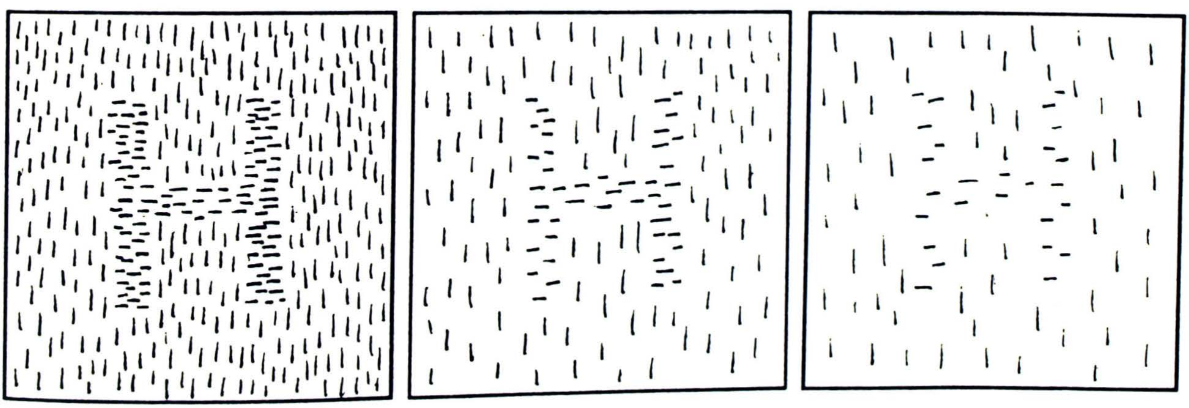
Figure 8. Example of Form Constancy. Children are shown a stimulus figure and asked to choose two of the figures below it that match the stimulus but may vary in size, position, or shade.

Content validity item analysis found that all of the test items in the DTVP-2 satisfied statistically significant coefficients of .3 which can be considered acceptable (Anastasi, 1988). Concurrent validity of the DTVP-2 was investigated by correlating the subtest and composite scores with total scores of the Motor-Free Visual Perception Test (MVPT) (Colarusso & Hammill, 1972), a relatively pure measure of visual perception, and the Developmental Test of Visual-Motor Integration (VMI) (Beery, 1989) a measure of visual perception and motor coordination that is currently used in the present study's school system. All of the quotient scores were in the high 70s and were not statistically different at the 5% level of confidence, suggesting that the tests measure the same construct - visual perception. The DTVP-2 evidenced a strong relationship with the WISC-R Performance Scale although this data should be viewed with caution since it was based on a study with only 24 subjects. These tentative results although suggest that the DTVP-2 has construct validity (Hammill et al., 1993).

<u>Texture-Defined Form</u>

Texture-defined (TD) letter stimuli were produced on a Toshiba 486PC and displayed on a video monitor to measure texture-defined form. This software was provided by David Regan (Regan & Hong, 1994). Letter stimuli were presented on a computer monitor. A texture-defined letter was created by placing horizontal bars inside the letter, and vertical bars outside the letter (see Regan & Hong, 1994). These texture-defined forms were degraded in two different ways, and observers abilities to recognize these forms were tested. One way that texture was degraded was by reducing the total amount of texture in the total display - both in the figure and in the ground defined as <u>bar density</u>. In bar density the question is "how much texture do we need to recognize and detect these letters?" Bar densities used were 1, .09, .07, .05, .03, and .01. The lower this value, the more sparse the texture will become in both figure and ground with .01 being the most difficult to detect (see Figure 9).

The second way texture was degraded was by manipulating the difference (not the amount) between the horizontal and vertical bars in the texture between the figure and the ground defined as horizontal density. Students were presented letters at horizontal densities of 1, .9, .8, .7, .6, and .5. At horizontal density 1, the letter is most easily detected because the letter (figure) is made up of only vertical bars and the background (ground) is made up of only horizontal bars, thus the letter is purely segmented. At horizontal density .5, fifty percent of the bars in the letter are horizontal and fifty percent are vertical. The same is true for the ground and so the letter becomes "invisible" and cannot be segmented. By manipulating the bar density and horizontal density one can determine the observer's threshold ability for recognizing a letter, where the difference between the letter ("figure") and background ("ground") has been reduced.



a b c

FIGURE 9. Example of a texture-defined letter (H) whose visibility (bar density) is progressively degraded in (a-c) respectively.

Procedures

Regan charts were hung at eye height and viewed from a distance of 10 feet beginning with the 96% chart to test acuity. Each chart thereafter was hung and tested in order of decreasing contrast (i.e. 11%, and 4%) until four errors or more were made on a line of eight letters on each of the three charts. A 300 watt photoflood light mounted on a stand five feet above the floor and placed nine feet from the chart was used to produce the recommended luminance of 103 cd/m^2. A three inch sample of each letter on the chart was placed on a table in front of the student. Letters were read aloud one by one or matched to its sample from the 96% chart. Letters were read binocularly. The students were instructed: "Read the letters one by one or you may match the letter to its sample in front of you. As the letters get smaller you will become more uncertain, but this is normal. Do not give up and make your best guess. Sometimes your answer will be right and sometimes wrong." Errors were marked on a scoring sheet as the student read.

Four subtests of the DTVP-2 were administered: the Position in Space subtest, the Figure-Ground subtest, the Visual Closure subtest, and the Form Constancy subtest. These subtests were completed in one session. Testing began with item 1 on every subtest. Testing continued until three errors were made out of five items in a row.

Students were administered the tests in an environment that was free from distraction, well-ventilated, well-lighted, quiet, private, and comfortable. If at any point the child appeared fatigued or showed signs of tiring or losing interest, the test was stopped. The students were administered the subtests in the order recommended in the manual. As instructed in the manual, the examiner encouraged the examinee to progress through the tests not spending too much time on specific items. Students were administered example items to be sure directions were understood. Specific instructions were followed in the manual. Student's raw scores were converted to standard scores. The four subtest's standard scores were added to obtain a motor-reduced composite quotient.

On the computer stimulus for texture-defined form test, participants sat at a viewing distance of 1 meter from the computer display. Each trial was comprised of two 2000 msec texture presentations separated by a 1000 msec blank interval. Only one of the two presentations contained a letter. During the other presentation of a trial pair, every 8x8 cell contained either a vertical or a horizontal bar. The set of potential letters were: H,C,D,K,N,O,R,S,V, and Z. These letters were chosen by Regan on the grounds that, at least for high-contrast luminance-defined letters, they have roughly equal visibilities (Sloan, 1951). The order of the two presentations was randomized.A new texture pattern was generated for each presentation. Participants were instructed to state whether the letter was presented in the first or second trial (letter detection) and to name or point out the letter (letter recognition) from a set of 10 letters placed on cards in front of the viewer. Thus, a two-alternative forced-choice method was used to estimate letter detection threshold, and a 10-alternative forced choice method was used to estimate letter recognition threshold. No feedback was given. Students were instructed to indicate the interval (first or second) and recognize and /or detect letters at the horizontal densities of 1, .9, .8, .7, .6, and .5. Bar densities used were 1, .09, .07, .05, .03, and .01. All participants were tested using the same experimental conditions although the order of testing was counter-balanced for task and density (bar density or horizontal density) using a latin-square design. For purposes of this present research, viewing was binocular. Mean threshold data was obtained for each group on discrimination and detection for bar density and horizontal density.

CHAPTER III

RESULTS

The results are presented in the order that the measures were assessed. First the contrast sensitivity results are presented followed by the texture-defined form and lastly the form perception.

Contrast Sensitivity

Thresholds were obtained on every line of letters for each contrast chart (e.g. 96%, 11%, 4%). Threshold values are equivalent to 4 or more letters (50% or better) correctly identified on each line of letters presented. Mean threshold values for the SRD group and control group are shown in Figure 10. A repeated measures analysis of variance between subjects revealed a significant main effect of group [$F(19,20) = 5.43$, $p < .025$]. The SRD group had a significantly more difficult time seeing contrast reduced letters. Post hoc analyses t-tests for independent samples (and Bonferroni adjustments for experimentwise error rate) indicated a difference between groups for the 11% chart [$t(30)=2.87$, $p < .05$], but not 96% [$t(30)=1.61$, $p > .05$] or 4% [$t(30)=1.84$, $p > .05$].

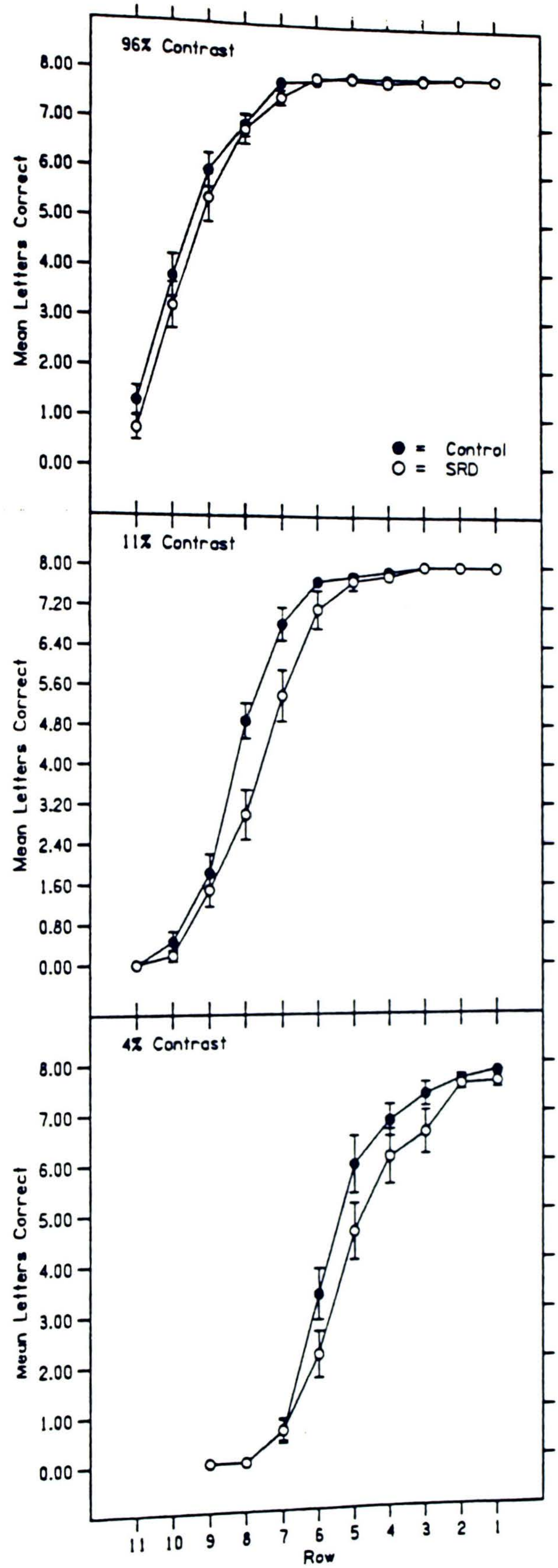


Figure 10. Contrast sensitivity mean thresholds (and standard errors) for SRD and control children are plotted for the 11 rows of letters for each subject on the 96%, 11%, and 4% contrast charts.

<u>Texture-Defined Form</u>

Letter detection and discrimination thresholds were obtained for each subject for bar density and horizontal density. These data are presented in Figure 11. For each variable, and at each level of the variables, the distributions of the data are nearly identical for both groups. For this reason no statistical analyses were performed.

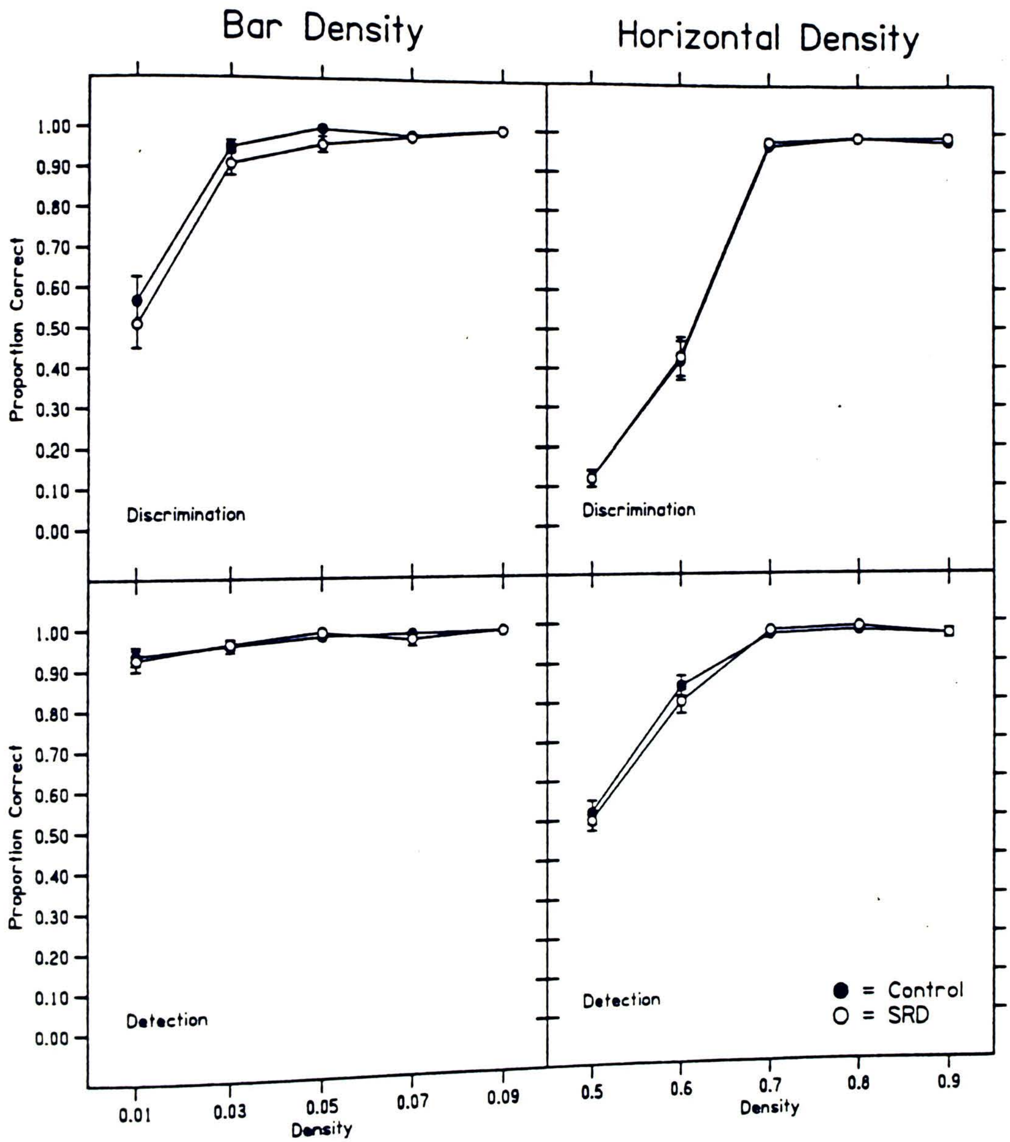


Figure 11. Texture-defined form mean thresholds (and standard errors) for SRD and control children are plotted for discrimination and detection for bar density and horizontal density.

Frostig Visual Perception Tests

The SRD and control groups were assessed on all four visual perception tests. Each of the visual tests yielded a standard score. Standard scores allow examiners to make comparisons across subjects. The mean standard scores for each group of subjects on all four tests is shown in Figure 12.

The four standard scores obtained from each subject was summed and converted into a quotient. Composite quotients are the most useful and reliable of the DTVP-2 scores because they reflect the actual content built into the test and they are composed of several representative subtests rather than just one (Hammill et al., 1993). According to Hammill and others, the motor reduced perception quotient is the "purest" and most direct measure of visual perception. Only very minimal motor skills (e.g. pointing) are needed to show visual perceptual abilities.

A repeated measures analysis of variance revealed significant difference between the SRD and control groups [$F(18,20) = 4.71$, $p = .037$]. Students with SRDs performed overall more poorly on the Frostig Visual Perception Tests.

To determine which tests were significantly different between the two groups, post hoc analyses were conducted using t-tests for independent samples (and Bonferroni adjustments for experimentwise error rate). Significant differences between the two groups performance were found on Position in Space [$t(30)=3.20$, $p<.05$] and Visual Closure ($t(30)=2.08$, $p<.05$]. No statistical significance was found for Figure Ground [$t(30)=0.23$, $p>.05$] and Form Constancy [$t(30)=0.57$, $p>.05$].

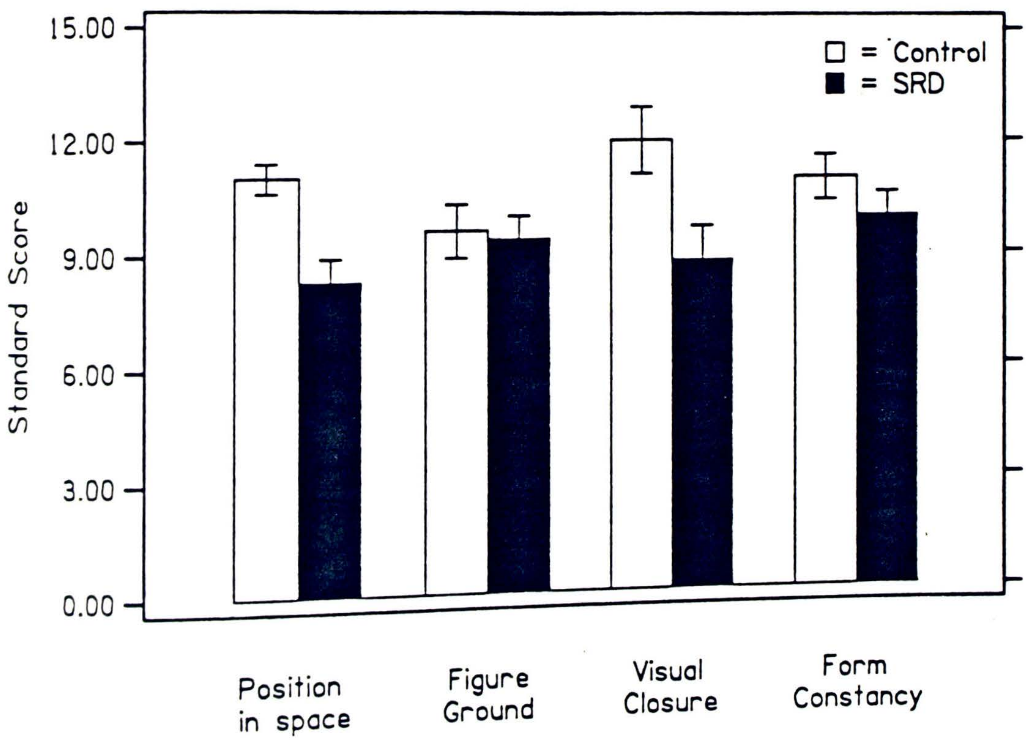


Figure 12. Means (and standard errors) of the scores are plotted for each of the four visual perception tests for both groups of subjects.

CHAPTER IV

DISCUSSION

The results obtained from the current study suggest that these children with specific reading disabilities differ significantly from control readers on measures of contrast sensitivity as well as measures of visual form perception. The data obtained from this study are consistent with a transient deficit and this is discussed below.

Contrast Sensitivity

Contrast sensitivity is the minimum contrast required to detect a form. It has been demonstrated that 75% of children with SRDs show reduced contrast sensitivity at low spatial frequencies (Borsting et al., 1996; Cornelissen, Richardson, Mason, Fowler, & Stein, 1995; Evans et al., 1994; Gross-Glenn et al., 1995; Lovegrove et al., 1986; Lovegrove et al., 1990). Current thinking is that these impairments may reflect a transient system deficit. In the present study, the children with specific reading disabilities, as a group, had greater difficulty identifying contrast-reduced letters.

Borsting et al., (1996) recently suggested that the presence of a transient system defect appears to be related to the subtype of dyslexia. These results are consistent with the Lovegrove et al, (1990) study which found that approximately 75% of children with SRDs demonstrated a visual pathway deficit. The presence of a transient system deficit is consistent with a subtype of reading problems known a dysphoneidetic dyslexia. Children with poor phonetic skills would be classified in this category (Borsting et al., 1996). Many children with SRDs have been found to have both language and visual deficits (Borsting et al., 1996; Eden et al., 1995; Lovegrove et al., 1986; Lovegrove et al., 1990; Reddington & Cameron, 1991; Snowling, 1980). Poor readers have been shown to have significantly more trouble pronouncing nonsense words than average or superior readers (Lovegrove et al., 1986). It is logical to think that the type of reading errors caused by a transient system deficit would most influence the visual route. Considering that the phonological route initially works by visual representation, it is also possible that a processing deficit could influence both routes (Lovegrove et al., 1986).

Frostig Visual Perception Tests

Significant differences were found between the SRD and control groups on the Frostig motor-reduced visual perception tests. Post-hoc tests revealed that the SRD group had significantly lower scores on two of the four tests administered. One of those tests, Position in Space, is strictly a visual discrimination task in which one figure is matched to another. This type of task is one often seen on test batteries that measure school readiness and aptitude. The second test found to discriminate the two groups, Visual Closure, involves the psychological principle of closure or "gestalt." The idea behind this subtest is that a familiar object can be recognized when seen in a fragmented form. Students must mentally supply the missing parts.

Neither the Figure-Ground or the Form Constancy subtests revealed any significance between the SRD group and the control group. Corah and Powell's (1963) observations that where subtest discrepancies on the DTVP occurred, Figure-Ground and Form Constancy usually varied together. Previous studies found that these two subtests usually varied together. Becker and Sabatino (1973) defined these two tests as the figure-ground factor. Total mean scores for the SRD group on these two subtests were nonsignificant compared to the control group scores, but very similar when compared to each other.

One question is whether the two tests that showed significant difference require processes which are characteristic of a transient system or a sustained system. As described, the sustained system is predominantly responsible for pattern recognition and dominates in central vision. The transient system is a holistic system that processes large amounts of global information at high speed and relies heavily on peripheral vision.

These two subtests of the Frostig involve multilevel processing. The tasks require subjects to: 1) match a stimulus to forms that have similar stimulus features and 2) match a stimulus to similar fragmented forms of the stimulus. In both cases these tasks demand focused attention. Williams and Bologna (1985) found that poor readers demonstrated difficulty in selectively attending to relevant portions of a figure. Their data suggests that poor readers rely on the holistic information they obtain while reading, making quick decisions about the identity of words before a more detailed analysis is made. Thus, reading errors made by poor readers are likely based on holistic percepts of words. Williams and Weisstein (1980) found that the ability to perceptually distinguish between connected and fragmented forms is characteristic of transient, global processing. Feild and Feild (1974) demonstrated with a series of perceptual closure tasks that poor readers give fewer correct responses to closure tasks. Also, May, Williams, and Dunlap (1986) found that poor readers needed more time than good readers to make temporal order judgments. In the study, poor readers were asked to specify which of two simple words was presented first. Their findings suggested that poor readers have slow or "sluggish" perceptual processing abilities indicating a temporal order judgment deficit.

If children with SRDs have a transient system deficit, their attentional processes may be deficient which would contribute to the slowness of their reactions (Whyte, 1994). The transient system plays a major role in directing eye movement and bringing together information across fixations. As suggested earlier, children with dyslexia have been identified as having a problem with saccadic eye movements. They seem to have difficulty integrating information from successive fixations. Their ability to attend may be limited because of a deficient transient system (Whyte, 1994).

The use of the DTVP tests could be beneficial to teachers wanting to identify children with possible visual processing impairments. The four tests can be administered in about 20 minutes and can reveal information that could lead to remediation and compensating activities for the reading disabled child. Also, teachers who have children with attentional deficits in their rooms could have a better understanding of the underlying problems contributing to the attention deficits.

<u>Texture-Defined Letters</u>

No significant differences were found between the SRD and control group in their abilities to discriminate and/or detect texture-defined letters. As mentioned previously, it was unknown whether children with SRDs would have difficulty on this task. Initial thought was that the students with SRDs would have difficulty seeing the forms as they were degraded by horizontal and bar densities because SRDs have been shown to have difficulties seeing figures in confusing backgrounds. Further thinking was that the use of letters, as the texture-defined stimulus, would have an effect on the SRD group's ability to discriminate or detect when compared with average readers. Letters relate more to the task of reading. No significant differences were found between the two groups which may indicate that the texture-defined form test requires responses that are associated with sustained system operations. It has been shown that the sustained system is predominantly a pattern system that transmits information about spatial detail with information being extracted during eye fixations (Lovegrove et al., 1986). Texture-defined letter detection and discrimination also involve spatial integration processes (Regan & Simpson, 1994). A series of experiments by Lovegrove et al., (1990) demonstrated that the sustained system function has not been shown to be significantly different between readers with SRDs and control readers when measured with sine wave gratings. However, the present study used stimuli defined by texture differences which preferentially stimulates the sustained system. Stimuli of these type have not been previously used, and did not determine any significant differences between the groups. If the texture-defined form test is a pure measure of sustained system activity, then these results possibly provide further evidence of a "transient system only" deficit in children with SRDs.

Summary

This study found that individuals who show specific reading disabilities and reduced contrast sensitivity also have one type of form perception difficulty (as determined by the Frostig visual perception tests.) It is unlikely that a reduction in contrast sensitivity is causing the reading problem, but only a symptom of the underlying problem. The texture-defined form test is thought to stimulate the sustained system which could explain why no significance was found. These results lend further support to the hypothesis that the problems children with SRDs experience lie in the transient system and not the sustained system. It could be that a temporal processing impairment may be the root of the reading disability causing a branching out of various symptoms and problems for the child learning to read. Recent papers by Eden et al. (1996) and Farmer and Kline (1995) suggest that it may not be just a transient visual system impairment, but a broader cortical temporal processing impairment that affects both the visual and auditory mechanisms.

Future Implications for Educators

If the hypothesized transient system deficit or temporal processing impairment in children with specific reading disabilities is true, and there is a large body of evidence suggesting that it is, then it would be understandable why so many of these children have difficulty with schoolwork. Children who are identified with these processing impairments should be placed with a regular classroom teacher that understands the underlying difficulties and has learned methods of helping a child compensate for their disabilities. If we can identify the children with temporal processing deficits, educators could be challenged to find ways in which to present material to these students to compensate and/or remediate their deficiencies.

There are special reading programs that present material in ways that would make learning to read easier for the reading disabled child. Special reading programs that first present sounds in isolation and give special meaning to these sounds prior to blending have been successful with the nonreader (Herman, 1979). After words are learned through blending sounds, they are presented singularly through a tachistoscope. When reading paragraphs, a long narrow rectangular strip of material with an opening the size of a one word is used. This method alleviates peripheral processing deficits. As the child masters reading in this manner, the strip could be widened to allow two words to show through the opening, then three and so on until the child utilizes the strip with a full line of print opening.

Another method that may be helpful from the literature on colored masking effects (Edwards et al., 1996) is the use of a red transparency overlay on all material to be read.

Colored transparencies are inexpensive and easily available.

Students could also strengthen their visual attention through the use of hidden pictures and word searches. Some computer software companies have spelling games in which the word is flashed upon the screen and the student must identify the word and spell the word. The speed at which the word is flashed is manipulated by the teacher. The amount of time at which the word is presented could gradually be lessened to determine the student's threshold ability level. This method could possibly be one instrument used to determine the learner's threshold for temporal detection. Also there are activities in which a number of various items are briefly shown on a picture card. The child is instructed to identify as many of the items as possible. This skill would strengthen visual memory and force saccadic eye movements for extrafoveal visual information.

Motor-reduced visual perception tests could be utilized as a school entry test to predict possible reading problems. These and similar visual perceptual assessments could be used to determine placement of a child in a particular teacher's classroom that has had background training in various processing impairments. If a school system documented evidence showing a need for teachers with the necessary background to teach children with visual and auditory processing impairments, funding could be provided for the necessary course work through grants. The knowledge gained could then generate more research in the area of specific reading disabilities.

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APPENDIX

AUSTIN PEAY STATE UNIVERSITY

CHECKLIST FOR RESEARCH INVOLVING HUMAN SUBJECTS

TITLE: Visual Form Perception: Possible Deficits in Children with Specific Reading Disabilities

FUNDING SOURCE: Not Applicable

PRINCIPAL INVESTIGATOR: Teresa L. Fryer **DEPARTMENT:** Psychology

SPONSOR: Dr. Charles Woods

1. **Give a brief description or outline of your research procedures as they relate to the use of human subjects. This should include a description of the subjects themselves, instructions given to them, activities in which they engage, special incentives, and tests and questionnaires. If new or non-standard test or questionnaires are used, copies should be attached to this form.**
   NOTE: If the subjects are minors or "vulnerable" (children, prisoners, mentally or physically infirm, etc.).

Research has documented the existence of a range of visual deficits in children defined as specifically reading disabled (SRD). The ability to "see" an object involves segregating the object's retinal image from the image of the object's surroundings so the object can be detected. It appears that SRDs with a visual perceptual problem have more difficulties than their control peers in distinguishing properly between figure and ground or seeing relations between parts and wholes. This ability to form a visual image is affected to some extent by extra items in the periphery of the retina. Objects or forms are detected by size, shape, color, position in space, and movement. Even with all of these contributions to our detection of an object, the description is incomplete without reference to the object's surface texture. The present study is interested in children with SRDs and known visual perceptual difficulties and their ability to detect form when the difference between surface and background textures is reduced.

Before these experimental studies can be examined, a group of children with SRDs with visual perceptual difficulties must be located. Subjects targeted for this study will be children between the ages of 7 and 10 years selected based on the following criteria:

1. A reading lag of at least 2 years below that expected for their grade level
2. Average or better intelligence
3. No gross behavioral problems

4. No organic disorders
5. At least normal visual acuity

The experimental subjects will be identified based on formal psychological and educational diagnosis, performance on a visual acuity chart test, and achievement on the Weschler Individual Achievement Test (WIAT). The control subjects will be matched for age, selected from the same elementary schools, and reading at or above their age level as determined by classroom placement. When experimental and control groups have been established, each subject will participate in a contrast sensitivity test, a computer generated texture-defined form test, and the motor-reduced Developmental Test of Visual Perception subtests.

2. **Does this research entail possible risk to psychic, legal, physical, or social harm to the subjects? Please explain. What steps have been taken to minimize these risks? What provisions have been made to insure that appropriate facilities and professional attention necessary for the health and safety of the subjects are available and will be utilized?**

Subjects will be administered the visual perception tests, contrast sensitivity test, and the texture-defined form test by a school psychology intern. These tests will be conducted in a testing room located in each subject's school building. Each subject will be informed of the tests they will be asked to perform prior to verbal consent. Written consent will be obtained from parent, teacher, and child prior to any assessment. Teachers will be requested to excuse any work the student misses while being assessed.

3. **The potential benefits of the activity to the subjects and mankind in general outweigh any possible risks. This opinion is justified for the following reasons:**

Results of this study will be used to identify specifically reading-disabled children having

visual perceptual problems with texture-defined form segregation. Having identified the visual disabilities of children with SRDs, possible remediation techniques could be developed and utilized to benefit these areas of weakness, thus allowing for more success with school related tasks.

4. **Will legally effective, informed consent be obtained from all subjects or their legally authorized representative?**

Yes, informed consent will be obtained from parents, teachers, and the children involved. The possibility of the information being used in a School

Psychology Thesis will be presented to all of the above parties giving consent. In addition, prior to accessing any relevant psychological or school records for students involved, permission will be sought from the school psychological services and from the parents of the students involved. This permission will be shared with the Supervisor of Special Education as well as with each school principal.

5. **Will the confidentiality/anonymity of all subjects be maintained: How is this accomplished? (If not, has formal release been obtained: Attach: (a) If data will be stored by electronic media, what steps will be taken to assure confidentiality/anonymity? (b) If data will be stored by non-electric media, what steps will be taken to assure confidentiality/anonymity?**

   Anonymity of all participants will be maintained. Student's data will be entered into the computer for analysis using unique subject numbers. Results will be reported pertaining to the group as a whole, not based upon individual results. Information will not be used by the school system to make decisions about individual programs or placements. All protocols will be stored in a locked file cabinet.

6. **Do the data to be collected related to illegal activities? If yes, explain.**

   No.

7. **Are all the subjects protected from the future potentially harmful use of the data collected in this investigation? How is this accomplished:**

   Yes. No identifying information will be connected with the data.

I have read the Austin Peay State University Policies and Procedures on Human Research and agree to abide by them. I also agree to report to the Human Research Review Committee any significant and relevant changes in the procedures and instruments as they relate to subjects.

________________________ Signature

________________________ Date

Student research directed by faculty should be co-signed by faculty supervisor.

________________________ Signature

________________________ Date

December 4, 1995

To: Jan Hodgson, Special Education Supervisor
Clarksville-Montgomery County Schools

From: Teresa Fryer, School Psychologist Intern

Re: Austin Peay State University, Master of Arts
Thesis Proposal

I am currently a student at Austin Peay State University working on a master's program in school psychology. I am conducting a study investigating possible visual perceptual deficits in children with specific reading disabilities. Attached to this letter is a form addressing any "human subjects" concerns that have been identified in the course of my proposed study and copies of letters I will be sending out to principals, teachers, and parents pending your approval.

If you have any questions regarding my study, please contact me. I plan to begin my process of securing permission from parents, students, principals and teachers after receiving written permission from you to do so.

Thank you for your continued support!

cc: Irene Gudgeon, Principal, Burt Elementary
Margie Ford, Principal, Smith Elementary
Elinor Martin, Supervising School Psychologist
Gail Hudson, Supervising School Psychologist
Carol Ryan, Supervising School Psychologist

December 4, 1995

To: Irene Gudgeon, Principal, Burt Elementary

From: Teresa Fryer, School Psychologist Intern

I am currently a student at Austin Peay State University working on a master's program in school psychology. I am conducting a study related to my field of experience. I have been a special education teacher at Burt School for the past nine years. I am interested in how visual perception (the way we visualize our surroundings) is related to children's ability to learn. Research tells us that children with reading disabilities have visual perception difficulties. I am looking at what those specific difficulties may be.

In order to conduct my study, I will need to assess not only reading disabled students, but also a control group of students reading on or above their current grade level. Selected students will be assessed on the following visual tests:

1. a short reading test to determine the student's current reading ability
2. a simple acuity test which includes identifying letters from a chart at a distance (similar to the mass vision screenings conducted at the schools each year)
3. a contrast sensitivity test which is similar to the acuity test except the letters become lighter in print until barely visible
4. the Frostig Developmental Test of Visual Perception, a booklet form test in which the students identify shapes in a variety of background pictures and check their ability to draw certain forms
5. a computer test in which the student looks at a computer screen and identifies letters that have been flashed up on the computer screen for a brief amount of time

The total amount of time involved for the battery of tests above is about 2 hours. I will ask for the teacher's permission to excuse the selected students from any class work missed during my assessment.

Prior to the assessments, permission will be secured from Jan Hodgson, special education supervisor, supervising psychologists, principals, teachers, parents, and the students themselves.

The results from this study will be helpful in understanding visual perception problems the reading disabled student may be having in the classroom. The more understanding we have of the problems experienced by reading disabled children, the more we are able to help with these problems.

No student names will be used in the study. The results of the study will only be used to determine what visual perception difficulties, if any, that children with reading disabilities may have. If at any time during the testing the child wishes to stop, he or she may go back to the classroom and that data will not be used in the study.

Please sign and return the attached consent form as soon as possible. If you have any questions or concerns, please contact me at 648-5633. I appreciate your cooperation in my work as I assist our schools in providing the best possible program for our children.

I give permission for Teresa Fryer to test students at Burt School with a battery of vision and visual perception tests. I understand that this information will remain confidential and only be used to determine the possible visual perceptual difficulties of reading disabled children.

______________________________ ______________________

principal's signature date

* Please return this form to Teresa Fryer at Psychological Services through the mail courier as soon as possible. -- Thank-you

December 4, 1995

To: Teachers of special education students and regular education students served in Burt Elementary School and Smith Elementary School

From: Teresa Fryer, School Psychologist Intern

I am currently a student at Austin Peay State University working on a master's program in school psychology. I am conducting a study related to my field of experience. I have been a special education teacher at Burt School for the past nine years. I am interested in how visual perception (the way we visualize our surroundings) is related to children's ability to learn. Research tells us that children with reading disabilities have visual perception difficulties. I am looking at what those specific difficulties may be.

In order to conduct my study, I will need to assess not only reading disabled students, but also a control group of students reading on or above their current grade level. I would like to include your student ____________________. The tests that I would give this student include:

1. a short reading test to determine the student's current reading ability
2. a simple acuity test which includes identifying letters from a chart at a distance (similar to the mass vision screenings conducted at the schools each year)
3. a contrast sensitivity test which is similar to the acuity test except the letters become lighter in print until barely visible
4. the Frostig Developmental Test of Visual Perception, a booklet form test in which the students identify shapes in a variety of background pictures and check their ability to draw certain forms
5. a computer test in which the student looks at a computer screen and identifies letters that have been flashed up on the computer screen for a brief amount of time

The total amount of time involved for the battery of tests above is about 2 hours. I am asking your permission to excuse the above named student from any class work missed during my assessment.

The results from this study will be helpful in understanding visual perception problems the reading disabled student may be having in the classroom. The more understanding we have of the problems experienced by reading disabled children, the more we are able to help with these problems.

No student names will be used in the study. The results of the study will only be used to determine what visual perception difficulties, if any, that children with reading disabilities may have. If at any time during the testing the student wishes to stop, he or she may go back to the classroom and that data will not be used in the study.

Please sign and return the attached consent form as soon as possible. If you have any questions or concerns, please contact me at 648-5633. I appreciate your cooperation in my work as I assist our schools in providing the best possible program for our children.

I give permission for Teresa Fryer to test my students with a battery of vision and visual perception tests. I understand that this information will remain confidential and only be used to determine the possible visual perceptual difficulties of reading disabled children. I will not require students being assessed to make up the work missed in the classroom.

______________________________ ______________________________

teacher's signature date

Please return this form and any permission forms from parents to Teresa Fryer at Psychological Services through the mail courier as soon as possible.

-- Thank-you

December 7, 1995

To: Parents of special education students and regular education students served in Burt Elementary School and Smith Elementary School

From: Teresa Fryer, School Psychologist Intern

I am currently a student at Austin Peay State University working on a master's program in school psychology. I am conducting a study related to my field of experience. I have been a special education teacher at Burt School for the past nine years. I am interested in how visual perception (the way we visualize our surroundings) is related to children's ability to learn. Research tells us that children with reading disabilities have visual perception difficulties. I am looking at what those specific difficulties may be.

In order to conduct my study, I will need to assess not only reading disabled students, but also a control group of students reading on or above their current grade level. I would like to include your child. The tests that I would give your child include:

1. a short reading test to determine the student's current reading ability
2. a simple acuity test which includes identifying letters from a chart at a distance (similar to the mass vision screenings conducted at the schools each year)
3. a contrast sensitivity test which is similar to the acuity test except the letters become lighter in print until barely visible
4. the Frostig Developmental Test of Visual Perception, a booklet form test in which the students identify shapes in a variety of background pictures and check their ability to draw certain forms
5. a computer test in which the student looks at a computer screen and identifies letters that have been flashed up on the computer screen for a brief amount of time

The total amount of time involved for the battery of tests above is about 2 hours. Your child will not be required to make up the work missed in the classroom during this testing time.

The results from this study will be helpful in understanding visual perception problems the reading disabled student may be having in the classroom. The more understanding we have of the problems experienced by reading disabled children, the more we are able to help with these problems.

No student names will be used in the study. The results of the study will only be used to determine what visual perception difficulties, if any, that children with reading disabilities may have. If at any time during the testing that your child wishes to stop, he or she may go back to the classroom and that data will not be used in the study.

Please sign and return the attached consent form as soon as possible. If you have any questions or concerns, please contact me at 648-5633. I appreciate your cooperation in my work as I assist our schools in providing the best possible program for our children.

I give permission for Teresa Fryer to test my child with a battery of vision and visual perception tests. I understand that this information will remain confidential and only be used to determine the possible visual perceptual difficulties of reading disabled children.

______________________________ ________________________

parent/guardian signature date

____

student's signature

* Please return the bottom part of this form to your child's classroom teacher as soon as possible.

VITA

Teresa Logan Fryer was born in Nashville, Tennessee on October 11, 1957. In June, 1975, she graduated from Goodlettsville High School in Goodlettsville, Tennessee. The following September she entered Austin Peay State University in Clarksville, Tennessee and in May, 1980 received a Bachelor of Science degree in Special Education and Elementary Education. After receiving her degree, she married and moved to Shreveport, Louisiana where she taught children with learning and emotional problems for three years followed by one year of experience in a regular third grade classroom. In 1986, she moved back to Clarksville, Tennessee and continued to teach special education. She reentered Austin Peay State University in January, 1993 and in August, 1996 received a Master of Arts degree with a major in Psychology and a concentration in School Psychology.

She has been married 16 years and has two children, ages 9 and 12 years. She is presently employed as a Special Education Resource Teacher at Burt Elementary School in Clarksville, Tennessee.