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The effectiveness of colored overlays on reading achievement and attitudes toward reading for students with Scotopic Sensitive Syndrome

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THE EFFECTIVENESS OF COLORED OVERLAYS ON READING ACHIEVEMENT AND ATTITUDES TOWARD READING FOR STUDENTS WITH SCOTOPIC SENSITIVE SYNDROME

A Dissertation

Submitted

in Partial Fulfillment

of the Requirements for the Degree

Doctor of Education

Approved:

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December, 2009

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ABSTRACT

This study investigated the effects on students identified with Scotopic Sensitivity Syndrome (SSS) or Irlen Syndrome (IS) when using colored overlays as an intervention (immediately and over time) to assess reading performance (rate, accuracy, and comprehension); to measure visual-motor integration; and to assess attitude toward reading. SSS/IS is a visual perceptual problem related to a collection of symptoms that affects an individual's performance when reading. Three participants, all males (one 3rd-grade student, one 4th-grade student, and one 5th-grade student), were identified as having SSS/IS and other learning disabilities.

The study involved five test instruments (Irlen Reading Perceptual Scale, Qualitative Reading Inventory-4, Running Records, Visual Motor Integration, and Elementary Reading Attitude Survey), using pre- and post tests combined with a single-subject Alternating Treatment Design (ATD). Data were analyzed qualitatively through visual analysis of tables, line graphs, and bar graphs.

While this study showed inconsistent and mixed results for the use of colored overlays, there were some interesting positive effects in the area of attitude toward reading and in immediate effects on rate and accuracy. Results were inconclusive on the long term effects of the use of colored overlays over time. The lack of consistent results in this study suggests that there is not a clear clinical significance for the use of colored overlays.

CHAPTER 1

INTRODUCTION

Reading literacy is an important skill for learning and the key to accessing numerous forms of knowledge and information (National Assessment of Education, [NAEP], 2005). High numbers of students are leaving elementary school with reading skills inadequate for the next level of instruction. According to NAEP, 2005, the results are divided into four groups: Below basic, basic, proficient and advanced. Thirty- seven percent of fourth-graders have below basic reading skills. Research has identified the following facts concerning reading:

- Seventy-four percent of children in the third grade who are poor readers remain poor readers at the ninth grade (Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1996).
- Eighty-eight percent of children in the first grade who were poor in word recognition skills remain poor readers at the fourth grade (Juel, 1988).
- Eight of ten children with reading difficulties at the end of first grade performed below the average range at the beginning of third grade (Rashotte, Wagner, & Torgesen, 1997).

Therefore, identifying and addressing reading problems during the early grades is important to provide a strong foundation for lifetime learning.

Between 1965 and 2004, the U.S. federal government has provided more than $100 million to research why so many children have problems learning to read and what can be done to help them (Shaywitz, 2004). In 1999, the National Institute of Health

estimated that one in five children have serious difficulties learning to read. These children are potentially among the most troubled children in society (Lyon & Fletcher, 2001). Children with reading problems can grow up in danger of failing in school and in life unless they benefit from early identification and individualized intervention or treatment.

Classroom teachers and reading specialists must carefully plan their approaches for helping students with reading difficulties. Areas of difficulty are generally broken into five categories: (a) phonological and phonemic awareness, (b) word decoding and phonics, (c) fluency, (d) vocabulary, and (e) comprehension (National Reading Panel [NRP], 2000). For some students, the problem can be compounded because of a difficulty in processing, such as auditory processing, language processing, visual processing, auditory/visual integration, or phonological processing (Shaywitz, 2004).

Sensory integration is the neurological processing of information that is received through the five senses (Parham et al., 2007). The organization of behavior, learning and performance is a natural outcome of this process, as is the ability to adapt to incoming sensations. Sensory Integration Dysfunctions (SID) occur when information perceived through the senses is interpreted through previous experiences and can affect appropriate development in learning or behavior. Examples of these dysfunctions include "sensory seeking" (increased activity in sensory input to make sense of an environment) or "sensory avoiding" (avoidance of sensations for individuals who are over-responsive to the environment) patterns or "dyspraxia" (a motor planning problem which affects initiating, organizing and performing actions; Dawson, & Watling, 2000, p. 415).

Sensory integration dysfunction is a problem with processing sensations. This problem can cause complexity in daily life because learners have difficulty detecting, modulating, discriminating or integrating sensation adaptively. This causes children to process sensations from the environment or from their bodies in an inaccurate way. Children with disorders such as autism are not able to process sensory input effectively; as a result, they experience *turbulence* (disambiguation) usually seen as early as infancy and early childhood and lasting through their adulthood (Houzel, 2000). Symptoms of poor sensory integration are often treated with sensory integration therapy (Healing Thresholds, 2008). Davies and Gavin (2007) found that 71% of learners who followed traditional and alternative treatments used sensory integration methods with 91% of these learners experiencing success with these methods (Davies & Gavin, 2007).

In the last 40 years, an approach termed Sensory Integration Therapy (SIT) has been used with children to correct behavior, learning, and motor problems (Dawson & Watling, 2000). The foundation for sensory integration therapy comes from a body of work developed by Dr. A. Jean Ayres in 1970. She introduced this as a treatment based upon play, with a strong theoretical foundation in brain-behavior relationships. This therapy develops the brain's ability to organize sensory information that comes from the environment.

Visual perception problems can be addressed through vision therapy. Vision therapy can use visual training to address physical problems (i.e., ocular disorders) or perceptual processing problems (i.e., Scotopic Sensitive Syndrome [SSS]; Irlen, 1983). Vision therapy is a proposed optometric treatment method for developing efficient visual

skills and processing. It involves a sequence of activities individually prescribed and monitored by an optometrist or ophthalmologist with the therapeutic goal of correcting or improving specific dysfunctions of the visual system (American Academy of Ophthalmology [AAO], 2001; American Academy of Optometry [AAO], 1999).

Vision therapy is also called vision training, visual training, behavioral optometry, or developmental optometry. Orthoptics, also called optometric vision therapy, is a physical form of therapy where eye exercises are used to correct undesirable conditions (i.e., amblyopic as lazy eye, and strabismus a misalignment of the eyes). Vision therapy can also involve using corrective apparatus instead of exercise (American Academy of Ophthalmology [AAO], 2001).

One such intervention involves children with learning disabilities using colored or tinted overlays to alter contrast between letters on the page and the background. This has been recommended by national organizations in the United States as a treatment for accommodative disorders, amblyopia, binocular disorders (strabismic and nonstrabismic), learning disabilities, and ocular motility disorders (American Academy of Ophthalmology [AAO], 2001; American Optometric Association [AOA], 2004). Although the AAO and AOA recommend the colored overlay treatment for various disorders, there is not enough research showing significant effects to recommend this treatment to facilitate reading. The present research study is designed to contribute to the existing body of knowledge in using colored overlays during reading with the SSS/IS student population.

In psychology, visual perception is defined as the ability to interpret information registered as visible light through the eyes (American Academy of Ophthalmology [AAO], 2001). It involves the ability to detect light and to interpret (see) the consequences of light stimuli. The resulting perception is known as eyesight, sight or vision. However, vision and perception of what is seen often do not match. For example, individuals do not always see something even when it is right in front of their eyes. For example, the average person does not notice her or his nose, even though it is clearly visible. The various physiological components involved in vision are referred to collectively as the visual system (Essen, Anderson, & Felleman, 1992; Goldner, 2006).

Visual processing is composed of more than 20 separate visual abilities (Goldner, 2006). Two of these abilities that relate to the present study include:

1. Visual Perceptual Skills: organizing, interpreting, and assigning meaning to information. These information-processing skills include figure-ground, form constancy, spatial relations, visual closure, visual discrimination, visual memory, and visualization (Goldner).
2. Visual-Sensory Integration: the process of gathering visual input, processing it, and acting on it in combination with sound (auditory-visual integration), balance (bilateral integration/gross-motor), posture, and movement (eye hand coordination, visual-motor integration) (Goldner).

One problem that interferes with visual perceptual processing skills is known as the Scotopic Sensitivity Syndrome or Irlen Syndrome, referred to as SSS/IS. SSS/IS is a perceptual dysfunction associated with the brain's inability to accurately process visual

information (Wilkins, 2003). SSS/IS individuals have a figure-ground information processing problem which causes a child to have difficulty selecting one thing from a group. In reading, this can be seen when a child has difficulty selecting a particular letter in a word or a word in a sentence (Goldner, 2006). They complain of difficulty in processing starkly contrasted print when they read black print on white paper under bright lighting or under fluorescent lighting. These difficulties are reported by learners even when traditional visual examinations and correction have found no problems (Irlen, 2005; Wilkins, 2003). Initial research in the field found that SSS/IS causes physical discomforts such as headaches, eye strain, fatigue, blurry vision, and academic difficulties, such as inefficient reading resulting from poor background accommodations and print resolution, slow reading, and reading difficulties (Alder & Atwood, 1987; Irlen, 1983, 2005; Meares, 1980; Miller, 1984). While SSS/IS causes vision problems, its presence cannot be determined by ophthalmologic, optometric, psychological, or educational testing (Irlen, 2005), which led Irlen to develop an assessment called the Irlen Reading Perceptual Scale (IRPS; Irlen, 1997, 2003).

Some researchers have found that by filtering written text through colored media as a method of reading augmentation, SSS/IS students can improve letter recognition and ultimately improve reading (Evans, 2001). Although the AAO and AOA recommend the colored overlay treatment for various disorders, they contend that there is still not enough research showing significant effects to recommend this treatment to remediate reading difficulties.

Researchers working with colored overlays have found that integrating color with text changes the wave lengths of light that the reader perceives. Particular colors can affect individuals differently. Using different colors can affect readers both emotionally and physiologically, so color can provide visual and perceptual enhancement that has the potential to increase children's ability to read and copy accurately. Using color for reading and copying tasks has been examined and tried for several years; researchers discovered long ago that colored chalk, colored paper, and color highlighting were easier on the eye and more appealing to readers (Moore & Dwyer, 1991, 1994).

Individuals perceive the light energy of varying wavelengths as color, detected by two kinds of light-sensitive receptors in the retina of the eye, rod cells and cone cells. Rod cells and cone cells are used to clarify pictures and other visual stimuli. Rod cells detect just the amount of light, working at still low light degrees with fewer photons. They are stimulated through the intensity of light and are responsible for perceiving the size, shape, and brightness of visual images, not perceiving color and fine detail. Cone cells help the reader perceive color and fine detail. There are three types of cone cells; each one is able to detect a dissimilar variety of wavelengths of light being received. They need hundreds of photons to make them active. Cones are sensitive to low illumination degrees except for receiving color information. Each one of the three types of cones holds an individual kind of pigment which absorbs red, green, or blue light (Evans, 2001).

Filtering text through colored transparencies was first explored by Irlen from1981 to 1983, who found that using specially-colored filters helped individuals who had

consistently been unable to learn how to read easily and successfully. In her book, *Reading by the Colors* (Irlen, 2005), she described how her students reported less visual distortions once they were served by colored filters. One of the five students she was treating had a red overlay and had used it four years earlier in vision training exercises. Another student placed the colored overlay on the page and screamed. She explained that this was the first time she had ever been able to read without having the words swaying back and forth. Other students tried to read with the red-colored overlay but found it did not make any difference. Irlen tried other colored overlays and placed them over pages with text. Her first experiment yielded interesting results. Out of thirty-seven individuals with visual perception problems, thirty-one were helped by identifying the appropriate colored overlay. The other colored overlays made no difference in improving visual perception (Wilkins, 2003).

The use of this inexpensive, noninvasive intervention involves sheets of translucent or transparent colored plastic placed over a page and has been shown to produce immediate improvements in reading letters and words for reading-disabled children in many studies since 1980 (Noble, Orton, Irlen, & Robinson, 2004). Irlen originally developed a diagnostic instrument to assess individual benefits from reading using colored overlays. The key to the success of the Irlen Method is the ability to decide which wavelengths of light are creating a problem. The premise of Irlen's work was that every individual needs a particular color. The system she created can determine, on an individual basis, which colors of the light spectrum need to be filtered and to what degree.

Since Irlen's original work (1983), the use of colored overlays has been empirically verified as a reading improvement tool (Tyrrell, Holland, Dennis, & Wilkins, 1995; Wilkins, et al., 1994; Wilkins, Lewis, Smith, & Rowland, 2001). Some studies have investigated the effectiveness of the overlay within the background of varied environments (Meares, 1980). She tested a modified gray overlay with children with SSS, and reported the slight change in color helpful for these children to gain focus on the lettering instead of the background coloration and noticed validity to their reactions and descriptions of change in their reading capabilities (Meares, 1980). Other studies examining colored overlays with populations experiencing particular physiologic and cognitive conditions connected to reading disabilities found improvement in visual perception regardless of reading ability, comprehension, and handwriting (Whiting, 1988). In one study, approximately 80% of children with reading disabilities experienced gains in their reading performance (Williams, Lecluyse, & Rock-Faucheux, 1992).

Statistics show that SSS/IS affects 12-14% of the general population, 33% of people with ADD/HD, dyslexia and behavior problems, 44% of individuals with LD, and 55% of individuals with autism, traumatic head injuries, and other medical conditions (Irlen, 1997, 2005; Krouse & Irvine, 2003). In fact, Krouse and Irvine (2003) contended that two-thirds of individuals diagnosed as being dyslexic have SSS/IS. There do not appear to be gender or ethnic differences, but there is a genetic component: parents often have the same syndrome as their children.

While Irlen used colored transparencies to support reading, a school psychologist named Dorothy Henson-Parker (1994) reported a similar instance of using color to

diagnose and effectively recommend remediation techniques for visual-perceptual difficulties and for some visual processing disorders. She explained that a number of her students who were identified as having visual perceptual and/or visual processing disorders had problems related to light sensitivity which responded to the use of color. She had used color with both informal and standardized testing instruments in her extended study. Henson-Parker reported positive results in eliminating visual distortions using colored overlays. She stated that "when the right color is placed over the page: letters become clearer, movement ceases or lessens, letters become correctly oriented, spacing becomes regular, headaches cease and eyes no longer hurt" (Henson-Parker, 1997, p. 139).

The work of Henson-Parker was supported by additional research that has shown using colored overlays to be an effective intervention for improving ability to discriminate text more effectively in students with SSS (Meares, 1980). Meares–Irlen Syndrome (MIS) is a visual perceptual problem related to a collection of symptoms of visual fatigue when reading. It is another name for the Irlen Syndrome (IS) or Scotopic Sensitivity Syndrome (SSS). The literature is divided about which name to use for this syndrome so for the purpose of this study it will be referred to as SSS/IS.

SSS/IS, with its optical symptoms, appears to best fit the category of reading disability, although the literature refers to it sometimes as a disability and sometimes as a difficulty. In describing SSS/IS, "It is important to separate vision and perception since SSS/IS is unrelated to visual skills assessed by an optometric exam" (Irlen, 2008b, p. 3).

The effects of colored overlays have been researched in younger readers. One study, conducted by Donovan (1995), measured the effects on students in grades 2 – 8. Donovan found that student response to using colored overlays was more positive in grades 2-4 than grades 5-8. Donovan suggested that this preference for colored overlays by younger readers over older readers may be due to older, more mature readers having developed better coping mechanisms than younger children. Though there is limited research to support the impact of colored overlays on reading performance, there have been enough studies to suggest this is possibly a viable approach, and one that warrants additional study.

While there are many studies that validate the effectiveness of using colored overlays with students affected by SSS/IS, some research has not found this treatment to yield improvement in comprehension (Fletcher & Martinez, 1994; Menaker, Breton, Breton, Radcliffe, & Gole, 1993) or accuracy (Ciuffreda, Scheiman, Ong, Rosenfield, & Solan, 1997; Simmers, Bex, Smith, & Wilkins, 2001). The mixed results of research into this treatment support the ongoing examination of this method.

Statement of the Problem

Students in the third, fourth, and fifth grade have been diagnosed as being afflicted with SSS/IS. This perceptual problem can interfere with learning how to read effectively. Limited research in the area of SSS/IS suggests that early intervention can address these problems and can assist learners in developing their reading skills. From the standpoint of practicality in the classroom for struggling learners, effective interventions will be more successful if they are simple to administer. Therefore, it would be useful to identify low-

tech interventions that can facilitate reading performance and visual-motor integration, and can improve attitudes towards reading.

The present study used diagnosis and systematic interventions to explore the immediate effects on reading performance of using colored overlays by 3rd, 4th, and 5th grade students who have been identified as having SSS/IS. Student reading skills, with and without colored overlays, were tested twice daily over one semester. Differences were also measured over time by pre and post testing reading performance, visual-motor development and attitudes towards reading.

Most studies of the Irlen method have been limited in scope and administered in clinical situations without classroom teacher involvement (Willis, 2002). Studies of colored overlays and reading have traditionally assessed one or two variables in reading, such as fluency with various colors, or fluency and comprehension, or word recognition and rate, and so on. Moreover, no previous investigations have tested students with the visual perceptual problem SSS/IS to determine the effects of using colored overlays on the development of visual-motor integration. And none have measured changes in attitude toward reading when colored overlays were used as an intervention; researchers have focused only on attitudes toward school, toward academic activities, and on self-image.

Purpose of the Study

The purpose of this study was to investigate the effects on students identified with Scotopic Sensitivity Syndrome (SSS) or Irlen Syndrome (IS) when using colored overlays as an intervention (immediately and over time) to assess reading performance

(rate, accuracy, and comprehension); to measure visual-motor integration; and to assess attitude toward reading.

Research Questions

Four research questions were investigated in this study. These questions specifically focused on improvements that occur with the intervention of colored overlays.

1. Is there a difference in reading rates and accuracy on a daily basis with identified students reading text without and with colored overlays?
2. Is there a difference in reading rate, accuracy and comprehension over one semester with identified students reading text without and with colored overlays?
3. Is there a difference in visual-motor integration over one semester with identified students reading text without and with colored overlays?
4. Is there a difference in attitude towards reading over one semester of using colored overlays with identified students?

Significance of the Study

Significant contributions and benefits to education are expected to come from this study. The use of filtered colored light and the reduction of medium-to-high spatial frequency features of text, with contrast, have shown immediate improvement in reading text. Colored filtering of visual material has produced a broad range of immediate and over-time improvements, such as eye movement efficiency, word matching, word identification, recognition of letters or numbers, reading, rate, accuracy, comprehension in students with reading disability (Robinson, 1994; Smith & Wilkins, 2007).

According to U.S. Census, 1999-2000 about 8% or almost 6 million U.S. children were diagnosed with visual impairments by standard optical examinations and were recommended for early intervention programs (Naas, 2006). Forty percent of children with reading delays for their actual school age, for whom visual acuity was normalized with the use of eyeglasses, continued to show symptoms of visual problems (e.g., seeing moving letters and blurred text.) That means that a problem that cannot be diagnosed through standard optical examinations may still affect as many as 40% of children diagnosed with visual impairments.

Identifying these problems in the beginning grades is crucial. The ability to read and perform reading-related tasks in education is so important that it is necessary to facilitate such tasks in children as early as possible (Jones, 1998). The earlier the causes of learning and reading delays are addressed in ways appropriate for individual children, the more likely it is that they will require fewer services later in life (Naas, 2006).

This study contributes to the existing literature about addressing learning disabilities by studying children in third through fifth grades to determine if there are differences between pre and posttest performance through the use of colored overlays. This study employed data derived from genuine instructional contexts to determine whether the colored overlay method can provide immediate assistance to students suffering from SSS/IS.

Even though significant research regarding the possible causes and treatments of reading delays already exists and many types of remediation have been tried, large numbers of students continue to read below their grade level (Robinson & Miles, 1987).

Therefore, the present study is significant for additional reasons related to both research and practice:

1. To explore the use of single-subject experimental design, particularly the Alternating Treatment Design (ATD) and the use of running records assessment in studying the immediate effects of reading interventions (Autry, 1993; Bouldoukian, Wilkins, & Evans, 2002; Farber, 1994).
2. To provide comprehensive measurements (rate, accuracy, and comprehension) that enable a richer understanding of the effects of the colored overlay treatment on students who have SSS/IS through the use of pre and post tests measurements (Robinson, & Conway, 1994; Whiting & Robinson, 1988; Whiting, Robinson & Parrot, 1994; Wilkins, 1993; Wilkins, Jeanes, Pumlrey, & Laskier, 1996).
3. To investigate the relationship between visual-motor integration and the use of colored overlays with students who have SSS/IS.
4. The composite of all of these factors applied for the first time in a classroom-based research situation will be the beginning of continuing discussion and ongoing data collection.

Definitions of Terms

Asperger Syndrome

A developmental disorder characterized by impaired social and occupational skills, by normal language and cognitive development, and by restricted, repetitive, and stereotyped patterns of behavior, interests, and activities often with above average performance in a narrow field against a general background of deficient functioning, called also *Asperger's disorder* (Dictionary.com, 2009).

Asthenopia or Eye Strain

A fatigue or tiring of the eyes, usually characterized by discomfort, dimness of vision, and headache, caused by overuse of the visual organs, dysfunction of the ocular muscles, and incorrect refraction (Dictionary.com, 2009).

Attention Deficit / Hyperactivity Disorder (ADHD)

Symptoms involve developmentally inappropriate behavior including poor attention skills, impulsivity, and hyperactivity. A person can be predominantly inattentive (often referred to as Attention Deficit Disorder), predominantly hyperactive-impulsive, or a combination of these two (Learning Disabilities Online, 2009).

Autism

A neurodevelopmental brain disorder characterized by problems in social interactions, in ability to communicate verbally and nonverbally, and in unusual patterns of interest or behavior. The term *autism* is commonly used as a general term to refer to several disorders that fall under the category of Autism Spectrum Disorders (ASD), also called (*Pervasive Developmental Disorders [PDD];* Healing Thresholds, 2009).

Autism Disorder

Diagnostic term for a severe form of autism, characterized by severe disabilities in language and communication. The disorder is often accompanied by extreme stereotypical behaviors (Healing Thresholds, 2009).

Autism Spectrum Disorders (ASD)

A diagnostic term that includes a range of disorders with varying degrees of neurodevelopmental severity. ASDs are defined by difficulty or impairments in communication skills and social interactions, along with the presence of repetitive or stereotypical behaviors like hand-flapping. Autism spectrum disorders include autism disorder, Asperger syndrome, Rett syndrome, childhood disintegration disorder, and "pervasive developmental disorder-not otherwise specified (PDD-NOS)" (Healing Thresholds, 2008, p.9). The term autism is usually used to describe any disorders included on the autism spectrum (Healing Thresholds, 2009).

Colored Overlays

Sheets of translucent or transparent-colored plastic that can be placed over a page of a book so as to color the text beneath without interfering with its clarity (Edelson, 1999).

Dyslexia

A language-based disability that affects both oral and written language. It may also be referred to as reading disability, reading difference, or reading disorder (Learning Disabilities Online, 2009).

Fluency

Fluency in reading is the ability to read with speed and ease. When readers are fluent, they read accurately, without making mistakes in pronunciation, with appropriate rate, intonation, and rhythm (National Institute for Literacy [NIL], 2009).

Irlen Method

A non-invasive, patented technology that uses colored overlays and filters to improve the brain's ability to process visual information. It is a scientifically-based method shown to successfully correct the processing problems associated with Irlen Syndrome (Irlen, 2008a).

Learning Disability (LD)

A disorder that affects people's ability to either interpret what they see and hear or to link information from different parts of the brain. It may also be referred to as a learning disorder or a learning difference (Learning Disabilities Online, 2009).

Ocular Motor (OM)

General eye movement ability, which include *pursuits* (to visually track and/or follow moving objects) and *saccades* (to direct and coordinate eye movement as the eye quickly and voluntarily shifts from one target to another) (EyeCare, 2009).

Ocular Motor Dysfunction

Poor eye movement skills. Vision therapy is an effective treatment option (EyeCare, 2009).

Oculomotor Skills

The ability to quickly and accurately move one's eyes. These are sensory motor skills that allow an individual to move her or his eyes in order to fixate on objects (fixation), to move eyes smoothly from point to point as in reading (saccades), and to track a moving object, known as pursuits (EyeCare, 2009).

Optometrist

A health care professional who is state licensed to provide primary eye care service (EyeCare, 2009).

Optometric Vision Therapy (VT)

As defined by the American Optometric Association: Optometric vision therapy is a treatment plan used to correct or improve specific dysfunctions of the vision system (EyeCare, 2009).

Orthoptics

The science of correcting defects in binocular vision (EyeCare, 2009).

Photophobia

Unusual sensitivity to light (EyeCare, 2009).

Reading Accuracy

The quality of a reader's pronunciation of words while reading. Accuracy is usually determined by the number or percentage of words read correctly. Accuracy is one aspect of fluency (National Institute for Literacy [NIL], 2009).

Reading Comprehension

Understanding text that is read or the process of *constructing meaning* from a text. In comprehension, all the elements of the reading process work together to create a mental understanding of the text for the reader (National Institute for Literacy [NIL], 2009).

Reading Disability

Demonstration of reading achievement significantly below what is expected for the reader's age or grade level (National Institute for Literacy [NIL], 2009).

Reading Rate

The speed at which someone reads text. Reading rate is usually measured as the number of words read per minute (words per minute) (National Institute for Literacy [NIL], 2009).

Sensory Integration

Neurological process of organizing sensations from one's own body and the environment. Sensory integration is what makes it possible to use the body effectively within the environment. Children with autism are believed to have difficulties integrating sensory information (Healing Thresholds, 2009).

Sensory Integration Therapy

A type of therapy that focuses on improving the ability to receive sensory information and process it productively. Sensory integration therapy is designed to help the child develop more appropriate and effective sensory input processing and responses (Healing Thresholds, 2009).

Scotopic Sensitivity Syndrome (SSS), also known as Meares-Irlen Syndrome (MIS) or Irlen Syndrome (IS)

This is a problem with the brain's ability to process visual information, not an optical problem. This problem tends to run in families and is not currently identified by other standardized educational or medical tests (Irlen, 2008a).

Limitations of the Study

The ability to generalize the results of this single-subject experimental study was limited due to

- the small number of identified students used, and
- the limited time used for the intervention (three months versus one school year).

Assumptions

1. It was assumed that all respondents would answer all self-reporting survey questions honestly and to the best of their abilities.
2. It was assumed that the term *disability* is a meaningful and viable term.
3. It was assumed that the difficulty a student experiences with reading can be traced to organic or experience-based phenomena which can be improved through access to specific approaches.

CHAPTER 2

LITERATURE REVIEW

A review of previous research revealed limited information about the effects of the Irlen method as experienced by students and teachers in actual school settings, as well as across diverse ages (Willis, 2002). Irlen (1983) discovered one of the most controversial approaches to improving the reading performance of individuals who have perceptual difficulties, providing colored filters to improve the visual distortions of those individuals with Scotopic Sensitive Syndrome (SSS/IS) or Irlen Syndrome (IS). This chapter will review and analyze the pertinent literature concerning the effectiveness of colored overlays as it relates to individuals with SSS/IS. Basic issues in reading related to SSS/IS will be described. Then, a description of the mechanism of visual processing of SSS/IS as a visual perceptual dysfunction along with the relevant research will be discussed. In addition, studies that offer evidence regarding both effects and non-effects of interventions based on colored filters will be described.

This review of literature begins by describing the context for this study, the pervasiveness of reading difficulties and disabilities through evaluation, and the effects of a treatment method for one type of perceptual dysfunction that impedes reading, as well as explaining the notion of visual perceptual which is considered relevant to reading difficulties. This chapter also includes discussion and analysis of research on the use of spectral modification techniques (i.e., colored overlay). The chapter then focuses on findings regarding the effectiveness of colored overlays, which are organized under ten major themes: (1) reading, (2) the eye, (3) Scotopic Sensitive Syndrome (SSS), (4) the

Irlen method, (5) outline of key studies, (6) placebo studies, (7) applications related to the present study, (8) validity and reliability of test instruments used in the present study, and (9) conclusion.

Reading

Reading is a multi-dimensional procedure relating together word recognition, comprehension, fluency, and motivation. Learning how to read does involve combining all of these dimensions to build meaning from print. Reading requires that readers effectively engage in a sequence of processes:

- Word recognition - identifying words in print,
- Comprehension - constructing an understanding
- Fluency - identifying words and making meaning of words automatically and accurately (Leipzig, 2001).

According to Stevens, Slavin, and Farnish (1991),

> Learning to read is one of the most important things children accomplish in elementary school because it is their foundation for most of their future academic endeavors. From the middle elementary years through the rest of their lives as students, children spend much of their time reading and learning information presented in text. The activity of reading to learn requires students to comprehend and recall the main ideas or themes presented……in text. (p. 8)

Leipzig (2001) developed a list of requirements necessary for students to learn to read:

- Beginning experiences for young readers to become familiar with concepts of print, background knowledge, and phonemic awareness.
- Clear and direct practice instruction to develop the following:
    - phonics in alphabetic basis
    - fluency

- vocabulary
- spelling

- Rich experiences that provide reading and writing connections
- Instruction that provides comprehension strategies
- Attention to motivation

The process of reading is measured through a variety of factors. These factors include: accuracy, rate, fluency, and comprehension (Leslie & Caldwell, 2006).

The Reading Components

The major components of literacy are often described in terms of fluency that includes accuracy, rate, and prosody of reading, word recognition and vocabulary, and comprehension (Cutler & Swinney, 1987; Leslie & Caldwell, 2006). However, much of the research on struggling readers and writers focuses attention more on the issues of fluency and its relationship to both vocabulary and comprehension (Vaughn et al., 2000). The following section provides key information regarding elements of fluency (rate, accuracy, and overall reading fluency) and comprehension.

Reading rate. Reading rate is most often given as the number of words read correctly in one minute (wpm) or the length of time it takes for a reader to complete a passage (Leslie & Caldwell, 2006; Rasinski, 2004). Poor readers are frequently characterized by slow, difficult reading of linked text (Rasinski, 2004; Vaughn, et al., 2000). Most fluency interventions are designed to increase reading rate because slow reading can result in weakened comprehension. Students who read slowly commonly do not succeed in completing their work, lose interest in school, and rarely read for pleasure

(Rasinski, 2004). There is correlating evidence suggesting that increased reading rate is related to higher levels of comprehension in average and poor readers (Rasinski, 2004; Vaughn, et al.).

Reading rate is facilitated by developing word-level automaticity. Automaticity is defined as fast, accurate, and effortless word identification at the single word level (Hook & Jones, 2002). Automaticity is defined as fast and easy word identification in or out of context. It frees up cognitive resources that can be devoted to text comprehension (Ehri & McCormick, 1998; Kuhn & Stahl, 2000). Being able to decode or identify words is important for word-reading accuracy.

Reading rate is one of four essential dimensions for the assessment of fluency; these comprise measures of (1) oral reading accuracy; (2) oral reading rate; (3) quality of oral reading; and (4) reading comprehension (Rasinski, 2004). These dimensions will be used as measurements throughout this study.

Reading accuracy. Reading accuracy refers to the ability to recognize or decode words correctly. It requires four elements: (1) a strong understanding of the alphabetic standard, (2) the ability to mix sounds together, (3) knowledge of high-frequency words, and (4) the ability to perceive and process letters on the printed page (Ehri & McCormick, 1998).

Poor reading accuracy has a clearly negative influence on reading fluency and comprehension. Accuracy and speed are factors related to fast and fluent word recognition, but reading accuracy is mostly dependent upon phonological decoding skills (National Assessment Governing Board, 2002). Students who read words incorrectly are

unlikely to understand the author's intended message and inaccurate reading can lead to misunderstanding the text. Researchers have found that errors children make can change the meaning of the text and therefore reduce reading comprehension (National Assessment Governing Board, 2002).

Readers must decode words if they cannot accurately read them from memory as sight words. Decoding is a sequenced process in which the reader combines sounds to form words from their parts, combines the individual phonemes (beginning decoding), or combines phonograms, which is a more advanced form of decoding involving a single letter that can represent more than one sound or a combination of letters representing one sound (Ehri, 2002).

Reading fluency. Reading fluency is "a level of accuracy and rate where decoding is relatively effortless; where oral reading is smooth and accurate with correct prosody; and where attention can be allocated to comprehension" (Wolf & Katzir-Cohen, 2001, p. 219). One of the most important problems for children with reading deficits is a lack of reading fluency, characterized by slow, hesitant, and laborious reading. When the process used to identify words is fast and almost automatic, it means the reader is successful with decoding. This concept of *automaticity* refers to a student's ability to recognize words rapidly with little attention to the word's appearance (LaBerge & Samuels, 1974; Samuels, 2002). Increasing automaticity in processing word components is a desirable sign of reading skill development, and automaticity in turn builds cognitive resources for close attention and text processing.

There are two major instructional approaches related to fluency. First is the approach of repeated and monitored oral reading, a strategy called *repeated reading*. The students using this approach read passages aloud many times, and teachers give them guidance and feedback. The second approach is silent and independent reading in which students are encouraged to read on their own (Armbruster, Lehr, & Osborne, 2003). Fluency makes it possible for children to achieve accurate, rapid, expressive oral reading and makes possible silent reading comprehension.

Reading comprehension. Comprehension is "intentional thinking during which meaning is constructed through interactions between text and the reader" (Harris & Hodges, 1995). Comprehension evaluation focuses on two mechanisms: (1) the quality and degree of understanding, and (2) knowing what to do when comprehension fails (Dole, Duffy, Roehler, & Pearson, 1991).

All sources suggest the centrality of fluency to reading comprehension. It is impossible to discuss comprehension without more fully considering the relationship to fluency, which is, in fact, an effective means of increasing reading comprehension (Armbruster, Lehr, & Osborne, 2003). Armbruster, Lehr, & Osborne found a close relationship in their research between fluency and reading comprehension. They found that participants with lower scores on measures of fluency also had scored lower on measures of comprehension. Armbruster, Lehr, & Osborne argued that "fluency is important because it provides a bridge between word recognition and comprehension" (p. 22). Vaughn et al., 2000, also stated that increases in fluency lead to increases in comprehension and vice versa. Research has established that fluency instruction can be

an effective means of enhancing students' understanding of text. The theory of automatic information processing (Samuels, 1979) lends additional support to this argument, stating that fluent decoding is what allows the reader to focus cognitive resources on comprehension (Vaughn et al., 2000).

Teaching students strategies to monitor and improve their reading comprehension is an effective means of facilitating understanding (Vaugh et al., 2000). One strategy for students involves recognizing and identifying difficult passages and engaging in discussion to improve comprehension. Another is the *looking back* strategy, where students are given the opportunity after reading a text to look back in the text to help answer comprehension questions and to help in retelling and text discussions. Data exists to demonstrate that the strategy increases reading comprehension (Dole, Duffy, Roehler, & Pearson, 1991).

Reading Difficulties and Reading Disabilities

Reading problems are identified in published literature as reading difficulties, reading disabilities, reading disorders, or by specific names, such as dyslexia. According to the National Assessment of Educational Progress (NAEP, 2005), about 40% of fourth-grade students perform below basic reading levels. Approximately 10% of the American school-age population has a diagnosed reading disability (NAEP, 2005). Drummond (2005) estimated that about 10 million children have difficulties learning to read. In the population receiving special education, 50% of all students with disabilities are identified as having learning disabilities (Drummond). Eighty-five percent of students with learning disabilities have severe reading problems (Lyon & Fletcher, 2001).

For over two decades, reading disabilities have been studied from diverse perspectives. Recent findings from neurological studies on dyslexia (e.g., Perry & Zeki, 2000) have provided additional insight into causes, including evidence that a visual deficit is an important factor contributing to reading disabilities. The majority of individuals with reading difficulties have problems considered biological in nature, have visual problems, have issues with perception, and/or have issues related to language processing (e.g., Perry & Zeki, 2000).

Drummond (2005) stated that a variety of terms are applied to children who may have average or above average intelligence but still find it difficult to learn to read. This can be problematic because there is a major difference between a reading *difficulty* and a reading *disability*. The following definitions will be used for this literature review: (a) Students with Reading Difficulties: individuals who have to exert great effort in reading, but do not have a diagnosed disability. (b) Students with Reading Disabilities: individuals who have been officially diagnosed with learning disabilities.

According to the Learning Disabilities Association of America (2008), "a *learning disability* is a neurological disorder that affects one or more of the basic psychological processes involved in understanding or in using spoken or written language. The disability may manifest itself in an imperfect ability to listen, think, speak, read, write, spell or to do mathematical calculations" (p.1). Essentially, a *reading disability* is a condition in which a sufferer displays difficulty in reading caused primarily from neurological factors. There are diverse categories of reading disabilities that include

Word-Level Recognition Disability (RLRD). Reading difficulties and reading disabilities interfere with a reader's ability to read and comprehend text.

Dyslexia as a learning disability. Dyslexia is the most prevalent identifiable term in the field of learning disabilities as related to a child's failure to learn to read. In the 1800's, Dejune and Bastian (1868) defined dyslexia as a variety of neurological problems reported for reading problems in their patients. Language processing turned out to be the basis of the concept and a majority of the beginning research in the field was conducted in clinics where speech clinicians were working with victims of war. Until now, dyslexia research has included a wide collection of topics, such as "delayed language development, light sensitivity, oral reading, directional confusion, memory deficits, problems with attention, right-left confusion, reduced naming rates, motor sequencing problems, verbal processing deficits, family history, verbal-performance IQ split, and social behavior problems" (Division of Special Education [DSE], 2003, p.3).

There are various definitions of dyslexia. The National Institute of Health and the International Dyslexia Association's defines dyslexia within the realm of several learning disabilities.

> Dyslexia is one of several distinct learning disabilities. It is a specific language-based disorder of constitutional origin, characterized by difficulties in single word decoding, usually reflecting insufficient phonological processing. These difficulties in single word decoding are often unexpected in relation to age and other cognitive and academic abilities; they are not the result of generalized developmental disability or sensory impairment. Dyslexia is manifested by variable difficulty with different forms of language, often including, in addition to problems with reading, a conspicuous problem with acquiring proficiency in writing and spelling. (Lyon, 1995, p.10)

Swarbrick & Marshall (2004) stated, "Dyslexia is a learning disability that primarily affects one's ability to learn to read and develop a strong understanding of language" (p. 1). Additionally, Irlen (2005) affirmed that "dyslexia makes it difficult for individuals to learn information, to retain it, and to communicate it" (p. 95). Dyslexia is the most common type of learning disability among students who struggle with academics.

Swarbrick & Marshall (2004) found that dyslexia is caused by differences in how the brain processes information. "Scientists have discovered that the brains of children with dyslexia take a fraction of a second longer to respond to certain stimuli than the brains of children who read well; this pattern persists through adulthood" (p. 9). Dyslexics use a different part of the brain than non-dyslexics when they read, and they use a larger portion of their brain when they read or perform visual tasks.

Irlen (2005) stated that many of the symptoms suffered by SSS/IS students are the same as those reported among those who have dyslexia. Dyslexic students have problems accommodating specific wavelengths of light, creating difficulty with certain frequencies for individuals. Some factors, such as bright light, fluorescent light, high-gloss paper, and black-and-white contrast can make the disorder worse. The victim's scope of focus may be restricted so that she/he may only see very small bits of a line of text instead of the entire line. The text that the person sees might blur, swirl, move, pulsate, vibrate, or even disappear. Many of the symptoms experienced by people with dyslexia are also experienced by individuals who have SSS/IS (Whiting, 1985). Perceptual dyslexia is also known as Irlen Syndrome, Scotopic Sensitivity Syndrome, SSS/IS, Scotopic

Sensitivity/Irlen syndrome (Krouse, & Irvine, 2003). According to Whiting (1985), 50% of individuals who have dyslexia have Irlen Syndrome. Irlen (1997) projected that 12-14% of the general population suffers from the Irlen Syndrome and this figure increases to 46% for those diagnosed with dyslexia, attention deficit disorder and specific learning difficulties.

> Weak readers and those who do not enjoy reading nevertheless receive enough data from the page to process the information. Dyslexics with SSS/IS [Scotopic Sensitivity Syndrome] however, cannot read the words. An inefficient reader might find that the white background become puffy and more noticeable than the black letters, while the dyslexics with SSS/IS could find that the white background swallows up whole words or even sentences. (Irlen, 2005, p. 100)

> The awareness that there is a connection between SSS/IS and dyslexia has resulted in help for many individuals. Treatment for SSS/IS is NOT a treatment for dyslexia. Treatment for SSS/IS corrects an underlying visual perceptual problem. For some individuals, the correction leads to such improvement that they no longer need to be labeled dyslexic. But for dyslexics who have a multitude of problems, treatment for SSS/IS eliminates only one of the layers that contribute to their dyslexia. (Irlen, 2005, p. 103).

Effective Therapies for Reading Difficulties

Sensory integration therapy and visual therapy are approaches providing help for children with behavior, learning, and motor problems.

Sensory Integration Therapy (SIT). SMI describes how an individual with impaired sensory-motor integration can experience interference with learning, coordination, and social development. Sensory Integration Therapy is described as a multi-sensory approach that addresses the needs of children who experience various developmental delays such as low muscle tone, dyspraxia (loss of the ability to coordinate and perform certain movements and gestures), and attention deficits. By

incorporating methodologies of sensory integration and perceptual motor development, the SMI approach allows children to sequentially and successfully acquire motor capabilities and motor planning skills.

For example, individuals who fall within the dyspraxia category often have "difficulty planning and completing intended fine motor tasks" (The National Center for Learning Disabilities [NCLD], 2009, p.1). Overall, individuals in the dypraxia-dyslexia-ADD-HD-Aspergers-autism spectrum struggle to process sensory input and have difficulty responding appropriately.

SIT was established by Jean Ayres in 1979. SIT works on the principle that integrating and focusing the senses of balance, vision, and hearing builds perceptual readiness for better learning. The aim of the approach is to "improve the way the brain processes and organizes sensations" (Ayres, 1979, p.184). SIT therapy provides "a direct one-on-one intervention model in a clinic environment that requires specialized equipment" (Baranek, 2002, p. 406). Sensory Integration is the process through which the brain organizes and interprets external stimuli such as movement, touch, smell, sight and sound. Autistic children often exhibit symptoms of Sensory Integration Dysfunction (SID), making it difficult for them to process information brought in through the senses. Children can have mild, moderate or severe SID deficits manifesting in either increased (hypersensitivity) or decreased (hyposensitivity) sensitivity to touch, sound, movement, etc. For example, a hypersensitive child may avoid being touched whereas a hyposensitive child will seek the stimulation of feeling objects and may enjoy being in tight places (Autism Community, 2009).

Ottenbacher (1982) meta-analyzed multiple studies investigating the effectiveness of sensory integration therapy, most of them using quantitative methods. Ottenbacher identified the following research design elements to be necessary in determining SIT effectiveness: (1) they examined the effect of sensory integration therapy, (2) they included dependent measures of academic achievement, motor or reflex performance, and/or language function, (3) they compared at least two groups, and (4) they reported quantitative results of the effect of sensory integration therapy. Of 49 studies, these research design elements were used in only eight. The eight studies contained a total of 47 statistical hypothesis tests that evaluated the effectiveness of sensory integration therapy. Participants in sensory integration therapy performed significantly better than others in the control groups who did not receive sensory integration therapy (Ottenbacher, 1982).

While Ottenbacher's (1982) research validated that SIT had a positive effect on participants, other research has had contradictory results. Dawson and Watling (2000) conducted a review of the research examining the effectiveness of interventions for sensory and motor abnormalities in children with autism. In carefully examining the methods of introducing interventions (including SIT and auditory integration training) and the selection of experimental and control populations, the reviewers concluded that although sensory and motor impairments are commonly found in autism, the interventions developed to address them have not been well-validated. In the case of SIT, it was noted, "there exist so few studies that conclusions cannot be drawn…In the case of Auditory Integration Therapy (AIT), there is no, or at best equivocal support for this

intervention approach based on the available controlled studies" (Dawson & Watling, 2000, p. 419). Their research is inconclusive about which ages or subgroups of individuals are most likely to benefit from therapies targeting sensory and motor difficulties, Dawson & Watling recommended further research.

Different professional societies and organizations disagree about the effectiveness of SIT. The National Academy of Sciences (NAS) concluded that there is insufficient evidence as to the effectiveness of SIT for autism. NAS confirmed that there are a small number of studies relating to SIT in autism and that these interventions show positive results in experimental studies (NAS, 2001). As well, The American Academy of Pediatrics (AAP) Committee on Children with Disabilities has affirmed similar statements that the scientific legitimacy of SIT has not been established for children with motor disabilities (Michaud, & Committee on Children with Disabilities, 2004). The Association for Science in Autism Treatment (ASAT) has cited a viewpoint on their website that most scientific evidence suggests that SIT is ineffective and that practitioners of this therapy need to present reliable evidence of its effectiveness, not just opinions and subjective reports. "We need to challenge SI (Sensory Integration) practitioners to offer some evidence of effectiveness stronger than their own opinions or the occasional anecdote" (Fox, 2004, p.13).

Vision Therapy (VT). Becoming a successful reader requires having smooth eye movement. The control of saccades (a rapid irregular movement of the eye as it changes focus moving from one point to another), smooth chase, fixation and convergence (a coming together of vision from different directions) plays a significant part in producing

a stable image of the word on the page, and enables smooth tracking of the eyes along a line of print (Robinson, 1981). The accurate control of both involuntary (jump) eye movements and smooth (continuous) eye movements are necessary for reading (Fowler, 2000).

VT is based on the premise that diversity in children's visual perceptual motor abilities facilitates skills like reading, writing, and other motor activities important in ordinary daily activities. VT targets a child's motor awareness, motor planning, and motor sequencing to improve learning disabilities, speech and language disorders, and nonverbal learning disorders. Part of VT is using colored overlays, filters, or lenses to alter contrast. Glasses are sometimes prescribed for mild refractive errors, with or without prisms, to reduce pattern glare, which is a hypersensitivity to repeated patterns, as in lines of print on a page (EyeCare America, 2007).

VT includes oculomotor exercises, ambient prism lenses, and colored filters (i.e, Irlen lenses). These interventions have been tried with children to address symptoms such as unusual visual stereotypes, coordination problems, strabismus (the eyes deviate, or turn, when looking at the object of regard), attention, etc., and to reduce pattern glare. Pattern glare is a type of hypersensitivity to repeated patterns, including lines printed on a page (Baranek, 2002).

VT has been used for various vision difficulties such as amblyopia (Medem, 2004), which is better known as lazy eye; strabismus (Hayes, 2002), which is the condition of the two eyes being directed to different points when observing an object; esotropia (Suchoff, & Petito, 1986), which involves one eye turning inward; exotropia

(Coffey, Wick, Cotter, Scharre & Horner, 1992), which involves the eye turning outward; and convergence insufficiency (Birnbaum, Soden, & Cohen, 1999). VT has also been used in working with dyslexia and other reading and learning disabilities. Harris and MacRow-Hill (1999) found significant results in using tinted lenses for individuals diagnosed with dyslexia who self-reported distortions when reading, such as blurring of the text, movement of text, and distracting patterns caused by space in text. Colored overlay filters have been shown to be most helpful in reducing pattern glare commonly reported by individuals with hypersensitivity to repetitive patterns such as that found in lines of text (Tyrrell, Holland, Dennis, & Wilkins, 1995; Williams, Littell, Reinoso, & Greve, 1994). Further research in this area, specifically investigating the efficacy of tinted lenses and colored overlays, has been encouraged by the American Optometric Association (2004).

The American Academy of Pediatrics, the American Association for Pediatric Ophthalmology and Strabismus, and the American Academy of Ophthalmology (1999) produced a combined policy statement on the use of eye exercises, filters, and colored lenses purported to improve children's reading. Regarding these approaches as they relate to learning disabilities and reading difficulty, the policy states, "Visual problems are rarely responsible for learning difficulties. No scientific evidence exists for the efficacy of eye exercises 'vision therapy,' or the use of special tinted lenses in the remediation of these complex pediatric neurological conditions" (AAO, 1999, p. 2).

The American Optometric Association's policy stated that "Vision therapy does not directly treat learning disabilities or dyslexia. Vision therapy is a treatment to

improve visual efficiency and visual processing, thereby allowing the person to be more responsive to educational instruction. It does not preclude any other form of treatment and should be part of a multidisciplinary approach to learning disabilities" (American Optometric Association, 2003, p.2).

While VT is not seen as a technique to eliminate learning disabilities or eye conditions, research on the use of tinted lenses and overlays when reading supports the use of VT to help improve visual efficiency and processing. Professional organizations, such as the American Optometric Association, encourage further research on VT specifically with the use of tinted overlays or lenses.

The Eye

The complexity of the eye is a key element in the discussion of reading difficulties. The following section will discuss the eye in terms of the rod and the cone response sensors, understanding color perception with the eye, how colored overlays sample chromaticities, and SSS as a visual dysfunction.

The Rod and the Cone Response Sensors

The retina holds two kinds of photoreceptors, rods and cones. Rod cells are photoreceptor cells in the retina of the eye that can function in less intense light than cone cells. About 120 million rod cells are in the human retina. They respond in dim light and dark conditions, but cannot sense color differences.

Cone cells are photoreceptor cells in the retina of the eye that function best in bright light. The cone cells slowly become dispersed around the retina. Therefore, rod cells are for brightness and the light-sensitive nerve and cone cells are for color response

to the light. They all three (retina, rods, and cones) interrelate with each other and send messages to the brain that indicate brightness, color, and contour. Different cone cells respond to different wavelengths of light that let an individual see color. As conditions become darker, the eye transfers from cone vision to rod vision and objects seem to lose their color. However, differences between rods and cones cells are helpful. Apart from allowing sight in both dim and light conditions, they have additional advantages (Bruce, Green, & Georgeson, 1996). Rods respond to very low levels of light at all wavelengths of the visible spectrum by generating a signal. Consequently they are of greatest importance under conditions in which lighting is dim and discriminating colors is not a primary requirement. However, the cones are wavelength specific to a degree, and are therefore responsible for color vision. Cones are also much less sensitive than rods, and require higher levels of light to generate signals. Thus they work best in daytime conditions.

How to Understand Color (The Chromaticity Diagram)

The CIE Chromaticity Diagram (see Figure 2.1) is one standard method of specifying all the perceived colors as a pair of -x- and -y- numeric values. In Evans' (2001) description of the diagram, the outside numbers on the curve in the figure below represent saturated color-wavelengths in nanometers, representing the degree to which the color is seen. Less saturated colors are at the center of the figure. The human eye has receptors for red, green, and blue light. The chromaticity diagram (shown below) is the conventional way of representing these three colors conveniently in two dimensions of color (x and y). The third dimension is intensity, which is related to the brightness and

depth of the color. It is important to understand color wavelengths to comprehend the colored overlay intervention, where colored overlays can sift the brightness from the colors and affect the eye's response to the brightness of the page.

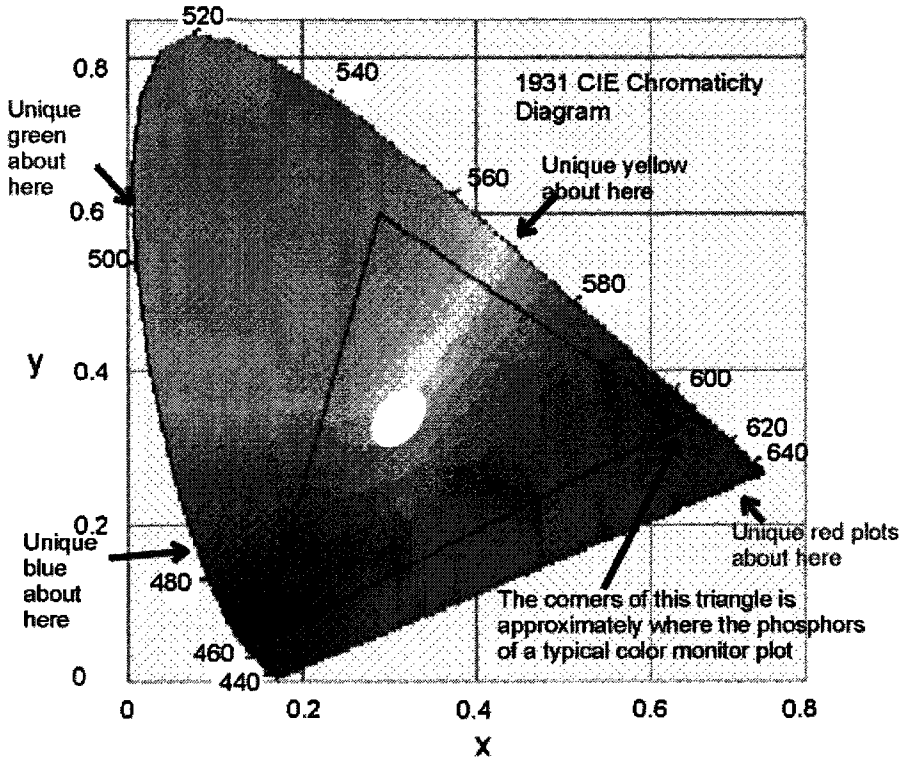


Figure 2.1. The CIE Chromaticity Diagram (http://www.yorku.ca/eye/ciediag1.htm)

How Colored Overlays Sample the Chromaticities

A number of studies (Evans, & Joseph, 2002; Evans, Patel, & Wilkins, 2002; Jeanes, et al., 1997; Wilkins et al., 1992; Wilkins, 2002) have found that individuals who

are sensitive to color often have specific colors on the chromaticity diagram that alleviate their symptoms. The use of colored filters (representing hues from the chromaticity diagram) with text is a VT approach that was employed successfully to alleviate color sensitivity. To find an effective filter it is important to sample great numbers of colors. The Intuitive Overlays (using the same plastic filter process as Irlen Color Overlays) are colored transparencies that are placed over the page when reading. These transparencies are in hues that can work to help filter the colors represented in the CIE chromaticity diagram. The transparencies are used singly or in pairs with the same or similar chromaticity, one on top of another (Smith & Wilkins, 2007; Wilkins, 1993; Wilkins, 2002).

Irlen (1983) has confirmed that some individuals experience symptoms once they look at text with white light and that these symptoms are alleviated when the text is seen through a lens of a color that is specific to that individual's needs.

A color technique is used for selecting appropriate colored overlays. Individuals are asked to experience a one-hour session to choose an appropriate tint. In working with colored overlays and text, the individual goes through a large set of trial tints, picking out colors that appear to improve the visual perception of the page through a long process of elimination. The best tint is finally selected and other tints are added to fine-tune the color selection. The final color selection can engage a combination of three or more tinted overlays and the combination is often quite dark.

Scotopic Sensitivity Syndrome (SSS)

Scotopic Sensitivity Syndrome (SSS) is a visual perceptual dysfunction and one of the reading problems that may affect students in schools. Samuel Orton, in 1928, was the first neurologist who investigated the phenomenon that eventually became known as SSS/IS. He named it Strephosymbolia, meaning twisted symbols, which referred to people who had no specific visual impairments, but who experienced various kinds of distortions when reading printed text (Bogdashina, 2003). In the 1970s, a teacher in New Zealand, Olive Meares, wrote the first detailed description of the syndrome and first recognized that some individuals with dyslexia experience difficulty with glare from the page when reading. Meares published her study in its final form in 1980, reporting that the effects could be reduced or eliminated by the use of colored paper or by using colored plastic overlays. Further research with adults diagnosed with learning disabilities and visual-perceptual processing deficits caused by light sensitivity found that these adults had a problem in the length of time that their brains needed to receive and process visual information. This processing problem can cause distortions of print and of the background; Meares (1980) argued that altering the processing time would permit the visual information to be more accurately received and processed. Meares' (1980) findings that some children's general perception of text and certain reading disabilities were also influenced by print characteristics served as the basis for what Helen Irlen called Irlen Syndrome (IS), later called Scotopic Sensitive Syndrome (SSS/IS). There has not been an agreement across the field on the labeling of this syndrome. Dr. John J. Ratey, a Harvard

Medical School psychiatrist who specializes in attention deficit disorders, stated, "I certainly don't think I would call it Irlen Syndrome" (Lee, 2004, p.2).

This Syndrome is a type of visual-perceptual processing problem related to sensitivity to lights, glare, patterns, colors, and contrast. A person with SSS/IS can experience any or all of these problems when trying to process text: light sensitivity, inadequate background accommodation, poor print resolution, restricted span of recognition, and lack of sustained attention. This problem tends to run in families and is not currently identified by other standardized educational or medical tests (Robinson, & Foreman, 2004).

For these individuals with SSS/IS, reading is typified by sore, tired eyes, visual discomfort, and headaches. A variety of visual perceptual distortions may occur while trying to read text, including blurring, doubling and jumping words, disappearing numbers, and white gaps between the words and lines that mask the print and cause visual perceptual anomalies. These visual anomalies include: blurred print, watery eyes, fading, shimmering, or moving words or letters, seeing extra patterns and shapes on the page, and light sensitivity. These symptoms were relieved by reducing the size of the print, using colored paper, reducing contrast, or using white print on black paper (Irlen, 1983; 2005; Meares, 1980; Miller, 1984).

SSS/IS is not accepted as a visual perceptual dysfunction by all professional organizations. The American Optometric Association, while supporting further research in the use of tinted lenses and overlays for dyslexia and other learning difficulties, pointed out their lack of support for the syndrome of scotopic sensitivity.

> Current research does not support the validity or presence of an actual visual perceptual dysfunction termed 'scotopic sensitivity syndrome.' Therefore the use of this term is meaningless...It is the position of the American Optometric Association that: There is currently no scientific research to support the scotopic sensitivity hypothesis, but that the use of colored lenses requires further investigation." (American Optometric Association, 2003, p. 2).

Studies Describing the SSS/IS Symptoms

The first presentation of the SSS/IS symptoms was in 1989 by Irlen and Lass. They grouped the symptoms under five factors, each one including several other factors. Individuals with SSS/IS can be affected by one or more factors experienced. Faber (1994) further refined this list. Table 1 describes the symptoms and observable skill deficits in the context of the visual processing problem.

Table 1

SSS/IS Symptoms

Category	Symptom	Observable Skill Deficit in Reading
Light Sensitivity	• Complains of glare • Shades eyes or book • Fatigue, sleepiness • Eye strain signs: squinting, blinking, opining wide	• Short attention span • Hesitant horizontal and/or vertical tracking • Slow reading rate
Inadequate Background Accommodation	• White rivers form • Blurry symbols • Sees white flashes • Losses place	• Word recognition skills delayed, inconsistent • Word guessing • Slow rate
Poor Print Resolution	• Symbols change • Letters and words vibrate • Aversion to small print • Tracking devices • Headache, nausea • Eyestrain	• Poor spelling (visual memory impeded) • Unable to proofread • Unable to skim or speed read
Restricted Span of Recognition	• Sounds out word by word, or letter by letter • Looses place • Does not get meaning from context • Tracking devices, moves close to work	• Poor comprehension • Unable to copy • Unable to skim or speed read • Poor spelling
Lack of Sustained Attention	• Takes frequent breaks • Displays symptoms from other categories	• Has difficultly completing assignments

(Faber, 1994, p.7)

Miller (1984) found that 74% of low scoring readers and 15% of high scoring readers have SSS/IS. The study investigated the relationship of SSS/IS to Reading Disability. He identified the SSS/IS as a visual dysfunction and gave detailed descriptions of the symptoms and what they include. In his study SSS/IS includes: (1) impaired visual resolution, (2) impaired depth perception, (3) impaired peripheral vision, and (4) photophobia. Participants were adult college students diagnosed as reading disabled, not related to mental deficiency or visual handicap. They were given the Nelson-Denny Reading Test, the Woodcock-Johnson Psycho-Educational Battery: Perceptual Speed

Cluster, and the Wide Range Achievement Test (Vocabulary). Also, they were interviewed about significant educational problems, any history of reading disability, and any mental deficiency. In his initial screening for individuals with SSS/IS, participants were administered individually the Irlen Differential Perceptual Schedule [IDPS] to collect a portfolio of information on medical, ophthalmology, psychological, and visual dysfunctions. In comparing the SSS/IS participants with a control group, reading data were analyzed by using a t-test, finding a significant difference for the SSS/IS group in comparison to the control group (Miller, 1984).

A follow-up study of high school students found that 42 percent had SSS/IS (Alder & Atwood, 1987). Researchers proposed that the participants with SSS/IS were experiencing a unique syndrome (Alder & Atwood, 1987; Irlen, 1983, 2005; Meares, 1980; Miller, 1984; Robinson, 1994; Robinson, Foreman, & Dear, 1996; 2000; Whiting, 1985). Robinson, Foreman, and Dear (2000), investigating the familial incidence of symptoms of SSS/IS, interviewed people with reading disabilities and identified readers who described reading as extremely difficult and stressful. They gathered descriptions that included many of the specific symptoms for SSS/IS, with participants complaining of perceptual distortions, visual stress, headaches, glare, and sore, tired eyes.

Studies Describing Visual Processing Dysfunction

Visual processing as a reading disability has received increased additional attention as a result of Irlen's (1983) identification of this visual-perceptual dysfunction that is unrelated to those skills usually assessed by eye examinations. SSS/IS is a visual-perceptual dysfunction and not a vision problem concerning refractive errors, muscle

imbalance, vergence, or accommodative problems (Edwards, 1988; Irlen, 1983). This dysfunction is considered by Irlen (1981) to be connected with an overloaded sensitivity of the retina to exacting incidences of the light spectrum. Individuals with this dysfunction are referred to as having SSS/IS. Distortions of print and background can consist of blurring or movement of print, limited distance of recognition, and problems with sustaining focus (Whiting, 1985). Difficulties are reported regardless of a full optometric or opthalmological examination, through suitable lenses fitted where required. The distortions described by Irlen (1983) and Whiting (1985) are similar to those reported in several other studies (Lovegrove, 1984; Meares, 1980; Stein & Fowler, 1985). The problem of particular interest is the trouble of restricted span of recognition, which is an inability to read words in groups or see groups of objects in the environment together (Bouma & Legein, 1977; Legein & Bouma, 1982; McIntyre, Murray, Cronin, & Blackwell, 1978).

The Irlen Method

The following provides a description of the Irlen Method (Irlen, 1983, 2005, 2008a). In addition to the method is a discussion of the manner in which this method works within an instructional setting. The use of color is not a cure, but a tool of intervention for learning problems within the education system. It is a color-based technology that filters out offensive light waves; as a result, the brain can process visual information more precisely (Irlen, 2008a). Others have dissimilar beliefs about the Irlen method, such as Dr. Eli Peli, a low-vision specialist at the Schepens Eye Research

Institute. He argues, "any serious research that has been carried out in this area has failed to show an effect...I think there's nothing to justify it" (Lee, 2004, p.1).

Description of the Irlen Method

From 1981 to 1983, Helen Irlen, an American school psychologist from California, established Irlen Centers in many Western countries. She intended to treat SSS/IS. During these times she interviewed over 1,500 adults with reading problems by video-or audiotaping. After completing these studies, she stated, "The final conclusion had to be that I was dealing with a unique syndrome that was not being adequately addressed by the professional community dealing with learning disabilities and reading problems" (Irlen, 2005, p. 21).

Meares (1980) had also been involved in researching the same syndrome as Irlen (1981), and in recognition of both their work in this field, some researchers have since termed the Irlen Syndrome as the Meares-Irlen Syndrome (MIS). The term is "sometimes used to refer to the collection of symptoms and signs of visual fatigue when reading that are reduced when color is used as therapy" (Lewis, et al., 2007, p. 3). Across the literature, researchers have referred to this syndrome as Irlen Syndrome (IS) or Scotopic Sensitivity Syndrome (SSS/IS) (Edelson, 1999); all three of these terms, MIS, IS and SSS, refer to the same syndrome. This syndrome will be identified throughout the rest of this paper as Scotopic Sensitivity Syndrome/ Irlen Syndrome (SSS/IS).

The Irlen Method is a non-invasive, patented technology that uses colored overlays and filters to improve the brain's ability to process visual information. Irlen developed two methods of treating SSS/IS. The first treatment was to improve reading

with the use of colored overlays. The second method involved improving an individual's visual perception of the environment through using tinted glasses. According to Irlen (2005), the Irlen Method involves a two-step process: the first step involves identifying the problem and the second step involves identifying the color that works best to treat this problem. Identification involves a diagnosis session.

Choosing the correctly colored glasses/transparencies through testing can be done only by certified Irlen Diagnosticians Clinicians. After the diagnosis, the students are taught how to use the Irlen Method. This whole process typically requires two sessions. In the first testing session, the problem level is diagnosed and the clinician determines what color can help eliminate the reader's difficulties. The correctly-colored overlay for the individual's combination of symptoms is determined at this time. The second testing session is conducted only for individuals who show reasonable-to-significant improvement with colored overlays. According to Irlen (2008a), the precise wave lengths of light that are causing sensitivity problems can be addressed because there is a limitless number of color filter combinations possible.

Colored Overlays

Colored overlays are "sheets of translucent or transparent colored plastic that can be placed over a page of a book so as to color the text beneath without interfering with its clarity" (Edelson, 1999). Using colored overlays as an intervention for reading disabilities has been shown to be effective in improving the reading skills of students experiencing reading difficulties associated with SSS/IS (Meares, 1980).

For teachers, however, there is little time to study and digest the Irlen-related research. Therefore, an on-line Irlen test is available for students with reading problems. This online version provides a series of questions that tap into SSS/IS symptoms. This self-test is accessible to the public in general, but has not been a part of the research on SSS/IS. Once an individual has been identified as possibly having SSS/IS through this online screening, the next step involves careful screening for the correct color for each individual. The screening involves determining those who are a good fit for the method and determines which plastic overlay or combination should be used when reading. Finally, the process should continue with research into what type of reading disabilities the child has that require the use of the color overlays.

Many studies have assessed the effectiveness of the color overlay within the context of several environments and with differential factors, as well, where length of use and specific physiologic and cognitive conditions of the users were particularly of interest. The final outcomes in most of the research indicated that extended use, regardless of physiologic and cognitive conditions, does increase the reading ability and comprehension for troubled readers (Farber, 1994; Mason, 1999; Willis, 2002). Willis (2002) and Naas (2006) reviewed the major areas of interest in the field where colored overlays have been used. These areas of interest in validating the effectiveness of color overlays include:

1. Light Filtration (Chronicle & Wilkins, 1991; McLachlan, Yale, & Wilkins, 1993; Stokes and Stokes, 1990; Wilkins et al., 1992; Wilkins, Nimmo-Smith, Slater, & Bedocs, 1989; Wilkins & Wilkinson, 1991). Decreases in eyestrain were found in

research by Westergard (1993), Whiting and Robinson (1988), and Whiting, Robinson, and Parrot (1994). Decreases in light-sensitive epilepsy have also been reported (Wilkins, et al., 1999).

2. Contrast Improvement (Bouldoukian, Wilkins, & Evans, 2002; Chronicle & Wilkins, 1991; Good, Taylor, & Mortimer, 1991; Irlen, 1997; Kriss & Evans, 2005; Simmers, Bex, Smith & Wilkins, 2001; Wilkins, 2003; Wilkins, Huang, & Cao, 2004).
3. Placebo Effects (Bouldoukian, Wilkins, & Evans, 2002; Jeanes et al., 1997; Robinson, & Foreman 1999b; Wilkins, et al., 1994; Wilkins & Lewis, 1999).

History of Colored Overlays and Filters

Irlen (1983) obtained improved reading comprehension using colored lenses. Alder and Attwood (1987) found that pre-post test results on IDPS over four months indicated significantly lower scores in general visual problems for students who used the colored lenses, as well as significant reductions in indicators of problem areas of SSS/IS. Robinson and Miles (1987) reported improved accuracy in word-matching and letter-recognition tasks using colored overlays. O'Connor and Sofo (1988) found significant gains in rate, accuracy, and comprehension of reading by using colored overlays. Robinson and Conway (1990) found similar results with significant increases in reading comprehension and accuracy after using appropriate colored lenses, generalizing from their results that colored lenses will improve specific reading skills.

Evans and Drasdo (1991) wrote a broad and critical literature review of the 18 most important research studies on SSS/IS from 1983 to 1991. Eleven of these studies

affirmed a significant advantage for readers with dyslexia in using colored filters or lenses. The authors found serious research flaws in these 11 studies, arguing that lack of control groups, poor matching, small numbers, subjective data collection, and no controls for placebo effect cast serious doubt on the scientific validity of reported benefits.

Robinson's (1996) review of 15 published studies noted that 12 studies found positive effects for reading or/and visual perceptual tasks, two reported mixed results, one indicated no positive benefits from colored overlays, and one found no positive results of the use of color. That the last study did not screen participants for SSS/IS, may explain why they were not been responsive to color overlay support. Robinson also evaluated 24 review articles on colored lenses. Of these, 17 described the improvements in different reading tasks or skills, two reported mixed results, and five found no improvement. He cited nine follow up studies with Irlen lens users, which reported 82%-90% of respondents giving high ratings to their task improvement and symptom relief.

Some researchers have found that reading performance can be improved when colored lenses are used to improve the visual discrimination of symbols by individuals who are severely mentally retarded (Meador, 1984), and specific reading deficits (Wilkins, et al., 1994) can be alleviated by using colored overlays. Overlays have scientific support behind them as a tool for increasing reading speed significantly and reducing contrasts at least 25% more quickly with an overlay, provided that users have chosen the color (Wilkins, 2002). Colored overlays used as colored therapy showed reduced symptoms of migraine, but without affecting impairment or reading speed (Harle & Evens, 2004).

Noble, Orton, Irlen, and Robinson (2004) examined the effects of using colored overlays on reading rate, accuracy, fluency, and comprehension under conditions of immediate use and delayed use. After three months of overlay use, the Whitney group (school site of the study) demonstrated a significant improvement in reading achievement with mean gains in grade equivalence scores of between one year two months and one year seven months. Between the three to six month periods of use, the gains for the Whitney group reached a plateau, with no significant improvement in reading achievement. The McKinley group (other school site) had negligible gains in reading achievement during the first three months without the use of overlays, but significant gains during the three month to six month phase with the use of overlays that ranged from one year eight months to two years eight months.

Outline of Key Studies

Within the educational field, colored overlays have been used to address reading difficulties. According to the National Center for Education Statistics (NCES), more than 68% of American students in forth and eighth grades are not reading at grade level (National Assessment of Educational Progress, 2005). As early as 1981 numerous studies on the Irlen Method documented improvements in reading rate, accuracy, and comprehension (Irlen, 2005). The original technology of the Irlen Method used colored overlays and filters to improve the brain's ability to process visual information. Irlen (2008a) argued that the technology improved reading fluency, comfort, comprehension, concentration, and reduces physical symptoms by eliminating light sensitivity.

Reading Achievement Studies

A large number of research studies have examined the effect of the Irlen Method on reading achievement since 1983. Empirical research has shown the effect of using filters over time (Wilkins, 2002). Research has shown the effectiveness and relationship between colored overlays and specific reading areas, such as comprehension, reading speed, and fluency (Tyrrell, Holland, Dennis, & Wilkins, 1995; Schaffer, 1994; Scott et al., 2002).

Several studies have investigated the effect of colored filtering on reading achievement. The majority of these studies have produced more positive results than negative ones (Irlen, 1983; Kyd, Sutherland, & McGettrick, 1992; Noble, Orton, Irlen, & Robinson, 2004; O'Connor, Sofo, Kendall, & Olsen, 1990; Robinson, 1990; Robinson & Conway, 1990; Robinson & Miles, 1987; Saint-John & White, 1988; Williams, Lecluyse, & Rock-Faucheux, 1992).

O'Connor, Sofo, Kendall, and Olsen (1990) examined the effects of colored overlays on reading rate, accuracy, and comprehension. Sixty-seven children, grades 2 through 6, identified as having SSS/IS by using the Irlen Differential Perceptual Schedule (IDPS), were compared to 25 non-identified children. For the group using preferred overlays, after one week, post-test scores showed reduced symptoms and increased reading rate by 6.6 months, reading accuracy by 6.9 months, and reading comprehension by 19.4 months. The group of identified children who were given random overlays showed no significant change and the group given clear overlays regressed four months in reading rate, three months in reading accuracy, and seven months in reading

comprehension. The group of unidentified children showed no significant effect with clear or colored overlays. The regressed performance in the clear and non-preferred color overlay groups weakened the belief in placebo effect, accounting for the benefits from Irlen treatment.

Kyd, Sutherland, and McGettrick (1992) evaluated the influence of colored overlays on reading rate, accuracy and comprehension. Participants were 14 children, ages 8 through 13, identified with a learning disability, compared to 14 non-learning disabled students, ages 9 and 10. Rate of reading was significantly improved for 93% of the identified group using their preferred overlays, but reading accuracy and comprehension did not improve. The identified group reported immediate and clear improvement in symptoms and an increase in reading fluency. One hundred percent of the identified group reported greater ease and comfort when reading with colored overlays. Eighty-six percent of the identified group noted a reduction in brightness and improved clarity of print, and 57% indicated improved spacing between print. Unfortunately, after the study, ninety-three percent of the control group abandoned using their overlays.

More recent studies in reading achievement have been conducted by Noble, Orton, Irlen, and Robinson (2004). They studied the effects of using Irlen colored overlays on reading rate, accuracy, fluency, and comprehension under regular class conditions, with class teachers integrating the study and conducting the assessments. Participants in third grade in Whitney and McKinley schools were tested with 71 students identified. After 3 months of use of overlays, the Whitney group (with overlays)

confirmed a significant improvement in reading achievement with mean gains in grade equivalence scores of between one year, two months and one year and seven months. In the next three months, the gains for the Whitney group reached a plateau, with no more significant improvements, possibly due to having reached grade levels at that time. The McKinley group (without overlays) showed negligible improvements during those first three months, but showed significant improvement during the three to six month phase with the use of overlays, which ranged from one year, eight months to two years, and eight months.

Immediate Effect Studies

In reading, improvement in clarity between the white and black on the page stabilizes the background of the page which makes reading easier for the individual with more efficiency and smoothness in the reading task. At the same time, as a number of positive studies have been conducted on the use of colored filters, findings in other investigations that do not show positive effects may be a sign of the fact that SSS/IS is just one of many possible causal factors in reading achievement. Numerous studies have investigated using of colored overlays and their effects on reading speed, and they reported an immediate significant improvement in a timed classification task with and without certain colored background conditions. Several research studies documented a direct positive effect on reading speed, accuracy, and comprehension using Irlen Colored Filters (Croyle, 1998; Smith & Wilkins, 2007; Wilkins, 1993; 1996; 2002; 2003; Wilkins, Lewis, Smith, & Rowland, 2001; Wilkins, Sihra, & Myers, 2005). Without strong reading skills, learning becomes a struggle and it is necessary to provide support for readers to

build their reading speed by keeping their eyes on the line and filtering out distractions on the page. Participants in these previous studies explained that reading after using their particular color (overlays, lenses, or glasses) became successful in smoothly focusing and tracking what they read. Their fluency (the capacity to read text accurately and smoothly) and their reading rates increased, as well as their reading comprehension.

Noble, Orton, Irlen, and Robinson (2004) described the immediate effect of colored overlays in their study, showing a significant improvement in all reading skills assessed, which could be in part attributed to the exclusion of children with reading grade levels below 1.5. This factor was included to explain how improvements in print clarity when using colored filters are less likely to lead to improved reading achievement if there are deficiencies in basic word attack skills. Problems with letter-sound analysis and synthesis (phonics) are common in English-speaking children with reading problems. As well, the improved print clearness is not likely to result in the spontaneous development of these skills, especially due to the high degree of irregularity between sounds and symbols in the English language. If students with SSS/IS and proficiency in basic word attack skills experience improved print clarity through using colored overlays, they may identify words more quickly, automatically, and immediate, therefore directing more attention towards comprehension than towards word recognition.

Long-term Studies

Several long-term studies have been done with students with reading disabilities, and most of the research has been conducted in experimental settings (Willis, 2002). Some have involved the administration of tests to gather quantitative information in a set

time frame (Whiting, Robinson and Parrott, 1994). Optomologic experts and clinicians have acquired data through reading perception tests, reading comprehension tests, and eye exams (Chase, Ashourzadeh, Kelly, Monfette, & Kinsey, 2003). In addition, some of the most important research has involved observation and interaction with students of varied ages and reading abilities (Jeanes, et al., 1997; Noble, Orton, Irlen, & Robinson, 2004; Willis, 2002).

Whiting, Robinson and Parrott (1994), conducted a survey of 267 Irlen lens wearers – 114 responses were analyzed and who had used lenses for at least six years. The most improvement from wearing lenses was for overall reading, visual confusion, skipping lines, reading fluency, concentration, and comprehension. Ninety-four reported lenses to be of "some" or "large" benefit. Fifty-eight percent reported lenses to be of "large" help. Seven percent indicated no benefit. Responses, categorized in different areas of improvements, are compared with other surveys that have used similar methods. Benefits were greatest for those who already possessed basic reading skills. Peer pressure was found to be a factor in deciding not to wear colored lenses.

Improved reading achievement using the Irlen Method has been an important topic for long-term survey studies. The mostly positive survey results have been shown for participants who used the Irlen Method for one month to six years, with participants reporting improvements in 82% to 93% of cases for reading, handwriting, spelling, eye strain, school performance, and self-image, as summarized in a review by Whiting, Robinson, and Parrott (1994). This group of studies reported improvements in reading with the use of colored filters and lenses, as well as improvements related to increased

expectations of academics. The purpose of the studies was to identify the number of participants who still rated the filters as helpful, and researchers asked about different factors including fluency, overall difficulty of reading, self-confidence, comprehension, concentration, eyestrain, visual confusion, fatigue, tendency to skip lines, handwriting, and spelling. These long-term studies reported similar results, reporting improvements in reading when using colored overlays (Burgess, 1990; Evans & Joseph, 2002; Irlen & Robinson, 1996; O'Connor & Sofo, 1988; Stokes & Stokes, 1990; Tyrrell, Holland, Dennis, & Wilkins, 1995; Westergard, 1993; Whiting & Robinson, 1988; Whiting, Robinson & Parrot, 1994; Williams, LeCluyse, & Rock-Faucheux, 1992).

Colored Lenses Studies

Additional research reviewed in this section describes findings particular to Irlen's second invention, the Irlen lenses, which are worn like eyeglasses. Scheidler (2003) described how the lenses work: "The Irlen lens is a tinted glass which filters out certain wave lengths in white light. Helen Irlen claims these wavelengths impair reading performance" (p. 1). Reduction of reading disorders and visual stress in children using tinted lenses caused the lenses to be widely publicized as a successful new treatment (Simmers, Bex, Smith, & Wilkins, 2001).

Adler and Atwood (1987) investigated the influence of colored lenses on reading and visual perception in high school students and adults in a special education program. There were 41 students identified with Irlen Syndrome in the group, of which 23 were in the experimental group and 18 students were in the control group. The group using tinted lenses showed significant improvements in all areas including a significant decrease in

visual problem areas identified (photophobia, visual resolution, span of focus, target location time, timed reading, tracking ease, and accuracy). The control group without tinted lenses demonstrated no change.

Some studies have described the participants' experience of improvements in reading when using colored lenses and have found diverse effects for different reading skills with overall improvement in reading rate, accuracy, and comprehension (Alder & Atwood, 1987; Good, Taylor, & Mortimer, 1991; Harris & MacRow-Hill, 1999; Irvine & Irvine, 1997; Lightstone, Lightstone, & Wilkins, 1999; Miller, 1984; O'Conner & Sofo, 1988; Robinson & Conway, 1990;1994; 2000; Robinson & Foreman, 1999a; b; Solan, Ficarra, Brannan, & Rucker, 1998; Whiting,1988; Whiting & Robinson,1988).

Researching hereditary aspects of SSS/IS, some researchers administered IRLS questionnaires to participants and their parents (Burgess, 1990; Fricker, 1989; McLachlan, Yale, & Wilkins, 1993; Whiting, 1985, & 1988). Both participants and parents were colored lens users. The returned questionnaires indicated a high rate of clients' satisfaction and symptom reduction.

Eperjesi, Fowler, and Evans (2002) wrote a review of literature focusing on the question entitled "Do Tinted Lenses or Filters Improve Visual Performance in Low Vision? A Review of The Literature." They studied the possible rehabilitative assistance of tinted lenses and filters for individuals with low vision, noting that the decision to prescribe Irlen lenses can be a difficult one:

> Eye care practitioners will have to continue to rely on marketing literature, subjective reports, clinic-based observations and the results of real world trials in deciding whether the supply of tinted lenses and filters to a person with low vision

> is appropriate. The provision of tinted lenses and filters for use in low vision therefore remains controversial. (p. 76)

In case studies, physicians used brain-scanning technology to render opinions about the benefit of colored lenses. Daniel Amen, M.D. neuropsychiatrist (2004), reported that brain activity was significantly different in 42 participants with SSS/IS when compared with brain activity in 200 others without the condition. Those differences diminished after using Irlen lenses. He found through use of Single-Photon Emission Computerized Tomography (SPECT) scans, to a highly significant degree, there are areas of increased activity in the brain's emotional and visual processing centers and decreased activity in the cerebellum, an area that helps to integrate coordination and new information, with subjects who are diagnosed with SSS/IS (Amen, 2004).

Studies Finding Insignificant Effects

A few studies have been unsuccessful in finding improvement in comprehension scores or measurable differences between readers using/not using tinted lenses, or used observations that led to misleading conclusions (Fletcher & Martinez, 1994; Menaker, Breton, Breton, Radcliffe, & Gole, 1993). Other researchers have found no improvement in accuracy when participants were using tinted lenses or filters (Ciuffreda, Scheiman, Ong, Rosenfield, & Solan, 1997; Simmers, Bex, Smith, & Wilkins, 2001).

Winter (1987) studied 15 participants, but found no significant improvement on a timed letter identification task for poor and standard readers when comparing lens and no lens conditions. Irlen and Lass (1989) responded to Winter's findings by citing their own study where they found the four-minute time limit used for letter identification was not sufficient to complete the task, which could skew results.

Saint-John and White (1988) examined poor readers (N=11) and average readers (N=11) using controls under three conditions: (1) using plain frames, (2) using polarized (placebo lenses), and (3) using individually selected colored overlays. They found no significant pre/post error scores for all measures, nor no significant time scores for the reading passages. The authors conclude, "the fact that no obvious improvement was observed in any of the subjects tested challenges the claim that such a (SSS/IS) subgroup exists" (Saint-John & White, 1988, p.411).

Gole, et al. (1989) found no significant change in rate, accuracy, and comprehension of reading at the end of term for experimental (N=13) and control (N=11) groups. Similar results of Cotton and Evens (1990) found no significant pre- post lens difference of reading performance for SSS/IS (N=22) and non-SSS/IS (N=38) groups.

Blaskey, et al. (1990) used participants ages 9 through 51, randomly divided and tested for SSS/IS, into an Irlen filters treatment group and a vision therapy treatment group (control group). Results were mixed, with significant increases in speed of letter naming and word recognition in isolation for experimental groups compared to vision therapy groups (N=8), but not for passage reading or comprehension. Both groups stated that they started to feel more comfortable with visual tasks after treatments, but none showed any significant improvement in reading skills.

Martin, Mackenzie, Lovegrove, and McNichol (1993) found no improvement from using Irlen Filters in reading or other visual tasks. Negative outcomes of these studies may be related to the subject selection where the researchers did not identify poor

readers with visual perceptual problems or SSS/IS, but used varied groups of poor readers.

Studies on Individuals with Different Disabilities

SSS/IS is a type of perceptual processing problem, which affects 12-14% of the general population, 33% of people with Attention Deficit /Hyperactivity Disorder (ADD/HD), dyslexia and behavior problems, 44% of individuals with Learning Disabilities (LD), and 55% of individuals with autism, traumatic head injuries, and other medical conditions (Krouse, & Irvine, 2003). The following section describes research targeting these populations.

Individuals with Dyslexia studies. Individuals with reading difficulty are more likely than others to report visual perceptual distortion, and to obtain benefit from colored overlays. However, individuals who have dyslexia may also have difficulties with visual perception. Research has not shown conclusively what relationship there might be between learning disabilities such as dyslexia and SSS/IS, or whether Irlen filters have been effective in treating LD since the use of color to eliminate perceptual problems began as a federal research project in 1981. Some evidence has been found to support the idea that SSS/IS is more common in people with diagnosed disabilities and that Irlen's method can help symptoms related to the disability, though it is not a cure.

Perceptual dyslexia usually involves problems with behavior, motivation, and self-esteem (Evans, 2001). Those with SSS/IS often demonstrate symptoms of attention deficit disorder, acting out, and behavior problems (Irlen, 2005). The overlays or filters modify the light spectrum presented to the eyes of the perceptual dyslexic. This

modification appears to alleviate the effects of the symptoms of SSS/IS (Irvine & Irvine, 1997).

Livingstone (1994), in a publication of the Harvard Medical School of Pioneering Research, identified vision-processing problems that may cause dyslexia. She remarked that the visual system processes information in two ways when one reads. The one major pathway first tells individuals the location of the letters on the page, while the other, a few milliseconds later, and provides details about the shapes of the letters. If this synchrony is disturbed, she assumed, the rapid visual system operates a bit slower than it should and the results are that words appear to slide around on the page. These two vision-processing pathways are known as the magnocellular and parvocellular systems. The first reacts very quickly and is sensitive to motion and slight differences in contrast. The second pathway operates more slowly and handles color and resolution of fine detail. Livingstone believed the colored lenses prescribed by Irlen may be useful because they heighten the contrast between the letters and the background, thus altering the timing differences between the two systems.

A group of studies examined the basis for the successful operation of color overlays or filters in correcting dyslexic effects. The researchers reported that individuals with dyslexia often experience symptomatic relief when treated with specific colored transparent overlays (Evans, 1999; Henson-Parker, 1994; Irvine & Irvine, 1997; Lewine, Davis, Provencal, Edgar, & Orrison, 2001; Parker, 2004).

Evans (1999) has been a contributing author in a number of studies on colored filters that were well controlled and have had positive results. He gave a strong warning

about treating visual problems/perceptual symptoms; colored filters relieve just the visual component of reading problems and do not include phonological deficits which are the fundamental main cause of reading disabilities. Others caution that Irlen treatment promotions claim too much, when the effectiveness appears to be limited to certain children with certain reading problems. "Once individuals have been diagnosed with Irlen Syndrome (SSS/IS), and are successfully using colored overlays, they will generally experience improved self-esteem, self-confidence, and self worth and it can reenergize their will to learn..." (Saba, 2006, p. 2-3).

Individuals with Learning Disabilities (LD) studies. Other researchers interpreted the studies as showing that colored overlays or filters can be used for students with SSS/IS, dyslexia, autism, Asperger syndrome, ADD/ADHD, and/or LD in general.

Chan and Robinson (1989) examined the effects of comprehension by monitoring instruction for reading disabled students with and without tinted lenses. They investigated the need for instructional assistance on 20 reading disabled students, 20 age-matched reading disabled students, and 20 unmatched reading disabled students. The colored lens group required less instructional assistance and performed better than the control groups.

Warnock, Freeman, Moran, Halford, (1988) studied the effect of colored tint on reading with 50 learning disabled vs. 60 control students. The Irlen Differential Perceptual Schedule (IDPS) assessment test results suggested that about 10% of each groups would benefit from tinted lenses. Student interest in using the tinted lenses went far beyond the anticipated 10%. Preference for using a tint was evident in 87% of the LD

group and 37% of the control group. Fifty-four percent of those with Irlen lenses showed a slight increase in reading, but only borderline significance.

Participants were shown to increase reading fluency and speed as visual fatigue and visual distortions decreased. Also, the overlays were portable, which provided an easily accessible instrument to use by individuals with reading difficulties (Bouldukian, Wilkins, & Evans, 2002; Iovino, Fletcher, Breitmeyer, & Foorman, 1998; Jeanes, et al., 1997; Kriss, 2002; Kriss, & Evans, 2005). One final advantage reported in the studies was that the ability to interpret emotion in facial expression in the group with SSS/IS (LD) improved with colored lenses where colored lenses worn by participants appeared to affect participants' ability to recognize faces and facial emotion. This reduced the time needed to recognize emotions; consequently, a positive effect was theorized in the development and maintenance of good social relationships (Whiting & Robinson, 2001, 2003).

A Summary of Key Studies

A comprehensive summary is presented which highlights 82 in-depth studies investigating the effects of using colored filters (see Table 2). The studies are divided into nine subcategories. Some studies shared multiple applications that are described in this review.

- Eleven of the studies described the symptoms of SSS/IS.
- Nine studies explained the visual processing dysfunction and distortion samples that are affected by using the colored filters.

- Nine studies described the most important studies that investigated the effect of using colored filtering on reading achievement.
- Nine studies investigated the immediate effects on the students' reading rates, levels of fluency, and levels of comprehension.
- Ten long-term studies have been conducted using students with reading disabilities, and most of the research has been carried out in experimental settings.
- Twenty-three analyses concerning the reduction of reading disorders and visual stress in children using tinted lenses caused the lenses to be widely publicized as a successful treatment.
- Eleven studies were unsuccessful in finding improvement or found no difference when using the colored filters.
- Six studies involved using the Irlen method with dyslexic students. Each of these studies found positive results.
- Nine additional studies used students with reading difficulties. All of the studies found that they had an improvement in reading fluency and speed, as well as a decrease in visual fatigue and visual distortions (see Table 2).

Table 2

Summarized Studies Applications

Application of Studies	Lists of the Studies
Eleven Studies Investigated the SSS/IS Symptoms	Alder & Atwood, 1987; Faber, 1994; Irlen, 1983; 2005; Irlen & Lass 1989; Meares, 1980; Miller, 1984; Robinson, 1994; Robinson, Foreman, & Dear, 1996; 2000; Whiting, 1985
Nine Studies Described Visual Processing Dysfunction	Bouma & Legein, 1977; Edwards, 1988; Irlen, 1983; Legein, & Bouma, 1982; Lovegrove, 1984; McIntyre, Murray, Cronin, & Blackwell, 1978; Meares, 1980; Stein & Fowler, 1985; Whiting, 1985
Nine Reading Achievement Studies	Irlen, 1983; Kyd, Sutherland, & McGettrick, 1992; Noble, Orton, Irlen, Robinson, 2004; O'Connor, Sofo, Kendall, & Olsen, 1990; Robinson, 1990; Robinson & Conway, 1990; Robinson & Miles, 1987; Saint-John, & White, 1988; Williams, Lecluyse, & Rock-Faucheux, 1992
Nine Immediate Effect Studies	Croyle, 1998; Noble, Orton, Irlen, Robinson, 2004; Smith & Wilkins, 2007; Wilkins, 1993; 1996; 2002; 2003; Wilkins, Lewis,1999; Wilkins, Sihra, & Myers, 2005
Ten Long-term Studies	Burgess, 1990; Evans & Joseph, 2002; Irlen & Robinson, 1996; O'Connor & Sofo, 1988; Stokes & Stokes, 1990; Tyrrell, Holland, Dennis, & Wilkins, 1995; Westergard, 1993; Whiting & Robinson, 1988; Whiting, Robinson & Parrot, 1994; and Williams, LeCluyse, & Rock-Faucheux, 1992
Twenty Three Colored Lenses Studies	Alder & Atwood, 1987; Amen, 2004; Burgess, 1990; Eperjesi, Fowler, & Evans, 2002; Fricker, 1989; Good, Taylor, & Mortimer, 1991; Harris & MacRow-Hill, 1999; Irvine & Irvine, 1997; Lightstone, Lightstone, & Wilkins, 1999; McLachlan, Yale, & Wilkins, 1993; Miller, 1984; O'Conner & Sofo, 1988; Robinson & Conway, 1990; 1994; 2000; Robinson & Foreman, 1999 a; b; Scheidler, 2003; Simmers, Bex, Smith, & Wilkins, 2001; Solan, Ficarra, Brannan, & Rucker, 1998; Whiting 1985; 1988; Whiting & Robinson, 1988
Eleven Studies Finding Insignificant Effects	Blaskey et al., 1990; Ciuffreda, Scheiman, Ong, Rosenfield, & Solan, 1997; Cotton, & Evens,1990; Fletcher & Martinez, 1994; Gole, Dibden, Pearson et al., 1989; Irlen & lass 1989; Martin, Mackenzie, Lovegrove, & McNichol,1993; Menaker, Breton, Breton, Radcliffe, & Gole, 1993; Saint-John & White,1988; Simmers, Bex, Smith, & Wilkins, 2001; Winter,1987
Six Individuals with Dyslexia Studies	Evans, 1999; Henson-Parker, 1994; Irvine & Irvine, 1997; Lewine, Davis, Provencal, Edgar, & Orrison, 2001; Livingstone, 1994; Parker, 2004
Nine Individuals with Learning Disabilities Studies	Bouldukian, Wilkins, & Evans, 2002; Chan & Robinson,1989; Iovino, Fletcher, Breitmeyer, & Foorman, 1998; Jeanes et al., 1997; Kriss, 2002; Kriss & Evans, 2005; Warnock, Freeman, Moran, Halford, 1988; Whiting & Robinson, 2001; 2003

One of the issues related to these studies is the potential for bias. Several of the researchers engaged in studies of the effectiveness of colored overlays and filters were also involved in the development of the method. Another issue is the lack of substantial empirical evidence supporting the use of colored overlays. Many of the studies addressed in this literature review involve descriptive data providing insights regarding the effects of colored overlays on targeted populations. None of these studies examined the use of colored overlays across different variables (such as examining reading performance, attitude toward reading, and visual motor integration) individually within the school setting.

Placebo Studies

Several of the studies have used placebo controls, where the placebo procedure looks like a treatment, but with no element of treatment administered (Bouldoukian, Wilkins, & Evans, 2002; Jeanes et al., 1997; Robinson & Foreman, 1999a &b; Wilkins, Evans, Brown, Busby, Wingfield, Jeanes, & Bald, 1994; & Wilkins & Lewis, 1999). Placebos are colored overlays or lenses that do not relate to the Chromaticity Diagram. These include clear overlays or overlays that do not relate to the chromaticities of the nine colored overlays. These might also include plastic spectacle lenses that are similarly colored but do not provides appropriate chromaticity awareness.

Placebo controls in these studies (Bouldoukian, Wilkins, & Evans, 2002; Jeanes, Busby, Martin, Lewis, Stevenson, Pointon, & Wilkins, 1997; Robinson & Foreman, 1999a &b; Wilkins et al., 1994; & Wilkins & Lewis, 1999) did not have a positive effect. The results from studies using placebo controls concluded that: (a) colored overlays work

better than clear overlays (a placebo control) or grey overlays that reduce contrast and luminance by a similar amount; (b) different colors with correct chromaticity can benefit individual readers, (c) the chromaticity color chosen by the reader appears to give the greatest benefit; (d) using a complementary overlay or color that the reader does not prefer results in no or only small benefits; and (e) the rate of reading is unaffected by other factors such as motivational instructions. (See Table 3)

Table 3

Summarizing Four Examples of Studies Using Placebo Controls

Jeanes et al., 1997. Prolonged use of colored overlays for classroom reading.			
Group	Design	Instruments	Results
Study 1: 1st group 93 students, 2nd group 59 students	Questionnaire and individual testing	Used Intuitive Overlays and varied which overlay improved clarity	47 students from the 1st group and 32 students from the 2ndgroup reported improved perception with the overlay
Study 2: 47 students from the1st group and 32 students from the 2nd group	Follow up research	3 months later students had asked if they continue used their overlays and want to keep them. Then retested them with all overlays and asked which overlay improved clarity	42 of the 47 students from the 1st group and 24 of the 32 students from the 2nd group used the overlays. 33 from the 1st group and 21 from the 2nd group want to continue use the overlays. After retested the students who chose the same or close to the same color overlays related to study 1
Study 3: 34 students from the 1st group. 32 students from the 2nd group	Observational research	10 months retested the students had asked how many of them still used their overlays. Then observations were made	11 of the 34students in the 1stgroup and 3 of the 32 in the 2nd group were continue using the overlays. Students used more appropriate overlays more. Students who used the overlays consistently found a decrease in headaches, decrease in eye fatigue and the letters stables
Study 4: 30 students from the 1st group. 30 students from the 2nd group	Exploratory research	Students examined with the Rate of Reading Test (RRT)	11 out of 30 students in the 1st group and 3 out of 30 students from the 2nd group using overlays Students in the 1st group by continue to using the overlays reported increase reading speed, no decrease in reading accuracy
Study 5: 47 boys & 30 girls, two students were rejected	Test/Retest	Students tested with the RRT and with a clear acetate sheet included with the overlays. Then after students choice, they were retested with/without overlays	*Study 5:* 38 out the 77 students reported increased clarity, comfort, and reading speed with using the overlays. 39 preferred the without overlays
Study 6: 13 boys & 8 girls	Randomized & Counterbalan-ced	Students tested with the RRT to compare between no overlay, a gray overlay, a clear acetate sheet, the preferred overlay and a color overlay similar to the preferred overlay	With the color overlay reading rate was greater than with the clear, gray and no overlay. No considerable difference between the preferred color overlay and the overlay similar to the preferred overlay

table continues

Robinson, G. L., & Foreman, P. J. (1999a). Scotopic Sensitivity/Irlen Syndrome and the use of colored filters: A long-term placebo controlled and masked study of reading achievement and perception of ability			
Group	Design	Instruments	Results
88 students moderate to high symptoms of SSS & 35 students with reading problems & No SSS	Placebo controlled experimental	4 times across 18 months tested reading skills 2 groups used placebo colored filters or blue filters, were switched to their optimal diagnosed tints midway	Statistically significant total improvement was shown for all groups in reading accuracy and comprehension. Also, significant increase over time on a perception of Ability Scale
Wilkins, A. J., & Lewis, E. (1999), Colored overlays, text, and texture			
Group	Design	Instruments	Results
Study 1: 16 boys &10 girls aged 6-15	Four experimental conditions Randomized Control	Colored overlays, the Rate of reading Test, & The Arrows Test (best overlay, grey overlay, prototype overlay, & no overly)	Significant effect in reading speed of the overlay condition
Study 2: 15 boys & 7 girls aged 7-14	Two experimental conditions Randomized Control	Colored overlays, the Rate of reading Test, & The Arrows Test (best overlay, & no overly)	The correlation between scores improvement in texture segmentation. Correlated with the improvement in rate of reading
Study 3: 21 boys & 13 girls aged 8-17	Four experimental conditions Randomized Control	Colored overlays, the Rate of reading Test, & The Arrows Test (no overly, grey overlay, best overlay of perceptual benefit, & with overlay least benefit)	The best overlay of perceptual improve the rate of reading scientifically greater than the three other conditions
Study 4: 203 students aged 7-11	two experimental conditions Randomized Control	Colored overlays, the Rate of reading Test, & The Arrows Test (no overly, & best overlay)	Highly significant on overlay usages on reading rate ½ of students found improved from the overlay 3 months extended use of randomized
Bouldoukian, J., Wilkins, A. J., & Evans, B. J. W. (2002). Randomised controlled trial of the effect of colored overlays on the rate of reading of people with specific learning difficulties			
Group	Design	Instruments	Results
33, 4 adults, ages 18- 40 & 29 kids, ages 7-14	Used a placebo Randomized Control Trial	Compared between colored overlays effects of reducing the symptoms of visual fatigue and improve reading performance better than that of a placebo (a pale yellow UV blocking filter)	Colored overlays increased reading performance and decreased physical symptoms of visual fatigue, visual distortions and migraines/ headaches

Applications Related to the Present Study

Many conclusions can be drawn from this literature review. The literature indicated that most studies have occurred in clinical settings instead of real school settings. The purpose of this study was to investigate the effectiveness of colored overlays (immediately and over time) as an intervention to improve reading performance (rate, accuracy, and comprehension), visual-motor integration, and attitude toward reading for students identified with SSS/IS.

Some studies found positive results from colored overlays in improving reading achievements in the United Kingdom under regular class conditions (Jeans et al, 1997; Kyd et al, 1992; Tyrrell et al, 1995; Wilkins & Lewis, 1999; Wilkins et al., 2001). Other studies found positive results in the rate of reading and reading comprehension using the colored overlays *not* in regular class conditions, but in controlled clinical conditions in the United States (Williams et al., 1992; Solan et al., 1998). Investigations into improvement in sentence comprehension and reading accuracy with colored overlays were conducted by Williams et al. (1992), Robinson and Foreman (1999a), and Robinson and Conway (2000). Positive results were found.

Two positive results from using colored overlays in reading performance included significant increases in rate, accuracy, and comprehension in reading and higher mean scores for word matching and letter and number recognition tasks (O'Connor, Sofo, Kendall, & Olsen, 1990; Robinson & Miles, 1987). Studies indicated positive results of using colored filtered glasses rather than overlays which showed significant increases in reading rate, accuracy, and comprehension over four months to two years (Adler &

Atwood, 1987; Fricker, 1989; Hannell et al., 1989; Kreuttner & Strum, 1990; Robinson & Conway, 1990).

High pre-and post-test reliability of using colored filters (either overlays or eyeglass lenses) in a long-term study of colored lenses indicated that using color decreased visual distortions in text (Robinson & Foreman, 1999b). Other studies found the same result of reduced visual distortions, but by using colored overlays (Jeans et al., 1997; & Wilkins et al., 2001). Wilkins (1997) assessed the reliability of studies exploring individuals using colored filters for individuals from six months to two years and found the reliability to be high (Wilkins, 1997).

Unlike most existing work in education and psychology, the present study involves two additional effects of using colored overlays. These effects include visual-motor development and changes in attitudes toward reading for students identified with SSS/IS. None of the sixty-five reviewed studies investigated either of these two elements. The Single Subject ABBA format is also unique because only one out of these studies used this research design (Bouldoukian, Wilkins, & Evans, 2002).

Validity and Reliability of Test Instruments Used in the Present Study

This study explored the effects of using colored overlays while reading. It measured accuracy, rate, and comprehension. It also studied changes in the students' attitudes towards reading. Lastly, it studied the effects of using colored overlays on psychomotor skills over time. These effects are measured using the following:

- Elementary students who participated were screened for SSS/IS using Irlen Reading Perceptual Scale (IRPS);

- Qualitative Reading Inventory-4 (QRI-4);
- Running Record: An Observational Survey of Early Literacy Achievement;
- Beery-Buktenica Developmental Test of Visual-Motor Integration, 5th Edition (VMI); and
- Elementary Reading Attitude Survey (ERAS).

The following section reports the reliability of these instruments to measure changes in the identified areas.

The Irlen Reading Perceptual Scale (IRPS)

The Irlen Reading Perceptual Scale (IRPS) is a short version of the Irlen Differential Perceptual Scale (IDPS). The IRPS is used to screen for SSS/IS and overlays are used, while the IDPS is used by diagnosticians who use tinted lenses or filters. Both of them are instruments using the same format and questions but the IDPS is longer with more details. The names of the two instruments have been interchanged in the literature.

A number of efficacy studies have been conducted regarding Irlen syndrome and method. Haag (1984) found significant differences on scores of all sections of the IDPS between 18 reading disabled students and 18 average readers achieving students. The tasks were significant at the .01 level, while the diagnostic questions were significant at .05.

Miller (1984) studied whether the IDPS instrument could distinguish between low-level and high-level readers. He screened each participant and individually administered the IDPS to investigate the relationship of SSS/IS to Reading Disability. He discovered significant differences in scores between students of low and high reading

ability. In the low ability group, 73, 68% were diagnosed as having SSS/IS, while 14.8% of the high ability readers had SSS/IS. The low ability readers had much higher scores on the IDPS than did the high ability readers. There was a statistically significant difference ($p < .01$) between low and high readers based on their IDPS scores.

Robinson and Miles (1987) tested 42 participants with IDPS and classified three groups (no symptoms or non Scotopic, some symptoms or moderately Scotopic, and many symptoms or highly Scotopic) as a result of performance on the IDPS.

Tyrrell, Holland, Dennis, & Wilkins (1995) found a significant association between subjects with poor scores on the Irlen screening manual and below average reading achievement. A significant association ($p < .001$) was found between poor or high symptoms scores on the IDPS and below average reading achievement.

Gray (1999) stated that he found a high internal validity of subsections of the manual and significant relationships between scores on the manual and standardized measures of reading achievement, spelling achievement, and visual processing.

Noble, Orton, Irlen, and Robinson (2004) found that SSS/IS is a significant causal factor in reading difficulties. There was a relationship between students who may have lower reading levels (reading grade levels of below 1.5 were excluded) and the scores of the IRPS.

The Qualitative Reading Inventory-4 Test (QRI-4)

The QRI-4 (Leslie & Caldwell, 2006) is an informal reading inventory assessment instrument. Leslie and Caldwell conducted broad piloting of the test with about 1000 students and have integrated a technical manual (Section 16), addressing alternate-form

reliability, inter-scorer reliability, reliability of diagnostic judgments, concurrent validity, construct validity, and classification validity. Additionally, the inventory provides suggestions for intervention instruction, procedures for assessment of strategic reading, and information regarding inclusion of results in classroom portfolios

According to Nilsson (2008) in *A Critical Analysis of Eight Informal Reading Inventories*, eight of the informal reading inventories were critiqued and each demonstrated its strengths, limitations, and unique characteristics to best fit a teacher's needs. One of these inventories included the QRI-4; Leslie and Caldwell (2006) presented a think-aloud assessment section, practical for capturing information about the strategies readers use while they are in the process of constructing meaning based on the text. In order to assist in the usage of this assessment option, several of the passages of text at the sixth, upper middle school, and high school levels are written in two different formats, which allow the researcher to conduct assessments with or without students completing think-alouds. The authors of the inventory also provide a coding system, which categorizes the think-aloud answers based on the level of understanding (or lack of understanding) of the text that they indicate (Nilsson, 2008).

Regarding the alternate forms of the QRI-4 text passages, Leslie and Caldwell (2006) concluded the reliabilities, which were based on the average comprehension scores, all above .80, and 75% of the scores were greater than or equal to .90. The reliability levels of individual students for each grade-level text, beginner level through upper middle school, are reported. Additionally, Leslie and Caldwell investigated whether or not identical instructional levels could be determined. Nilsson's (2008)

evaluation of the QRI-4 found that "71% to 84% of the time the instructional level was the same on both assessments" (p.533).

Because all of the words in the QRI-4 word lists portion of the inventory are taken from the reading passages, evaluators and researchers are able to compare the word identification abilities of students both in context, and in isolation. This allows for the distinction between instant word identification (i.e., sight words) in comparison with words that are decoded after readers spend additional time to identify the words within the text of a passage (Nilsson, 2008).

The Running Records: An Observation Survey of Early Literacy Achievement

As the primary screening, diagnostic, and monitoring instrument for Reading Recovery, the *Observation Survey of Early Literacy Achievement* (OS) (Clay, 2005) is used by 13,000 Reading Recovery teachers in the U.S. as a broadly used assessment and evaluation instrument for Reading Recovery intervention in the United States and other countries. Every year, many countries implement Reading Recovery, namely New Zealand, Australia, Canada, the United Kingdom, the United States, and the Republic of Ireland (Schmitt, Askew, Fountas, Lyons, & Pinnell, 2005). Many other teachers who are not affiliated with Reading Recovery also use instruments from the OS. Researchers have addressed the issue of the validity and reliability of the OS for years.

One formal evaluation of the psychometric properties of this instrument was not conducted until 2006 (Denton, Ciancio, & Fletcher 2006). They found the OS to be a reliable instrument. Using a larger dataset and a different analytical approach, they addressed inter-assessor reliability, dimensionality, construct validity, concurrent

validity, as well as other properties of the OS. In checking the dimensionality of the OS, the Concepts about Print task was not included in the model. They also did not fit any model of the OS to the other measures examined in their study, and concurrent validity was checked by simply correlating the OS with other measures. Their analysis did not use all six measures when checking the dimensionality of the OS; it excluded the Concepts About Print measure. The Running Record was included in this analysis. Also, Denton et al. reported that "none of the conceptual confirmatory factor analysis models that we evaluated fit even marginally well [when we] ... evaluate the concurrent validity of the Clay scales with other measures that represent a variety of constructs related to reading development" (p. 21). It also addressed the concurrent validity of the OS by finding a good-fit model between the OS and the Iowa Test of Basic Skills (ITBS). The ITBS used the technique of inter-battery factor analysis. In comparing two batteries, inter-battery factor analysis is a good technique because it distinguishes between battery-specific factors and inter-battery or common factors.

The Beery-Buktenica Developmental Test of Visual Motor Integration (VMI)

The Beery VMI (Beery & Beery, 2006) was standardized on a national sample of 2,512 individuals of ages two to 18 years and 1,021 adults ages 19-100, and it has proven reliability and validity. Test-retest reliability is reported as .87, and inter-scorer reliability is reported as .94. Additional detailed information on the reliability and validity is cited in the test manual. Inter-coder agreement was examined for this study using a Pearson correlation. Resulting correlations between the first author and an experienced occupational therapist on a set of 10 student tests was .97.

Goyen and Duff (2005) examined the ability of the VMI to discriminate between children with and without handwriting dysfunction. Thirty-five children with handwriting dysfunction from grades 4-6 (as identified by their teachers) and 35 children without handwriting dysfunction were assessed with the VMI. They found that the VMI correctly identified only a small number of the children with handwriting dysfunction (sensitivity, 34%). The authors cautioned against the routine use of the VMI to assess older school-aged children with handwriting dysfunction. Use of a model of practice and clinical reasoning is recommended to guide the assessment of children with handwriting dysfunction.

Other studies had a lack of results for the VMI, such as Kulp and Sortor (2003), who found that there was a significant amount of variance in performance on the VMI that was not explained by performance on the tests of VP or MC alone. The VMI Supplemental Developmental Test of Visual Perception (VP) and VMI Supplemental Developmental Test of Motor Coordination (MC) were developed to help differentiate between such difficulties after administration of the Beery-Buktenica Developmental Test of Visual-Motor Integration (VMI). Kulp and Sortor mentioned that each area should be individually assessed during the visual perceptual examination of children, regardless of performance on the VMI. Even children who perform within normal limits on the VMI may show a deficit in VP or MC.

The Elementary Reading Attitude Survey (ERAS)

McKenna and Kear (1990) stated their purpose in developing the ERAS as "a public-domain instrument ... [that would] enable teachers to estimate attitude levels

efficiently and reliably" (p. 626) in an attempt to increase research on attitudes toward reading. A standardization sample was taken in 95 school districts in 38 states, with 18,000 students in grades 1-6. McKenna and Kear reported moderate to high internal consistency coefficients for ERAS scores, in addition to evidence of structural validity, and they published normative standards on the three scores (a recreational reading score, an academic reading score, and a total score) for the six grades they studied.

Allen, Cipielewski, and Stanovich (1992) examined the convergent validity of the ERAS scores in 63 fifth graders. They reported that ERAS recreational scores were reasonably related to six factors: (1) minutes read, (2) book title recognition task scores, (3) children's author recognition task scores, (4) reading scores on an activity preference questionnaire, (5) scores on a reading disposition questionnaire, and (6) two measures of vocabulary. Scores on the ERAS academic subscale were related just to the reading scores on the activity preference scale. They suggested that recreational reading is likely to have a bigger impact on academic performance, possibly for the reason that students who enjoy reading for recreation would also read more material more often.

McKenna, Kear, and Ellsworth (1995) evaluated the relationship between attitudes toward reading using the ERAS and teacher ratings of students' ability to read in a sample of first through sixth graders. Researchers' findings were that academic, recreational, and total attitude scores correlated significantly with teachers' ratings of reading ability.

In a sample of 289 students in grades first to fifth grades, Kush, Watkins, McAleer, and Edwards (1995) examined the stability of ERAS scores over a one-year

period. They affirmed that stability coefficients of .43, .36, and .43 for recreational, academic, and total reading scores, respectively, in spite of the substantial time interval.

Worrell, Roth, and Gabelko (2007) found support for the structural validity of the ERAS (McKenna & Kear, 1990), and contributed to the body of construct validity evidence for the instrument's scores (e.g., Allen et al., 1992; Kush et at., 1995; McKenna & Kear; McKenna et at., 1995). The internal consistency of scores on the two factors reported by McKenna and Kear are substantial for a measure of attitudes in elementary-aged populations. The support for the reliability of ERAS scores in an AT sample extends the generalize ability of the instrument. Also, it was revealed that groups chosen for high achievement have extra positive attitudes toward reading than additional representative sample of the elementary-aged school population. Finally, the ERAS is yet another instrument that can be used in working with and researching AT students, including those who are not living up to their academic potential. Attitudes toward reading, particularly recreational reading, may prove to be useful markers in educational programs for elementary-aged academically talented (AT) elementary-aged populations.

Conclusion

Reading difficulties and learning disabilities are complex problems that have no simple solutions. However, the significance of early identification and intervention on reading has been recognized among reading researchers. The earlier identification of students with reading difficulties is the more effective of intervention efforts. Early detection will reduce the impact of reading difficulties and avoid the problems with more primary steps. Literature suggests that colored filters placed over the page can reduce

glare, and the result is that readers can read faster, read longer, feel less tired, and, in some instances, understand more of what they read. The literature also clearly demonstrates a relationship between visual and perceptual problems and classroom difficulties. Therefore, vision and learning are undeniably related. Many questions, however, remain about causes and treatments.

The Irlen Method and the efficacy of colored overlays and colored lenses have been the subject of research studies surrounding the disciplines of education, psychology, and medicine. Research on colored overlays suggests a need for further research, especially in the context of the classroom, where little research has been conducted. In addition, the focus on both reading and attitude toward reading provides additional insights into the use of colored overlays, specifically with students identified with SSS/IS. This study examined the use of colored overlays within the school setting, with a focus on four major research questions:

1. Is there a difference in reading rates and accuracy on a daily basis with identified students reading text without and with colored overlays?
2. Is there a difference in reading rate, accuracy and comprehension over one semester with identified students reading text without and with colored overlays?
3. Is there a difference in visual-motor integration over one semester with identified students reading text without and with colored overlays?
4. Is there a difference in attitude towards reading over one semester of using colored overlays with identified students?

The research questions query the effects of using colored overlays on students' reading performance. There continues to be controversy surrounding the efficacy of colored overlays. The literature reviewed has mixed results in determining the effectiveness of using colored overlays or filters on K-12 students' reading performance. One of these studies measured changes in the students' attitudes towards school, but did not measure changes in students' attitudes towards reading as the present study does. Visual motor integration has been measured with other reading interventions but never with colored overlays. Therefore, the results of this study will add to the literature in this field.

CHAPTER 3

RESEARCH METHOD

The Rationale for the Study

The purpose of this study was to investigate the effects on students identified with Scotopic Sensitivity Syndrome (SSS) or Irlen Syndrome (IS) when using colored overlays as an intervention (immediately and over time) to assess reading performance (rate, accuracy, and comprehension); to measure visual-motor integration; and to assess attitude toward reading.

Students' reading performance was assessed at the beginning of the fall semester in a population of third, fourth, and fifth graders identified with SSS/IS. Reading performance was reassessed after four weeks. Many previous studies described in the literature review researched the effects of colored overlays on reading achievement. Most of these studies generally used a test-retest design. This study used pre and post test data because it was designed to assess the level and direction of change (improvement or non-improvement) in reading performance (rate, accuracy, and comprehension); visual-motor development; and attitude toward reading over a period of time with and without the colored overlays. It was conducted over a ten week period during the 2008 fall semester.

Setting

The setting of this study was at a NK-12 Laboratory School from a Midwest Teaching University; this laboratory school was part of the public school system in the area. At the time of the study, there was one third grade, one fourth grade, and one fifth grade classroom. All testing took place in a room connected to the classroom that was

generally used for individualized reading activities with students who struggle with reading (the special education teacher's room).

Participants

Reading researchers suggested that success or failure in reading is largely shaped by students' experiences in kindergarten through the fourth grade (Beron & Farkas, 2004). Three students from the Laboratory School described in the setting participated in this study, one from third grade, one from fourth grade, and one from fifth grade. The students were in the inclusion and/or full time special education settings within the school system and had been identified as having a visual processing disorder such as dyslexia. Students were screened to identify them as having SSS/IS. Participants were all males.

Methods

This study used the alternating treatments design (ATD) as a type of single-participant design used to determine the effectiveness of two treatment conditions; (a) reading with a colored overlay and (b) reading without using a colored overlay. Conditions in the ATD were alternated rapidly and randomly.

The alternating treatments design was used to compare treatments across ten weeks. Participants selected were screened using the Irlen Reading Perceptual Scale (IRPS) to find three students who had SSS/IS. Ten students were identified recommended by the resource teacher and verified through school records to have visual perceptual problem. Family self-tests (section 1 from the IRPS) were sent home with each of these ten students. Seven of these tests were returned. All seven self-tests indicated that these

students had SSS/IS at varying degrees. Parental permission forms were sent home to all seven families and only three granted permission. These three students were given pretests in reading performance, visual motor integration and attitude toward reading. After the pretest, students were given alternating tests for sixteen days, twice a day. One reading test was used as a colored overlay and the other was used without. Finally, the students were given posttests to identify any changes in their reading performance, visual motor, and attitudes.

These data were collected to answer the four research questions, as provided in Table 4. The following table describes how the performance data analysis aligned with each of the research questions and hypotheses. See Table 4.

Table 4

The Performance Data Management

Research Questions	Test Instruments	Interval Procedures
1. Is there a difference in reading rates and accuracy on a daily basis with identify students reading text without and with colored overlays?	Running Record Read Naturally	Baseline, Intervention, and Treatment Procedures
2. Is there a difference in reading rate, accuracy and comprehension over one semester with identified students reading text without and with colored overlays?	Qualitative Reading Inventory-4 (QRI-4)	Pretest and Post test Procedures
3. Is there a difference in visual-motor integration over one semester with identified students reading text without and with colored overlays?	Beery-Buktenica Developmental Test of Visual Motor Integration, (VMI)	Pretest and Post test Procedures
4. Is there a difference in attitude towards reading over one semester of using colored overlays with identified students?	Elementary Reading Attitude Survey (ERAS)	Pretest and Post test Procedures

Parent Permission Forms

All potential participants and their parents were asked to complete a parental permission form. See appendices A, B, and C for Parental Consent Form for Screening and Research, Parental Permission to Conduct Research, and Students Consent Form for Screening and Research. These forms included a demographic section, which asked for the name, address, phone number, age, and grade level of the participant.

Colored Overlays

The colored overlays used in this research were rectangles of thin, colored plastic 9x12 scientifically made from acetate sheets that can be placed over reading materials. Each sheet had a glare and non-glare side. Students were screened using the non-glare side of ten colored overlays (Rose, Yellow, Green, Blue Gray, Gray, Golden Rod, Aqua, Turquoise, Purple, and Peach) to identify which color was most effective for the student.

Test Instruments

Elementary students who participated were screened for SSS/IS using Irlen Reading Perceptual Scale (IRPS). Consequently, they took pre/post tests assessments:

- Qualitative Reading Inventory-4 (QRI-4);
- Beery-Buktenica Developmental Test of Visual-Motor Integration, 5th Edition (VMI); and
- Elementary Reading Attitude Survey (ERAS).

An Observational Survey of Early Literacy Achievement, Running Record; only used running records from this – these records were in the intervention phase by using the Read Naturally.

The independent variable in this study was the intervention: the use of colored overlays.

The Irlen Reading Perceptual Scale (IRPS). IRPS is not a standardized test, but a screening assessment to identify students with the visual-perceptual problem known as Irlen Syndrome (IS). The purpose of this test is to identify perceptual symptoms related to IS and assign the use of colored overlays to remediate these problems. This instrument is the first step in identifying and using Irlen Filters. The IRPS assessment includes 4 sections:

Section 1: Reading Strategy Questionnaire (RSQ). The examiner asks questions to determine if an individual experiences reading difficulties and discomfort while reading. Individual questions (e.g. Do you misread words?) are answered using questions using a four-point Likert scale (Often, Sometimes, Never, Don't Know). The answers are scored based upon the frequency of the events shown in the students' responses.

Section 2: Tasks. The examiner shows the client some images that can cause SSS/IS readers difficulty and/or discomfort. These provide the screener indications of the problems that the chosen overlays might eliminate. At this point the examiner would determine if the student had SSS/IS and at which level. If the examiner decided that the student had SSS/IS, then they continued to the next section of the assessment to identify the appropriate colored overlay.

Section 3: Overlay Selection. The methodology offers different ways to handle the overlays and compare them by matching them to the tasks in Section 2. The overlay assessment requires lighting comparable to that under which the overlays will actually be used. Two of the same passages of text of appropriate size are use, side by side, so the

overlays can be placed over them and compared. The overlays are contrasted in pairs; the best of each pair is kept and the other one replaced by another overlay. Helping participants choose an overlay was tricky, so the choice was repeated after all overlays have been assessed. Double sheets of overlays were used when symptoms continue (Wilkins, 2003).

Section 4: Distortion pages. The student was shown each distortion page and the researcher had him/her choose which pages are similar to the distortions experienced when reading, then the identified distortion page was covered with the overlay to observe the difference (Irlen, 2003). See Appendix D.

The Qualitative Reading Inventory-4 (QRI-4). The QRI-4 focuses on the assessment of children's reading performance at any reading level. It provides narrative and expository passages for each reading level. Additionally, the topics and content of the passages are based on age range and reading level of the student being assessed. The various passages are design to assess the oral reading, silent reading, or listening comprehension of a student. The test also includes questions to assess the student's prior knowledge; comprehension can is measured through immediate recall of the passage using a retelling profile, followed by implicit and explicit questions

The QRI-4 is considered an informal assessment instrument. The developers, Lauren Leslie and Joanne Schudt Caldwell, demonstrated its validity through alternate-form reliability, inter-scorer reliability, reliability of diagnostic judgments, concurrent validity, construct validity, and classification validity. The QRI-4 is widely used in school districts because of its focus on assessment of word identification, fluency, and

comprehension. It provides suggestions for intervention instruction and procedures for assessment of strategic reading, and inclusion of results in classroom portfolios. The fourth edition includes the following:

- Additional passages for grade four through higher middle school levels, representing content similar to that read by students in their classes.
- Think-alouds designs for sixth grade and higher middle school levels which include a modeling passage for the examiner to model think-aloud for every grade.
- Rate measured in two ways - words per minute and corrected words per minute.
- Video segments provided on a CD-ROM to demonstrate the administration and scoring of the QRI-4 with students of varying levels of reading ability (Leslie & Caldwell, 2006).

The Running Record Taken From An Observation Survey of Early Literacy Achievement. Marie Clay developed this method for formatively evaluating a child's reading competence in reading passages. Running records were recorded about a student's performance while reading from a book that the examiner had determined to be close to the child's developmental level. The child read the passage aloud as the examiner listened and also audio taped to confirm markings. The examiner tallied the student's success in reading each word. When the child was unable to continue or is confused, the examiner would wait five to ten seconds before providing guidance. The assessment measures reading error rate, accuracy rate, and self-correction rate (Clay, 2005). See Appendix E.

Read Naturally. Developed in 1991, this program is designed to help students to become better readers using a method that combines teacher modeling, repeated reading, and assessment and progress monitoring. It includes five essential components of reading, as determined by the National Reading Panel, phonemic awareness, phonics, fluency, vocabulary, and comprehension. The program uses stories, audio recordings, posters, videos, stickers, quizzes, puzzles, and graphs. It provides age-appropriate materials for students to work at their skill and ability levels, which produce a wide range of materials.

The section of the program used in this study is called the Sequenced Series, which contained samples of stories in a fluency-building series. Each grade reading level included 24 nonfiction stories in backline master, 12 cassettes or 12 audio CDs, and a teacher's manual.

The Beery-Buktenica Developmental Test of Visual-Motor Integration, (VMI). The Beery VMI is for students from ages 2-100. It screens for visual-motor deficits and assesses the degree to which individuals were able to integrate their visual and motor abilities. It includes short- format and full-format tests, 10–15 minutes each, and supplemental Visual Perception tests and Motor Coordination tests, five minutes each. Both formats asked participants to arrange drawings of geometric forms in order of increasing difficulty by copying them. The short format is often used with children ages 2–8 years. The researcher used the short format. Optional assessments are offered so that they can be administered if the Short Format or Full Format test showed the need for further testing. This way, individuals' test results can be compared with visual and motor

performances. The test booklets include a statistical comparison so the results from all three tests can be identified quickly and easily. The Beery VMI 5th Edition manual includes descriptions of basic gross motor, fine motor, visual, and visual-fine motor developmental traits that are recognized by research criteria, along with teaching suggestions. The examiner uses the age-appropriate information for comparison to help parents and teachers better understand their child's present stage of development. In addition, this can served as a guide to learning, neuropsychological, and behavior problems (Beery & Beery, 2006). See Appendix F.

The Elementary Reading Attitude Survey (ERAS). Created by McKenna and Kear, (1990). The ERAS is a 20-item instrument designed for students in grades 1 through 6. It is comprised of a 10-item assessment of attitudes toward recreational reading; (items 1-10) (e.g., "How do you feel when you read a book on a rainy Saturday?") The other 10 questions assess attitudes towards academic reading (items 11-20) (e.g., "How do you feel about taking a reading test?"). Students are responding to each item on a 4-point scale by circling one of four pictures of the cartoon cat character Garfield. Garfield represents feelings about each statement, *very happy* (with his hands in the air and a big smile on his face), *a little happy*, *a little unhappy* (the more positive of the two middle options shows Garfield smiling whereas Garfield's face is unhappy in the other picture), and *very unhappy* (Garfield scowling with his arms tensed at his side and fists clenched). Responses are scored on a four-point scale (very happy = four points; very unhappy = one point). These scores are summed across items to yield a recreational scale score

(maximum of 40 points), an academic scale score (maximum of 40 points), and total scale score (maximum of 80 points). See Appendix G.

In addition to the instruments used in this study, the researcher also maintained a daily journal that documented the individuals met, the environment of the study site, and any additional information that would inform the study. The content of the journal was then compared with the original design plan for any changes that may have occurred during the study.

Research Design

This study was designed as a single subject experiment which had three participants using an alternating treatments design (ATD). This design was described by Barlow and Hayes (1979): "in the typical design (i.e., ATD), after a baseline period, two treatments (A and B) are administered, alternating with each other, and the effects on one behavior are observed" (p. 200). This design allows for comparison of two or more treatments by rapidly alternating implementation on a single behavior or data series. This design is also called *Rapid A-B-A-B design*: treatment. It is implemented in alternating sessions within a phase and treatment sometimes accompanied by particular stimulus conditions/cues.

This design was selected primarily because SSS/IS can occur differently in each affected individual. The individuation is specified by five symptom categories (presented in Chapter 2, Table 1), and by individual responses gathered from the Irlen Reading Perceptual Scale (IRPS) assessment. The alternating treatments design exposed students to two different testing conditions in alternating way; i.e., students alternated between

receiving and not receiving accommodations until all of the study was completed. The starting point after a baseline period (with or without using the colored overlays) was randomly determined and task order is randomly assigned to each participant in reading different materials to prevent order effects.

The Screening Procedure

The students were selected from the existing pool of one third grade, one fourth grade, and one fifth grade problem reader as identified by the reading resource teacher. All of the selected students underwent the entire initial screening procedure in one 30-minute sitting. They completed the first section of *The Irlen Reading Perceptual Scale* (IRPS) that was named the *Reading Strategy Questionnaire (RSQ).* This questionnaire was composed of 34 questions; 17 questions identified reading difficulties and 17 questions identified reading discomfort. These questions were designed to determine if an individual had the reading difficulties and discomfort that made reading challenging.

Three students who had been identified as having SSS/IS completed the rest of the screening. The remainder of the assessment included section two, *tasks;* section three, *overlays selection;* and section four, *distortions.* All of these sections were explained previously. The results for each student were recorded in the Report of Screening Results form. The report presents the following information to students, parents, and resource or typical classroom teachers:

- Definition of the SSS/IS, symptoms, and other information about it.
- Extent to which the student demonstrated SSS/IS (low, mild, or severe).
- Explanation of reading difficulties and discomfort experienced by the student.

- Explanation of actual distortions of print and or background as described by each student throughout the perceptual task practice.
- The visible effects of the chosen overlay selected by the student.
- The particular color and density of the overlay recommended for the student.
- Some approaches and environmental modifications recommended for the individuals with SSS/IS.

The Pilot Study Procedure

A pilot project preceded this study to inform researcher and instructor about the methods for the larger, evaluative study. The pilot study was conducted at the Malcolm Price Lab School with one of the 5th grade students. The limited number of students with SSS limited the number of pilot participants, and was the major reason that the pilot study was only one student from the students who were identified as having SSS using the IRSP. There were only four students identified with SSS, and only three that agreed to participate in the study. The student chosen for the pilot was George, who later participated in the full study. This preliminary study consisted of two alternating running records given on each of two days. The text used for these running records was from the same series to be used during the study. The passages chosen for the pilot study were not used in the final study. The data were analyzed using the same method described for the full study. See Table 5.

Table 5

The Pilot Study

Pilot Test	Early in the Day	Later in the Day
Day 1	A	B
Day 2	B	A

(A) With and (B) Without Colored Overlays

From the pilot study, the reading with and without colored overlays format seemed to work well. General results from the oral reading miscue analysis indicate that the student was able to recognize his oral reading miscues and self-corrected slightly more often with colored overlays than without. Complete results from the pilot are discussed in Chapter 4.

The Pretest Procedure

A pretest design was used to establish a baseline for the three participants and then to measure any changes in the achievement. The screening procedure was used to identify three students who have SSS/IS. Each of these three students were given pre-tests using Qualitative Reading Inventory-4 (QRI-4), The Beery-Buktenica Developmental Test of Visual-Motor Integration, 5th Edition (VMI), and the Elementary Reading Attitude Survey (ERAS). All of the test elements— reading rate, accuracy, comprehension, visual motor integration and attitude toward reading were tested with and without using the colored overlays as pretest.

The Intervention Procedure

The intervention focused on measuring the students' reading rates and accuracy with and without colored overlays using the Observational Survey of Early Literacy Achievement (Running Record) and passages from Read Naturally. A *baseline phase* was establishing by administering six reading trails over three days without using colored overlays. This baseline was considered stable if the variance between scores of 10% or less. If the scores varied by more than 10%, then additional days of testing were administering to find a stable measurement.

An *intervention phase* was alternated between the two conditions of with and without colored overlays. There were thirty-two reading trials within a sixteen-day period. This procedure included three stages: the baseline stage, the intervention stage, and the treatment stage.

The *intervention phase* included ten days of 15-minute sessions with each participant. Each of these sessions involved reading a short literary selection that was written at each student's reading level. One session per day was held with a colored overlay and one without. The sequence for the day had been randomly selected (see Table 6).

The final stage of the intervention procedure involved *treatment phase* for three days (six reading trials) of reading using a colored overlay. This measured the effect of reading using a colored overlay for each student.

The Post Test Procedure

Before the end of the semester, the students were re-assessed using post-tests: the Qualitative Reading Inventory, 4th Edition (QRI-4), The Beery-Buktenica Developmental Test of Visual-Motor Integration, 5th Edition (VMI), and the Elementary Reading Attitude Survey (ERAS). All of the test elements: reading rate, accuracy, comprehension, visual motor integration and attitude toward reading were tested with and without using the colored overlays to measure change over the one semester period.

Table 6

Treatment Figuration

Experiments	A & B	Test Elements	Test Measurement
Pretest	A & B A & B B	Reading rate , accuracy, & comprehension Visual motor integration Attitude toward reading	QRI-4 VMI ERAS
Baseline Day 1	A & A	Reading rate & accuracy	Running Record
Baseline Day 2	A & A	Reading rate & accuracy	Running Record
Baseline Day 3	A & A	Reading rate & accuracy	Running Record
Intervention Day 1	A & B	Reading rate & accuracy	Running Record
Intervention Day 2	B & A	Reading rate & accuracy	Running Record
Intervention Day 3	A & B	Reading rate & accuracy	Running Record
Intervention Day 4	B & A	Reading rate & accuracy	Running Record
Intervention Day 5	A & B	Reading rate & accuracy	Running Record
Intervention Day 6	B & A	Reading rate & accuracy	Running Record
Intervention Day 7	A & B	Reading rate & accuracy	Running Record
Intervention Day 8	B & A	Reading rate & accuracy	Running Record
Intervention Day 9	A & B	Reading rate & accuracy	Running Record
Intervention Day 10	B & A	Reading rate & accuracy	Running Record
Treatment Day 1	B & B	Reading rate & accuracy	Running Record
Treatment Day 2	B & B	Reading rate & accuracy	Running Record
Treatment Day 3	B & B	Reading rate & accuracy	Running Record
Post Test	B & A B & A B	Reading rate, accuracy, & comprehension Visual motor integration Attitude toward reading	QRI-4 VMI ERAS

(A) With and (B) Without Colored Overlays

Data Collection

This single subject Alternating Treatment Design (ATD) has been used frequently with early childhood special education students for comparing a treatment with no treatment and for comparing effects through direct measurement (Horner, Carr, Edward, Halle, Mcgee, Odom & Wolery, 2005).

The data generated through the instruments were collected using the following procedures: the screening procedure; the pre-test procedure; the intervention procedure; and the post-test procedure.

The Irlen Reading Perceptual Scale (IRPS)

The IRPS generated a single score. Each student was asked thirty-two questions from Section 1. These related to Reading Difficulties and Reading Discomfort. The students answered the questions using a four-point Likert scale (Often, Sometimes, Never, Don't Know). Students who scored 4 or more points in each of the two parts of Section 1: Reading Difficulties and Reading Discomfort were identified as having SSS/IS and were eligible to continue to Section 2 to further define their areas of difficulty.

The presence of SSS/IS is determined by a descriptive score of a moderate to high level of the symptoms in at least three of the IRPS components. The scoring of this instrument was based on levels of Low, Moderate, High or No Scotopic Sensitivity. Irlen (2003) describes the qualities of candidates for the assessment in terms of levels:

- *Excellent Candidate:* moderate to high scores in both reading difficulties and reading discomfort (section 1). In section 3, the client reported at least one symptom on the white page and moderate improvement in one area with colored

overlays. Client might misidentify reading, attention, or motivation problems or/and physical symptoms, like headache, stomachaches, dizziness and fatigue.

- *Good Candidate:* moderate to high scores in reading difficulties and low score in reading discomfort (section 1). Client reported improvement in one area with colored overlays. Client might read slowly, lose place in reading, spend more time reading, or reread for comprehension and study in general. Low score of reading discomfort may be because client avoids reading or reading causes strain.
- *Good Candidate:* low score in reading difficulties and moderate to high scores in reading discomfort (section 1). Client reported moderate improvement in one area with colored overlays. Client might have good grades and not be identified as a problem reader, but is not able to read for extended time with good comprehension but not read for pleasure. Client has some physical symptoms.
- *Possible Candidate:* Moderate to high scores in both reading difficulties and reading discomfort (section 1); experiences just slight changes with colored overlays.
- *Non Candidate: N/A to* low score in both reading difficulties and reading discomfort (section 1). Client found no different in the colored overlays and preferred white page without any symptoms. Client has reading problem not related to perceptual basis SSS/IS. (p. 39)

The requirements for placement in each of categories for SSS/IS candidacy as measured by results on each of the sections of IRPS testing were described and detailed in Table 7.

Table 7

Interpretation of IRPS

Section 1 Check Sheet			Section 3 Overlays	
	Reading Difficulties	Reading Discomfort	White Page	Amount of Improvement
Expellant Candidate	Moderate to high scores in both		One symptom	Moderate improvement in one or more areas
Good Candidate	Moderate to high scores	Low score	One symptom	Moderate improvement in one or more areas
	OR			
	Low score	Moderate to high scores		
Possible Candidate	Moderate to high scores in either		One symptom	Slight improvement
Non Candidate	Low score to N/A		No symptom	Prefers the white page

(Irlen, 2003, p. 38)

The Qualitative Reading Inventory-4 (QRI-4)

Using this inventory, reading level scores were calculated from reported scores and test design data of raw scores. Inter-rater reliability measures were determined to be accurate, measuring in the .98 range. Additionally, alternate forms of reliability measured within the .90 range. The main outcome skills of the inventory were assessed based on four major areas:

List reading accuracy. Students identified words based on word lists appropriate to their grade level and the results of the assessment were recorded by the examiner, focusing on the number of automatically identified words, as well as the number of words not automatically identified.

Oral reading accuracy and fluency. Students read passages aloud from grade-appropriate text as determined by the word lists from teacher recommended and school

documented reading achievement levels and the examiner closely evaluated and monitored oral reading accuracy and fluency through an analysis of word recognition performance from oral readings of grade leveled passages.

Reading comprehension. During the reading assessment, the examiner instructed students to "think aloud" while reading the text. Thinking aloud included the students describing their thinking and/or thought process while they read the text. After the student had read each passage, comprehension was measured through retelling, explicit comprehension questions, implicit comprehension questions, and looks backs (reviewing the text again to find information).

Relevant background knowledge. Before reading each text passage, the student was asked concept questions to evaluate the level of understanding of relevant concepts the student exhibited prior to reading the passage. Students with a high level of understanding prior to the assessment expected to exhibit higher levels of comprehension of the text in that area.

The Running Record Taken From An Observation Survey of Early Literacy Achievement

Students read aloud selected passages that the student's teacher had identified as matching the student's reading level. The examiner listened to the student and noted errors and self-corrections. Misread words, but not self-corrections or repetitions, counted as errors. When the child misread a proper name in a story, the error was noted one time only and not counted on succeeding errors. Contractions counted as one error, rather than two. The examiner used predetermined formulas to calculate scores.

The error and self-correction rates were determined by dividing the total number of words by the number of errors; 10 errors in 100 words is calculated as 1:10, and translated into a percentage of accuracy, 90%. Clay's (2005) levels are determined by percentage: easy text 95-100%, instructional text 90-94%, hard text <90%. To be consistent in terminology with the other reading assessments used in this study, Clay's levels will be reflected using the same terminology: independent 95-100%, instructional 90-94%, frustration <90%.

The Beery-Buktenica Developmental Test of Visual-Motor Integration, (VMI)

The Visual-Motor Integration (VMI) test assesses visual and motor abilities. The VMI scores were obtained by asking the student to copying a series of geometric shapes into the VMI test booklet. They were presented in order of increasing difficulty. The student copied the shapes until there were three consecutive failures in recreating the specified form. The student's score was the number of the last successfully copied form. The student's success was related to the VMI norms for age equivalents. See Table 8.

Table 8

Standard Score Interpretation of the Visual Perception Section of the Beery VMI

Standard Score	Performance	% of Age Group
30	Very High	2
28 – 29	High	7
26 – 27	Above Average	16
21 – 25	Average	50
19 – 20	Below Average	16
17 – 18	Low	7
0 – 16	Very Low	2

For the purposes of this study, only one of the three available sections of the Beery VMI inventory was used to evaluate student reading levels and to determine the effectiveness of the intervention. However, the Beery VMI Administration, Scoring, and Teaching Manual only provided scoring information for the three sections of the inventory, in combination with one another. A separate scoring guide was developed for this study, using the standard score ratio for the inventory as a whole, and altering it to fit the number of questions used in the specific section used for this study.

In order to score the results of the student reading evaluations, the researcher incorporated all thirty questions from the reading section of the inventory into the scoring guide. For each question answered correctly, the student received one point toward his or her overall score. After each question was scored, an overall score between 0-30 was determined. Based on the ratio of questions for this section of the inventory, compared to the inventory as a whole, a ratio was also created to determine into which percentage of a student's age group an individual student should be placed (See Table 7). The researcher used this chart to determine the skill level of each individual student (i.e. low, average, high).

The Elementary Reading Attitude Survey (ERAS)

This 20-item instrument asked questions about the student's attitude towards recreational reading and academic reading. It used pictures of the cartoon character Garfield in different emotional states. This Likert scale provided four options: 4 = a very happy Garfield, 3 = a slightly smiling Garfield, 2 = a mildly upset Garfield, 1 = a very upset Garfield. Of the 20 items used, these items were phrased so that higher scores

indicated higher attitudes toward reading. A composite attitude score was obtained for each student by adding the 20 scores for the items, so yielding a possible low score of 20 and a possible high score of 80.

Data Analysis

As previously noted, this design allows for *intra*-individual experimental comparisons with/without for baseline, intervention, and treatment conditions. ATD was implemented to compare the effects of each condition on student reading performance. This design was chosen for the current study because it is appropriate for comparing the effects of two intervention conditions, reading with/without colored overlays over brief periods of time (Barlow & Hersen, 1984).

Data analysis consisted of visual analysis describing trends and comparing differences in reading achievements (rate, accuracy, and comprehension), visual-motor development, and attitudes toward reading without/with using colored overlays. The interpretation of data compared results with research hypotheses and past research.

Visual analysis involved interpretation of the level, trend, and variability of the reading performance (rate, accuracy, and comprehension) occurring during the three phases of the present study (baseline, intervention, and treatment). *Level* referred to the mean performance during the phases. *Trend* referred to the rate of increase/decrease of the best straight line for the dependent variable within the phase. *Variability* referred to the degree to which performance changed around the means during the phase (Horner, et al., 2005).

The ATD allowed for individual examination of data for each student via visual analysis. The student data was collected in tables and is represented graphically in the following manner:

- Pretest and post test data were represented using bar graphs (See Figure 3.1). This includes the comparisons of : (1) QRI-4, (2) VMI, (3) ERAS.
- The daily intervention procedure (rate and accuracy) is represented using line graphs.
    - The line graph shows the daily reading rate and accuracy with and without the colored overlay. (See Figure 3.2), One graph was created for each student and one shows data for all three of the students.

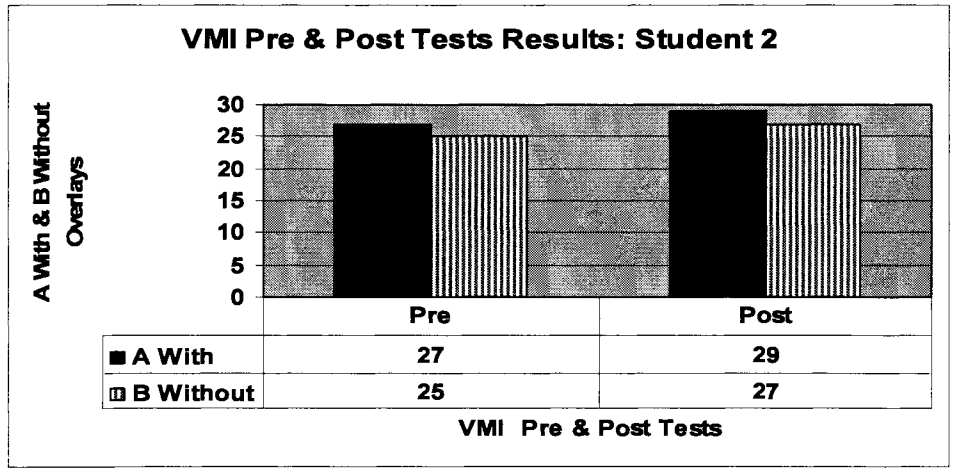


Figure 3.1. The Bar Graph Shows VMI Pre and Post Tests Results With and Without Colored Overlays: Student 1

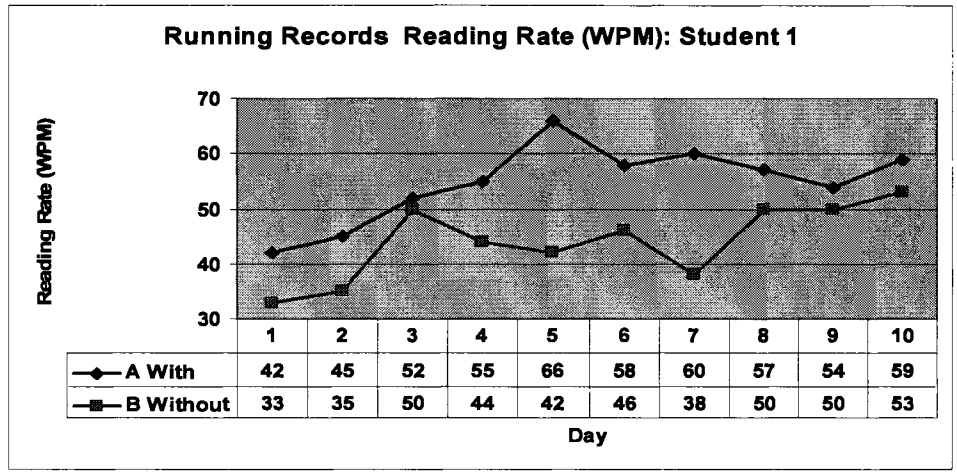


Figure 3.2. The Line Graph Shows Running Records Reading Rates (WPM) With and Without Colored Overlays: Student 1

The three participants' numerical scores for forty reading trials were presented in graphs. These graphs represented the three participants' reading performance in (rate, accuracy, and comprehension) during three trails stages: baseline (reading without colored overlay), intervention (reading without/with colored overlay), and treatment (reading with colored overlay). Each individual's performance graphed and effect sizes were calculated to examine the magnitude of the effects of accommodation on individual scores for a discussion of effect sizes in single-case research. The examination of graphed data was the primary means of data analysis in the present study and statistical data analysis procedures conducted as a supplemental source of information. See Table 9.

Table 9

Performance Data Analysis

Test Instruments	Procedures & Instruments	Collection Intervals	Presentation
The Pilot Study	Cross-checking of errors and self-corrections	One time before the beginning of the study	Line Graph
The Irlen Reading Perceptual Scale (IRPS)	30 minutes including: *Section 1:* Reading Strategy Questionnaire (RSQ) *Section 2:* tasks *Section 3:* overlays selection *Section 4:* distortion pages	One time at the beginning of the study to identify three students who have SSS/IS	Narrative Summary
Qualitative Reading Inventory-4 Fourth Edition (QRI-4)	Student's oral reading skills by scores for: *Rate:* The amount of time a student uses to read a story. *Accuracy:* student's ability to correctly pronounce each word in the story. *Comprehension:* student's correct responses to questions about the content of each story read	*Baseline:* 3 days in the reading without the colored overlay *Intervention:* ten days repeated frequently reading with/without the colored overlay. *Treatment:* three days at the end of the study reading with the colored overlay	Bar Graph & Line Graph
The Beery Buktenica Develop-mental Test of Visual-Motor Integration, (VMI)	Checklists for recording experimenter on the Short Format & Full Format tests: 10–15 minutes each; supplemental Visual Perception Test and Motor Coordination tests: 5 minutes each	(Pre-post-test) two times in the beginning and the ending of the study before and after using the colored overlay	Bar Graph
Elementary Reading Attitude Survey (ERAS)	Checklists for experimenter to record each item on a 4-point scale - very happy Garfield - a little happy Garfield - a little unhappy Garfield - very unhappy Garfield	(Pre-post-test) two times in the beginning and the ending of the study reading with/without the colored overlay	Bar Graph
Running Record	Cross-checking of errors and self-corrections	Baseline, Intervention, and Treatment	Line Graph

CHAPTER 4

RESULTS AND DISCUSSION

The purpose of this study was to investigate the effects on students identified with Scotopic Sensitivity Syndrome (SSS) or Irlen Syndrome (IS) when using colored overlays as an intervention (immediately and over time) to assess reading performance (rate, accuracy, and comprehension); to measure visual-motor integration; and to assess attitude toward reading. This study took place over a one-semester period of time. This chapter presents analysis and discussion of the data obtained from the study as measured by reading performance scores, reading attitude scores, and visual motor integration scores. Because multiple instruments were used, results related to one instrument at a time will be reported and then interpreted. This type of organization of the large amount of data will ensure a clear presentation for readers (Rudestam & Newton, 2007).

Findings were organized as follows: screening, pilot study, pre tests, and running records results involving baseline, intervention, and treatment, and post tests. The first step in the present study was to select the student participants based on the screening criteria described in Chapter 3. After that, the researcher sent home consent forms for screening and research permission from the parents of the selected students. Following acquisition of parental permission the students were asked to complete a consent form also. After consent forms were signed by both the parents and the students, the participants were placed into both the screening and the study. Three boys participated in the study, George, David and Charles (all names are pseudonyms to protect the identity of the participants).

The Setting

The study took place at a laboratory school associated with a university in the Midwest. The site for the study was in a fifth grade classroom. This site was provided after consultation with faculty at the school site, and with permission from the principal and faculty involved with the area. This site was suggested as it was considered a quiet corner in a learning space that would provide easy access to the participants, and would be conveniently located in one site. The site included one kidney-shaped table with two chairs. In the area where the study was conducted there were book cases, materials carts and other school supplies stored by the fifth grade classroom teacher. The fifth grade class was taught in the adjoining space. The resource room was adjacent to this site with a door that opened into the resource area.

The original agreement was to meet with the participants over a four week period of time, meeting five days a week (Monday through Friday). The meeting times were for ten to thirty minutes with each participant, depending on the type of instrument to be used. As the study began, it became clear that the original schedule was not going to work with the teacher schedule and school schedule. This altered the time line for the study, which culminated in a series of events that changed the order of intervention, and altered the dynamic of the study site.

Participants' Characteristics

The participants in this study represented three different learning levels, and all of them were enrolled in the resource room at one school site. Each student had a different and rather particular background. The similarity of these students was their

overwhelming desire to read effectively. However, their challenges may indicate some similar problems in reading, writing, and math. On the other hand, visual perception and basic lack of knowledge of reading and writing is another basis of comparison. The following information about the students includes information that was retrieved from their files in the school records after permission was given by their parents.

George

George is a 5th-grade boy who is very personable; according to his resource room teacher he works hard to reach his goals. He is preparing for postsecondary life: living, learning, and working. His reading (3rd-grade level) and writing are below the level of his average peers, and even though the classroom teacher provides accommodations, he needs individual or small group instruction at his level and pace of learning. His reading and math are at a third grade-level. He receives individual tutoring three times per week. A summary of his identified conditions follows:

- Conduct Disturbance (CD).
- Dyslexia.
- Dyscalculia (Developmental Arithmetic Disorder)
- Mathematics Disorder (problems with understanding math).
- Obesity.
- Wears eyeglasses.
- Other Learning Disabilities (LD) (problems in some areas of learning, such as reading, writing, and math).

- Uneven cognitive development (verbal and visual motor skills developing at different rates).

For purposes of clarity, Dyscalculia (Developmental Arithmetic Disorder) for math learning continues, with language processing disabilities. The student exhibits difficulty in solving basic math problems using addition, subtraction, multiplication, and division. He struggles to remember and retain basic math facts (i.e., multiplication tables), and has trouble figuring out how to apply his knowledge and skills to solve math problems.

Difficulties also arise for him because of weaknesses in his visual-spatial skills. He may understand the necessary math facts, but has difficulty putting them down onto paper in an organized fashion. Visual-spatial difficulties can also negatively affect his understanding of what is written on a board or in a textbook.

George is enrolled in general education with special education supportive instruction. He participates in special education for 75 minutes daily, with special services designed for instruction of reading, handwriting, and math, plus accommodations and program modifications.

He wears glasses and once removed his glasses during observation. When he was asked about removing his glasses, he stated, "It felt like my eyes are poking out." He demonstrates a lack of fluency in his oral reading skills. While writing some letters and numbers, he produced print that was not of a uniform size and shape, which caused his text to contain many inaccuracies along with misuse of lines and margins.

David

David is a 4th-grade boy who participates in the resource room. The resource room teacher mentioned that he does not work hard to reach his goals. His reading and writing are below the 3rd-grade instructional level in reading word recognition and comprehension. His reading (3rd-grade level), math, and speech are in need of improvement. He attends the resource room for individual tutoring three times per week, including his special education, which is 60 minutes of special services designed for reading, handwriting, and math improvement, as well as speech therapy. He needs positive preference accommodations (encouragement strategies) and program modifications when using computers.

A summary of his identified conditions follows:

- Attention Deficit Disorder (ADD) (struggling with attention and lack of focus).
- Lack of follow-through for most things, observed both at home and at school.
- Frequently exhibiting various Learning Disabilities (LD) (not just ADD) and his identified conditions including emotional and behavioral problems: depression, anxiety, conduct disorders, and delinquency in following classroom rules.
- Disordered: loses and/or cannot find belongings; desk and room may be a total disaster area.
- Difficulty working independently.
- Auditory processing or difficulty remembering verbal direction.
- Uneven speech and blending of some consonants (br, dr, fr, gr, kr,tr).

His speech error (or slip) is an unintentional movement, addition, deletion, blending, or substitution of material within an utterance or between utterances. He can use a word processor in school to assist in his reading and word recognition. The word processor helps him to break words up into syllables and to sound them out. He makes mistakes when speaking words that involve a single sound. He needs to slow his fluency rate to improve clarity and accuracy. David often needs to use word recognition strategies that will assist him in identifying unknown words (such as chunking words into recognizable syllables or morphemic units), and he needs to focus his attention, when reading, on the author's intended message (comprehension). His reading is fast and uneven. When reading aloud he appears to rush through the text, focusing on the surface level of the text and moving so quickly with little focus on meaning that he misses entire words, sentences, lines, and sections of text. When he slows down, his accuracy and reading improve dramatically. His errors often correspond with his behavior.

David works on developing strategies to facilitate organization. The resource teacher is using behavior modification techniques to provide social skills and organizational skills training.

Charles

Charles is a 3rd-grade boy who receives services in the resource room; the resource room teacher stated that he works very hard to reach his goals. His reading, writing, and math are two levels below his own grade level. He reads at the 1st-grade level and struggles in reading word recognition and comprehension. He has some challenges in language, reading, and writing, which relate to his Klinefelter's Syndrome

that affects the pace of his learning in the general education classroom. He requires support beyond that which can be provided and maintained in general education and receives special education. He has high absence rates due to his anxiety about school, which slows down his learning. He is seeing the speech and language teacher twice a week.

A summary of his identified conditions is as follows:

- Klinefelter's Syndrome, or 47, XXY or XXY Syndrome (condition caused by a chromosome aneuploidy; affected individuals have at least two X chromosomes and at least one Y chromosome; Klinefelter's syndrome is the most common sex chromosome disorder). This condition leads to delayed speech, reading and writing development.
- Speech and language development disorders; some degree of language impairment leads to difficulty learning to read, write, and speak.
- Low of self-esteem and trouble with self-expression.
- Low verbal scores and poor short-term auditory memory.
- Significant memory difficulties, which affect other parts of his life; does not know all of the basic information (address, phone number, spelling of parents' names, how to count quarters, etc.).
- Short attention span/easily distracted.
- Poor performance in an open classroom situation; seems to prefer a structured, tightly organized environment, centered on familiar routines.
- Passive and shy.

When he first started treatment in the resource room program, he was not able to isolate any sounds in words. He now isolates three sounds in three letter words that have a single vowel (short vowel words) with 80% accuracy. He is able to sound out words with four sounds with 40% accuracy. He needs to start working on consonant blends (st, mp, tr). He has difficulties recognizing sight words. The sight words have been grouped according to skills (has/have, at/is, will/did, got/on, up/must, name/like/came, cant /I'm/ I'll) and others that must be memorized (they, were, world) are learned gradually. He knows about 100 sight words.

Teachers help him to build a vocabulary through a variety of techniques and to develop his ability to express himself through solicited dialogue, engaging him in conversation through a series of questions. Teachers reduce distractions by placing him in front-row seating in the classroom and by slowly repeating key points several times, if necessary. They give him tasks that have many small steps and each step is presented individually.

The Screening Results

The purpose of the screening was to identify perceptual symptoms related to SSS/IS and assign the use of colored overlays to remediate these problems. This instrument was the first step in identifying and using Irlen Filters (Irlen, 2003). The Irlen Reading Perception Scale (IRPS) assessment includes 4 sections: Reading Strategy Questionnaire (RSQ); Tasks; Overlay Selection; and Distortion pages. The screening determined if participants could match four or more symptoms. They were selected for screening because they complained of glare and/or showed signs of squints and shading

the page. Screening indicated that they had SSS/IS with different levels of syndromes. Three male students were assessed by the IRPS. The procedure involved 25 to 35 minutes for each student, as described in the validation section in Chapter 2. All students completed the entire procedure in one sitting.

Some similar participants' symptoms include the following:

- Did not like reading and had trouble remembering what they read.
- Distracted when reading, needed frequent breaks, and read for short durations.
- Did not like reading under fluorescent lights, blinking eyes under the bright light.
- Losing place in text and moving closer to or farther from the page.
- Skipping, repeating, and ignoring words, lines, samples, and white spaces.

George

George was an excellent candidate of SSS/IS by earning 18 points out of 34 possible. He achieved moderate to high scores in both reading difficulties and reading discomfort (section 1, Reading Strategy Questionnaire of IRPS). In section 2, Tasks of IRPS, he reported five symptoms (dance, move, blurry, close in change, and bright) on the white page after he was shown some images that can cause SSS/IS difficulty and/or discomfort. He complained of lines and samples juggling and of dots moving and flowing; of print text blurring; of glare causing him to move his glasses; of headache and fatigue; and of needing to stop during the visual task section because of a headache.

In section 3, Overlay Selection of IRPS, were initially applied one by one to both text and pictures/graphics. Then overlays were compared two at a time by matching them to the tasks in section 2. His preferred overlay was identified and compared to other

overlays. He commented on the difference in level of comfort when eliminating overlays that provided no comfort. His preferred the green which was kept and compared with other overlays. This process helped him chose double green as his final preferred overlay color. Using the double green colored overlays, he scored five moderate improvements (bright/glary, poor spacing, other distortions, slow/hesitant, and error rate) and one considerable improvement (blurry). Using double green overlays, George demonstrated moderate to considerable improvement in his ability to perceive the examples in the screening. He was more definite in his statements in the overlays selection and he confirmed the difference between the overlays and the white page in making his eyes comfortable.

In section 4, Distortion Pages of IRPS, he was shown different patterns of distortion (e.g., blurry, halo, washable, etc.), and he chose the blurry distortion page as best representing the distortions he experiences when he is reading. Then the identified distortion page was covered with the double green overlay and he provided evidence of a difference by moving his head and stating, "Oh…wow."

David

David was a good candidate of SSS/IS by earning 16 points out of a possible 34. This is considered to be in the moderate to high scores in both reading difficulties and reading discomfort (section 1, Reading Strategy Questionnaire of IRPS). In section 2, Tasks of IRPS, he reported 3 symptoms (disappear, dimmer, and glare) on the white page after being shown some images that can cause SSS/IS difficulty and/or discomfort. He complained that his reading was worsening. This was evident because he showed labored

tracking; he preferred reading in dim light; he stated that some samples disappeared; he perceived lines and samples as being too close together, and lines as dancing and/or waving; he had problems in focusing (frequently distracted) and in becoming fatigued.

In section 3, Overlay Selection of IRPS, his preferred overlay (green). Green overlay was kept and compared with other overlays. He hesitated between green and yellow. To decide the difference in comfort between green and yellow overlays, previously eliminated overlays were re-tried. During repeated comparison between overlays he started to eliminate some colors, and was able to be more focused. Part of his difficulty in choosing a useful overlay color may have been attributed to his ADD condition. His final color choice (double green) was repeated after all overlays had been assessed. He reported three slight improvements (bright/ glary, blurry, and moving) and one moderate improvement (uncomfortable) with colored overlays. Using the double green overlays, David demonstrated slight to moderate improvement. Through using these colored overlays he demonstrated less physical movement closer to or farther from the page.

In section 4, Distortion Pages of IRPS, he chose the halo distortion page as best representing the distortions experienced when he was reading. The identified distortion page was covered with the overlays and David provided evidence of some difference by stating, "yes...kind of."

Charles

Charles was an excellent candidate of SSS/IS by earning 22 points out of 34 possible, considered moderate to high scores in both reading difficulties and reading

discomfort (section 1 Reading Strategy Questionnaire of IRPS). In section 2, Tasks of IRPS, he reported seven symptoms (move, blurry, wave, disappear, bright, glow, and glare) on the white page after he was shown some images that can cause SSS/IS difficulty and/or discomfort. He complained that he had to use his finger when reading; that lines and samples were being crowded and he was distracted by surrounding print; that white spaces appeared to be rising, flickering, and flashing and got wider and grew between lines; however, he did not describe what he saw or felt.

In section 3, Overlay Selection of IRPS, his preferred overlay (turquoise). Turquoise overlay was kept and compared with other overlays. He clearly preferred a single turquoise overlay and stated that double sheets of the same color were not as helpful. He reported four considerable improvements (bright/ glary, blurry, and strain and fatigue) with the colored overlay. Using a single turquoise overlay, Charles demonstrated considerable overall improvement. He was more definite in his statements with the overlay selection and he confirmed the difference between the overlay and the white page in making his eyes more comfortable.

In section 4, Distortion Pages of IRPS, Charles chose the swirl, rivers, and blurry distortion as best representing the distortions he experiences when he is reading. The identified distortion page was covered with the overlay and Charles provided evidence of a noticeable difference by moving his head and stating, "Awesome, I like it."

Individual differences in the IRPS screening results of the three participants discussed above are collapsed by specific categories in Table 10.

Table 10

The Screening Results

Student	SS/IS Level of Syndrome	Section 1: Reading Strategy Questionnaire (RSQ)	Section 2: Tasks	Section 3: Overlay Selection & Improvement	Section 4: Distortion Pages
George	Excellent Candidate	Moderate to Severe 18/34	5 Symptoms	Double Green Moderate improvement to considerable	Blurry
David	Good Candidate	Moderate to Severe 16/34	2 Symptoms	Double Green Slight improvement to moderate	Halo
Charles	Excellent Candidate	Severe 22/34	7 Symptoms	Single Turquoise Considerable improvement	Swirl, Rivers, & Blurry

The Irlen Reading Perceptual Scale (IRPS) was used to pinpoint individuals' possible visual processing difficulties and visual problems related to encoding visual information in memory (Irlen, reported 1983; Stanley, 1990; Wilkins, 1993). Results indicate that all three participants are good to excellent candidates to have SSS/IS, making them good candidates to continue as participants in the study.

The Pilot Study Results

During the 2 days of the pilot study, one participant was given 2 passages for running records assessment, one with (A) and one without (B) colored overlays randomly assigned. This pilot study was conducted to verify the running record intervention format of the research method. It was completed with a single participant who would be included in the final study. The pilot participant was selected from a very limited pool of candidates confirmed to have SSS/IS. Of the original ten students identified by the school records as having some form of visual perceptual problems, only four were identified

through screening to have SSS/IS. Of those four candidates with SSS/IS, one candidate declined participation in the study. In the pool of the remaining three candidates, all three were chosen for the study, with one also chosen to participate in the pilot.

The pilot study data results are presented in Table 11 (George). This table provides information on time, number of errors, number of self-corrects, WPM, CWPM, error ratio, accuracy, and self- correct ratio.

Table 11

Running Records Pilot Study Results: George

Day	Passages	Time	# of Errors	# of Self Corrections	WPM	CWPM	Error Ratio	Accuracy	Self Correct Ratio
Pilot Study Day 1	A 183	3.31	15	8	52	37	12.2	91.8%	16
	B 182	3.55	21	6	46.4	25.4	8.6	88.4%	N/L
Pilot Study Day 2	B 195	4.46	27	11	40.9	13.9	7.2	86.1%	28
	A 187	3.19	17	14	56.3	39.3	11	90.9%	9.5

(A) With and (B) Without Colored Overlays

Figure 4.1 and 4.2 represent George's various changes over two pilot study days in reading rate (WPM) and reading accuracy (%). He consistently scored higher when reading with colored overlays than without. The high scores he obtained were 52, 56.3 WPM, and 91.8%, 90.9% better accuracy when reading with colored overlays than without. The lowest rates of performance without colored overlays were 46.4, 40.9

WPM, and accuracy scores without colored overlays were 88.4%, 86.1%. Across these two days, his reading performance was better in rate and in accuracy with colored overlays than without.

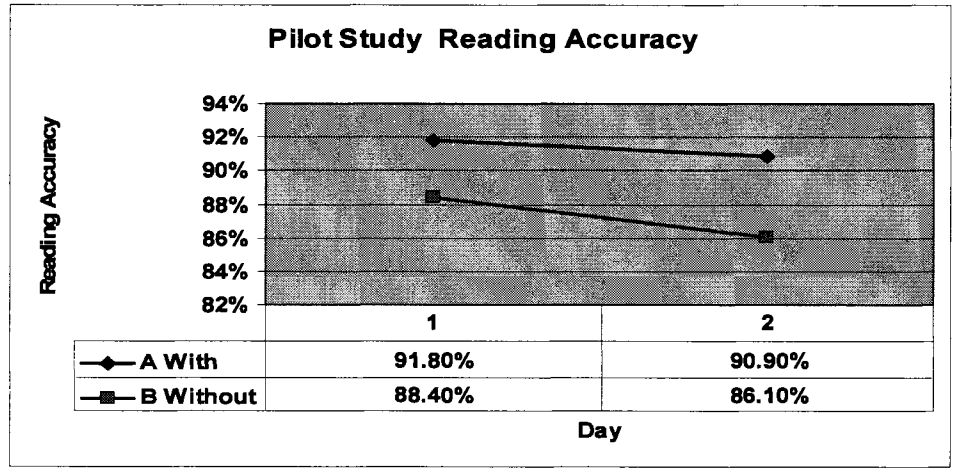


Figure 4.1. Pilot Study Reading Accuracy With and Without Colored Overlays: George

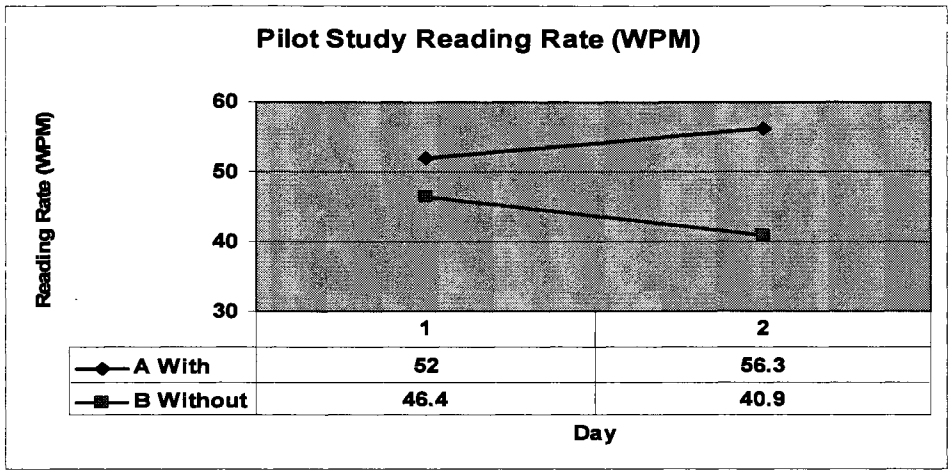


Figure 4.2. Pilot Study Reading Rate (WPM) With and Without Colored Overlays: George

Results from the pilot study indicated that the format of the running records were appropriate for length of reading time, for difficulty of text level, and for procedural methods for randomly reading with and without colored overlays. Initial results suggested the possibility of a positive effect for immediate use of colored overlays. From these results the design for the intervention was implemented in the full study.

The Pre and Post Tests Results

The three students with reading problems and SSS/IS were pre/post tested with and without colored overlays in reading rate, accuracy, and comprehension using the *Qualitative Reading Inventory-4* (Leslie & Caldwell, 2006), were pre/post tested with and without colored overlays in visual performance using the Visual Motor Integration assessment (Beery & Beery, 2006), and were pre/post tested in attitude toward reading using the Elementary Reading Attitude Survey (McKenna & Kear, 1990).

The following data are presented individually for each of the assessment instruments used during the pre and post testing: the Qualitative Reading Inventory, the Visual Motor Integration, and the Elementary Reading Attitude Survey.

The Qualitative Reading Inventory-4 (QRI-4) Pre and Post Tests Results

QRI-4 assessments included measures of oral reading level accuracy, rate (WPM) and comprehension performance (including explicit and implicit comprehension of text). Students read two grade-leveled passages chosen to represent their current reading level. They read these passages out loud with and without colored overlays, with the initial order of overlay use with text type randomly assigned followed by alternating order of overlay use with text type. Grade-level reading ability was determined by reading assessment results from the resource room teacher, using data from the same semester of this study.

The researcher administered the QRI-4 passages initially as an oral reading pretest and post test assessment using narrative and expository passages alternately, both with and without colored overlays. Analyses of oral reading miscues and comprehension retelling and questions (both explicit and implicit) were performed to determine oral reading performance in fluency, in accuracy, and in comprehension both with and without color overlays.

Data were analyzed using descriptive analyses of all students' reading accuracy, rate, and comprehension The QRI-4 is designed to assess three levels of performance: independent, instructional, and frustration. These levels can be assessed for word recognition and for comprehension. (For a complete overview of the QRI-4 data, see

Tables 12, 13, and 14. The data for each participant is described in detail in the following sections.)

The same procedures were used for assessing reading in both the pretest and post test. The participants were assessed individually and each participant orally read a narrative passage and an expository passage at the same grade level for that participant. The degree to which each participant orally read all of the words in the text accurately (oral reading accuracy) was recorded as a miscue analysis. In comprehension assessment each participant was asked to retell the passage, followed by a set of comprehension questions where each participant was asked to answer explicit (factual) and implicit (inferential) comprehension questions over the content from the reading passage.

The results of these assessments are found in Table 12 for George, Table 13 for David, and Table 14 for Charles. General results from the oral reading miscue analysis indicate that the three students were able to recognize their oral reading miscues and self-correct them slightly more often with colored overlays than without. In Table 12, George's pre test data showed that he self corrected reading errors 16.6% of the time with colored overlays and 14.4% without. His post test data showed self correction at 16.6% with colored overlays and 15% without. In Table 13, David's pretest data showed that self correction was 10.3% with colored overlays and 5.5% without. His post test data showed self correction at 5.1% with colored overlays and 3.7% without. In Table 14, Charles' pretest data showed that self correction was 15% with colored overlays and 11.1% without. His post test data showed self correction at 12.5% with colored overlays and 3.5% without. In addition, there was a decrease in the amount of omissions and the

amount of insertions with colored overlays than without. For substitutions, George and Charles included fewer substitutions with colored overlays than without. However, the results for David were inconclusive, as he included less substitutions with colored overlays when reading narrative text, but included more substitutions with colored overlays when reading expository text. In all instances where the colored overlays made a difference, the order of assessment (pretest versus post test) was not a factor.

Table 12

QRI-4 Pre and Post Tests Results: George

Pretest			
A = With overlays/ Expository = 288		B = Without overlays/ Narrative = 312	
Time	5.1 m	Time	6.1 m
Concept Questions	6/12 = 50%	Concept Questions	6/12 = 50%
Accuracy	19 Ins	Accuracy	26 Ins
Acceptability	13 Ins	Acceptability	11 Ins
WPM	57.4	WPM	51.8
CWPM	38.4	CWPM	25.8
Recalled	34/51 = 66.6%	Recalled	30/55 = 54.5%
Explicit	4/4 = 100%	Explicit	4/4 = 100%
Implicit	3/4 = 75%	Implicit	2.5/4 = 62.5%
Total Comprehension	7/8 = 87.5% Ins	Total Comprehension	6.5/8 = 81.2% Ins
Total Miscues	18	Total Miscues	21
Similar Beginning	17 = 94.4%	Similar Beginning	19 = 90.4%
Similar Ending	10 = 55.5%	Similar Ending	10 = 47.6%
Similar Vowel	13 = 74.2%	Similar Vowel	14 = 66.6%
Acceptable Grammar	0	Acceptable Grammar	2 = 9.5%
Retains Meaning	0	Retains Meaning	2 = 9.5%
Self- Corrected	3 = 16.6%	Self- Corrected	3 = 14.2%
Post test			
A = With overlays/ Narrative = 357		B = Without overlays/ Expository = 221	
Time	5.3 m	Time	5.5 m
Concept Questions	7/12 = 58%	Concept Questions	5/12 = 41.6%
Accuracy	37 Ins	Accuracy	43 Frus
Acceptability	27 Frus	Acceptability	34 Frus
WPM	63.9	WPM	43.4
CWPM	26.9	CWPM	0
Recalled	49/55 = 89%	Recalled	8/42 = 19%
Explicit	3.5/4 = 87.5%	Explicit	1.5/4 = 37.5%
Implicit	3.5/4 = 87.5%	Implicit	1.5/4 = 37.5%
Total Comprehension	7/8 = 87.5% Ins	Total Comprehension	3/8 = 37.5% Frus
Total Miscues	36	Total Miscues	40
Similar Beginning	31 = 86.1%	Similar Beginning	28 = 70%
Similar Ending	14 = 38.8%	Similar Ending	15 = 37.5%
Similar Vowel	17 = 47.2%	Similar Vowel	18 = 45%
Acceptable Grammar	1 = 2.7%	Acceptable Grammar	0
Retains Meaning	1 = 2.7%	Retains Meaning	0
Self- Corrected	6 = 16.6%	Self- Corrected	6 = 15%

Table 13

QRI-4 Pre and Post Tests Results: David

Pretest			
A = With overlays/ Expository = 288		B = Without overlays/ Narrative = 312	
Time	2.47 m	Time	3.33 m
Concept Questions	6/12 = 50%	Concept Questions	5/12 = 41.6%
Accuracy	20 Ins	Accuracy	27 Inst
Acceptability	27 Frus	Acceptability	18 Frus
WPM	103	WPM	87.8
CWPM	74	CWPM	60.8
Recalled	20/51 = 39.2	Recalled	15/55 = 27%
Explicit	3/4 = 75%	Explicit	3/4 = 75%
Implicit	3/4 = 75%	Implicit	2/4 = 50%
Total Comprehension	6/8 = 75% Ins	Total Comprehension	5/8 = 62.5% Frus
Total Miscues	26	Total Miscues	18
Similar Beginning	24 = 92.3%	Similar Beginning	16= 88.8%
Similar Ending	12 = 42.8%	Similar Ending	6= 33.3%
Similar Vowel	18 = 64.2%	Similar Vowel	9 = 50%
Acceptable Grammar	1 = 3.5%	Acceptable Grammar	6 = 33.3%
Retains Meaning	1 = 3.5%	Retains Meaning	7 = 38.8%
Self- Corrected	3 = 10.3%	Self-Corrected	1 = 5.5%
Post test			
A = With overlays/ Narrative = 357		B = Without overlays/ Expository = 221	
Time	3 m	Time	3.19 m
Concept Questions	8/12 = 66%	Concept Questions	6/12 = 50%
Accuracy	40 Frus	Accuracy	34 Frus
Acceptability	39 Frus	Acceptability	25 Frus
WPM	119	WPM	66.6
CWPM	79	CWPM	32.6
Recalled	18/55 = 32.7%	Recalled	6/42 = 14.2%
Explicit	3/475%	Explicit	0/4= 0%
Implicit	3/4 = 75%	Implicit	2/4 = 50%
Total Comprehension	6/8 = 75% Ins	Total Comprehension	2 = 25% Frus
Total Miscues	38	Total Miscues	27
Similar Beginning	35 = 92.1%	Similar Beginning	18 = 66.6%
Similar Ending	19 = 50%	Similar Ending	9 = 33.3%
Similar Vowel	15 = 39.4%	Similar Vowel	5 = 18.5%
Acceptable Grammar	0	Acceptable Grammar	0
Retains Meaning	0	Retains Meaning	0
Self- Corrected	2 = 5.1%	Self- Corrected	1 = 3.7%

Table 13

QRI-4 Pre and Post Tests Results: Charles

Pretest			
A = With overlays/ Narrative = 264		B = Without overlays/ Expository = 92	
Time	7.5 m	Time	4.35 m
Concept Questions	5/9 = 55%	Concept Questions	4/9 = 44%
Accuracy	24 Frus	Accuracy	13 Frus
Acceptability	20 Frus	Acceptability	12 Frus
WPM	37.2	WPM	20
CWPM	13.2	CWPM	7
Recalled	6/50 = 12%	Recalled	2/20 = 10%
Explicit	4/4 = 100%	Explicit	2/4 = 50%
Implicit	1/2 = 50%	Implicit	0/2 = 0%
Total Comprehension	5/6 = 83.3% Ins	Total Comprehension	2/6 = 33.3% Frus
Total Miscues	20	Total Miscues	9
Similar Beginning	19 = 95%	Similar Beginning	8 = 88.8%
Similar Ending	6 = 30%	Similar Ending	7 = 77.7%
Similar Vowel	14 = 70%	Similar Vowel	4 = 44.4%
Acceptable Grammar	4 = 20%	Acceptable Grammar	0
Retains Meaning	4 = 20%	Retains Meaning	0
Self-Corrected	3 = 15%	Self-Corrected	1 = 11.1%
Post test			
A = With overlays/ Expository = 76		B = Without overlays/ Narrative = 181	
Time	1.25 m	Time	4.12 m
Concept Questions	9/9 = 100%	Concept Questions	4/9 = 44.4%
Accuracy	18 Frus	Accuracy	64 Frus
Acceptability	17 Frus	Acceptability	61 Frus
WPM	53.6	WPM	42
CWPM	35.6	CWPM	0
Recalled	17/28 = 60.7%	Recalled	6/31 = 19.4%
Explicit	4/4 = 100%	Explicit	1.5/4 = 37.5%
Implicit	2/2 = 100%	Implicit	0/2 = 0%
Total Comprehension	6/6 = 100% Ind	Total Comprehension	1.5/6 = 25% Frus
Total Miscues	16	Total Miscues	57
Similar Beginning	13 = 81.25%	Similar Beginning	36 = 63%
Similar Ending	2 = 12.5%	Similar Ending	11 = 19%
Similar Vowel	7 = 43.75.2%	Similar Vowel	17 = 29.8%
Acceptable Grammar	4 = 25%	Acceptable Grammar	0
Retains Meaning	0	Retains Meaning	0
Self-Corrected	2 = 12.5%	Self-Corrected	2 = 3.5%

Reading accuracy. Figure 4.3 shows George's reading accuracy pretest results at 93.40% instructional level with colored overlays and at 91.66% instructional level without. The reading accuracy post test results are at 89.63% instructional level with colored overlays and at 80.54% frustration level without. There was a 1.74% increase in reading accuracy with colored overlay in the pretest and a 9.09 % increase in reading accuracy with colored overlay in the post test. The results show that George maintained a level of instruction from pretest to post test when using colored overlays, but dropped in performance level from instruction to frustration in the pretest and post test when reading without colored overlays.

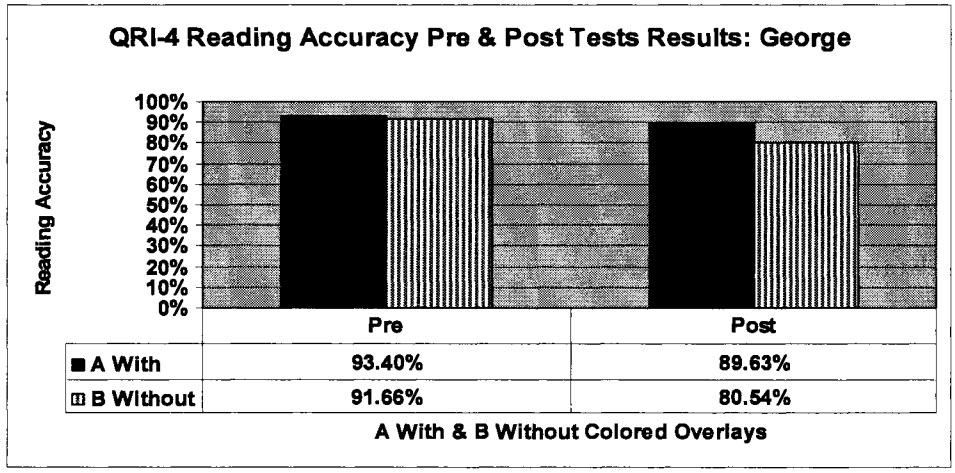


Figure 4.3. QRI-4 Reading Accuracy Pre and Post Tests Results With and Without Colored Overlays: George

Figure 4.4 shows David's reading accuracy pretest results at 93.05% instructional level with colored overlays and at 91.34% instructional level without. The reading accuracy post test results are at 88.79% frustration level with colored overlays and at 84.61 frustration level without. While there was a 1.71 % increase in reading accuracy with colored overlays in the pretest and a 4.18 % increase in reading accuracy with colored overlays in the post test, there was an overall decrease in performance for the post test. The results show that David did not maintain a level of instruction from pretest to post test when using colored overlays, but dropped in performance level from instruction in the pretest to frustration in the post test when reading with and without colored overlays.

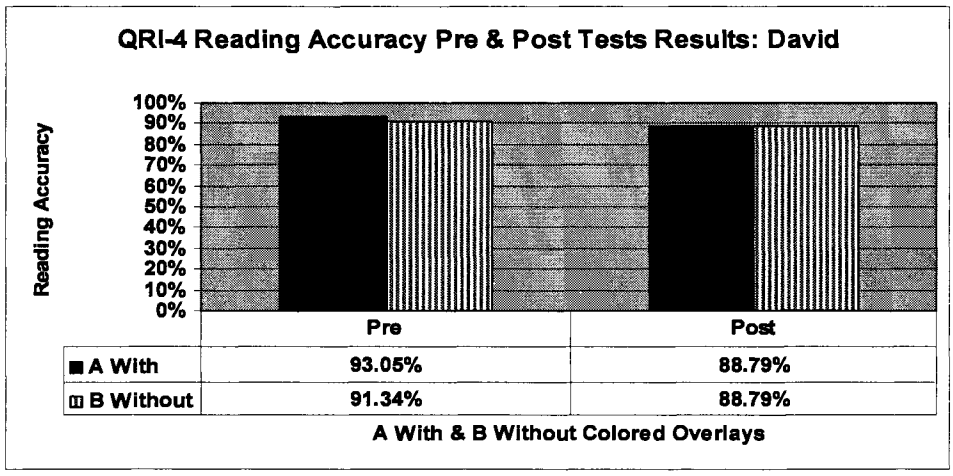


Figure 4.4. QRI-4 Reading Accuracy Pre and Post Tests Results With and Without Colored Overlays: David

Figure 4.5 shows Charles' reading accuracy pretest results at 90.90% instructional level with colored overlays and at 85.86% frustration level without. The reading accuracy posttest results are at 76.31% frustration level with colored overlays and at 64.64% frustration level without. There is a 5.04 % increase in reading accuracy with colored overlay in the pretest and an 11.67 % increase in reading accuracy with colored overlay in the post test. The results show that Charles did not maintain a level of instruction from pretest to post test when using colored overlays, but dropped in performance level from instruction in the pretest to frustration in the post test. His performance without colored overlays was consistently at the frustration level, both in the pretest and in the post test.

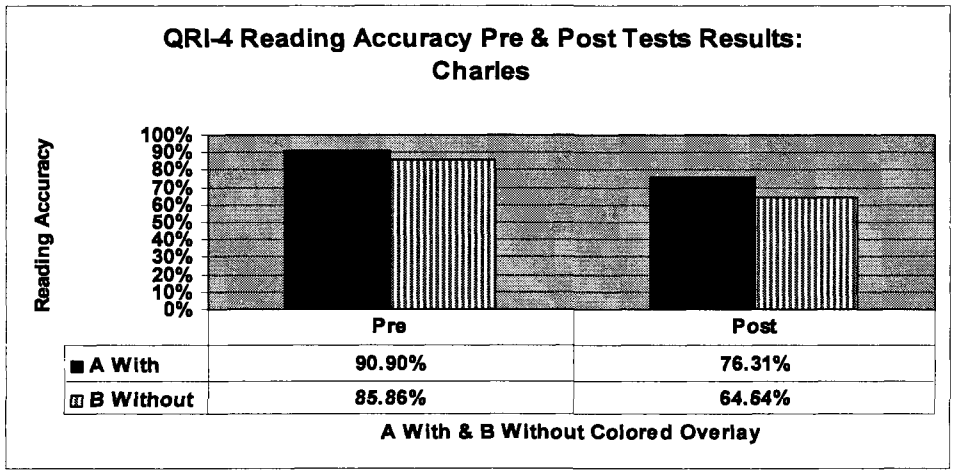


Figure 4.5. QRI-4 Reading Accuracy Pre and Post Tests Results With and Without Colored Overlays: Charles

In summary, accuracy scores were inconsistent when examining the pre/post test performance levels across the three participants. All three of the participants experienced an improvement in reading accuracy percentage when using color overlays compared to without colored overlays, ranging from 1.71% up to 11.67%. However, two of the three participants experienced a drop in their reading performance level from pretest to post test.

Reading rate (WPM). In the pretest George's reading rate was at 57.4 WPM [within the range of a 4th-grade reader (Leslie & Caldwell, 2006)] with colored overlays and at 51.8 WPM [within the range of a 3rd-grade reader (Leslie & Caldwell)] without, with an increase of 5.6 WPM when using colored overlays. In the post test his reading rate was at 63.9 WPM [within the range of a 5th-grade reader (Leslie & Caldwell)] with colored overlays and at 43.4 WPM [within the range of a 2nd-grade reader (Leslie & Caldwell)] without, with an increase of 20.5 WPM when using colored overlays. See Figure 4.6

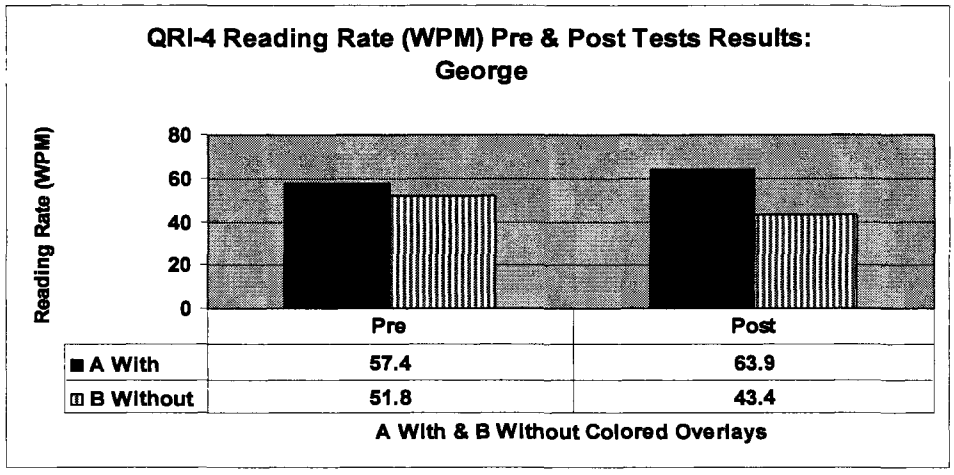


Figure 4.6. QRI-4 Reading Rate (WPM) Pre and Post Tests Results With and Without Colored Overlays: George

In the pretest David's reading rate was at 103 WPM with colored overlays and at 87.8 WPM without [both within the range of a 5th-grade reader (Leslie & Caldwell, 2006)], with an increase of 15.2 WPM when using colored overlays. In the post test his reading rate was at 119 WPM with colored overlays and at 66.6 WPM without [both within the range of a 5th-grade reader (Leslie & Caldwell)], with an increase of 52.4 WPM when using colored overlays. See Figure 4.7.

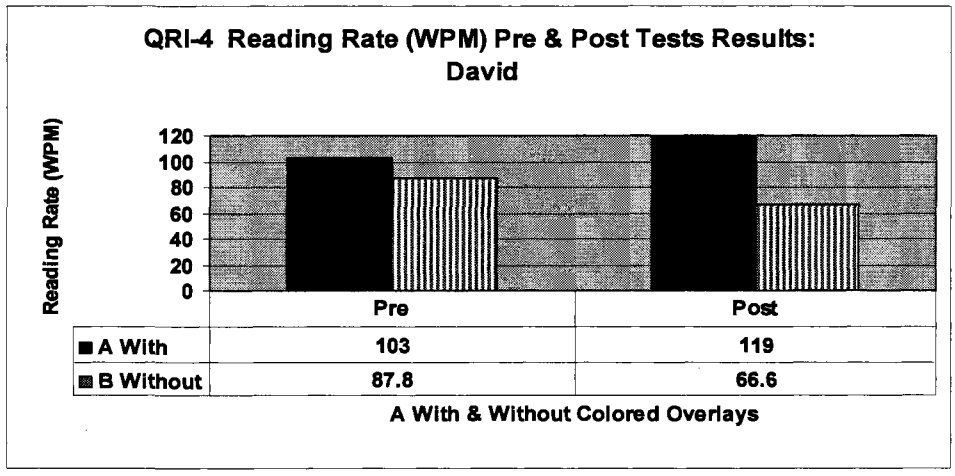


Figure 4.7. QRI-4 Reading Rate (WPM) Pre and Post Tests Results With and Without Colored Overlays: David

In the pretest Charles' reading rate was at 37.2 WPM [within the range of a 1st-grade reader (Leslie & Caldwell, 2006)] with colored overlays and at 20 WPM [below the range of a PrePrimer reader (Leslie & Caldwell)] without, with an increase of 17.2 WPM when using colored overlays. In the post test his reading rate was at 53.6 WPM [within the range of a 3rd-grade reader (Leslie & Caldwell)] with colored overlays and at 42 WPM [within the range of a 1st-grade reader (Leslie & Caldwell)] without, with an increase of 11.6 WPM when using colored overlays. See Figure 4.8.

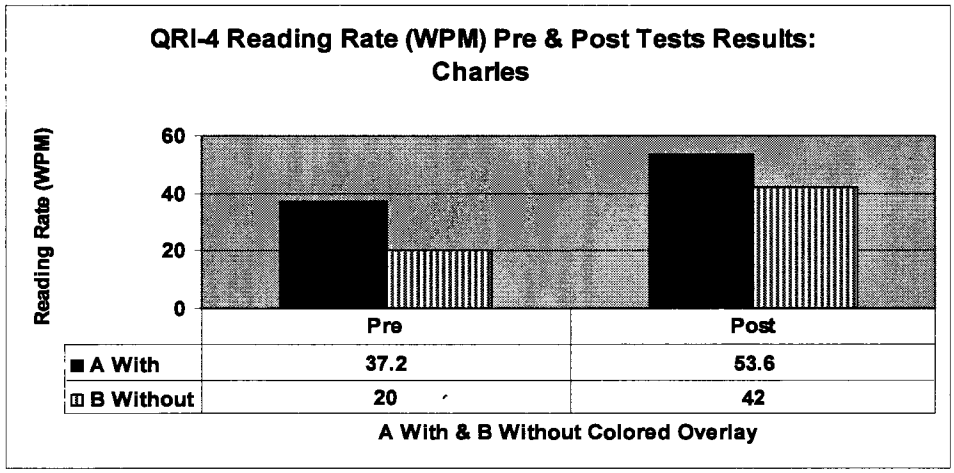


Figure 4.8. QRI-4 Reading Rate (WPM) Pre and Post Tests Results With and Without Colored Overlays: Charles

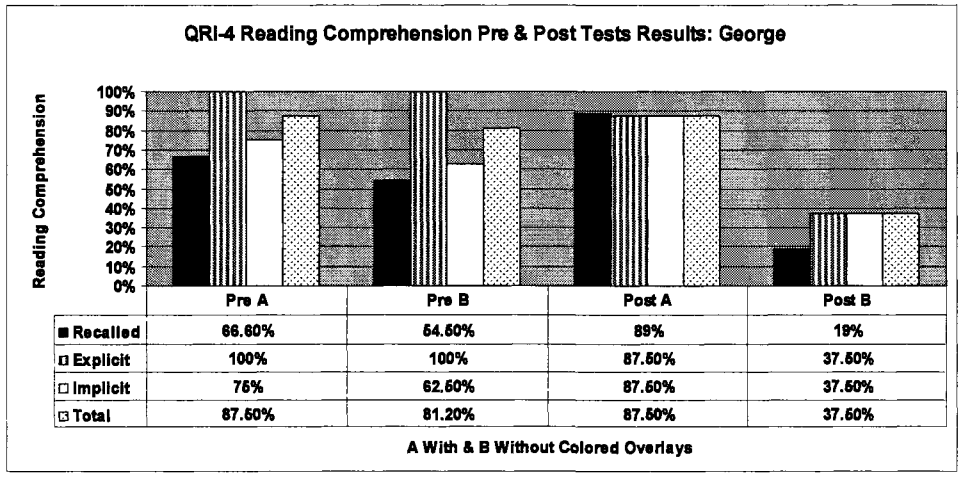
Across all three participants there was an increase in rate percentage from the pretest to the posttest when using colored overlays. After the intervention, the post test results with the QRI-4 showed an increase of 6.5 WPM for George, of 16 WPM for David, and of 16.4 WPM for Charles. Text type did not appear to make a difference in rate from pretest to post test for texts with overlays. Familiarity with the subject area discussed in the text did not appear to make a difference for three of the four passages for David and George, but may have influenced their reading of their narrative passages in the post test as they both scored familiar with these topics. This may have played a part in their increase of WPM rate. Familiarity of content may have also influenced Charles reading of all four of his passages, as he scored unfamiliar with both of his passages read without colored overlays and scored familiar with both the passages read with overlays.

Reading comprehension. The comprehension portion of the assessment involved two formats: retelling and comprehension questions. In the retelling, the reader was asked with a single retelling prompt to retell as much as he could remember, with a focus on recalling specific information from the text. In the comprehension questions, the reader was asked explicit questions that related directly to information in the text, and implicit questions that asked the reader to make inferences and to think beyond the text.

In the pre tests, George read an expository passage with overlays and a narrative passage without overlays. With overlays he recalled 66.6% of the passage, and without overlays he recalled 54.5%. In the comprehension questions, he scored 87.5% instructional with overlays, and 81.2% instructional without. With the explicit questions he scored 100% both with and without overlays. With the implicit questions, he scored 75% with overlays and 62.5% without.

In the post tests, George read a narrative passage with overlays and an expository passage without overlays. With overlays he recalled 89% of the passage, and without overlays he recalled 19%. In the comprehension questions, he scored 87.5% instructional with overlays, and 37.5% frustration without. With the explicit questions he scored 87.5% with overlays and 37.5% without. With the implicit questions, he scored 87.5% with the overlays and 37.5% without. The use of colored overlays with narrative passages did not seem to make a difference in his overall reading performance for comprehension questions (instructional for both). However, his use of colored overlays with expository passages did seem to make a difference in his performance on comprehension questions, where his reading score with colored overlays was at the instructional level but his

reading score without colored overlays was at the frustration level. With retelling, there was a positive difference when using colored overlays for both narrative passages (with colored overlays at 89% recall for the post test; without colored overlays at 54.6% for the pretest), and with the expository passages (with colored overlays at 66.6% for the pretest; without colored overlays at 19% for the post test). While the pre/posttest order may have been an effect for the narrative passage, it was not an effect for the expository passages. See Figure 4.9.



	Pre A	Pre B	Post A	Post B
Recalled	66.60%	54.60%	89%	19%
Explicit	100%	100%	87.50%	37.50%
Implicit	75%	62.60%	87.50%	37.50%
Total	87.50%	81.20%	87.50%	37.50%

Figure 4.9. QRI-4 Reading Comprehension Pre and Post Tests Results With and Without Colored Overlays: George

In the pretests, David read an expository passage with overlays and a narrative passage without overlays. With overlays he recalled 39.2% of the passage, and without overlays he recalled 27%. In the comprehension questions, he scored 75% instructional

with overlays, and 62.5% frustration without. With the explicit questions he scored 75% both with and without overlays. With the implicit questions, he scored 75% with overlays and 50% without.

In the post tests, David read a narrative passage with overlays and an expository passage without overlays. With overlays he recalled 32.7% of the passage, and without overlays he recalled 14.2%. In the comprehension questions, he scored 75% instructional with overlays, and 25% frustration without. With the explicit questions he scored 75% with overlays and 0% without. With the implicit questions, he scored 75% with the overlays and 50% without. The use of colored overlays with narrative and expository passages did seem to make a difference in his overall reading performance for comprehension questions. In his use of colored overlays with expository passages, David was instructional in the pretest with colored overlays, but frustrated in the posttest without colored overlays. In the narrative passages, David frustrated in the pretest without colored overlays, but was instructional in the post test with colored overlays. David scored a higher level with colored overlays than without, whether the assessment was during the pretesting or during the post testing. With retelling, there was a positive difference when using colored overlays for both narrative passages (with colored overlays at 32.7% recall for the posttest; without colored overlays at 27% for the pretest), and with expository passages (with colored overlays at 39.2% for the pretest; without colored overlays at 14.2% for the post test). While the pre/posttest order may have been an effect for the narrative passage, it was not an effect for the expository passages. See Figure 4.10.

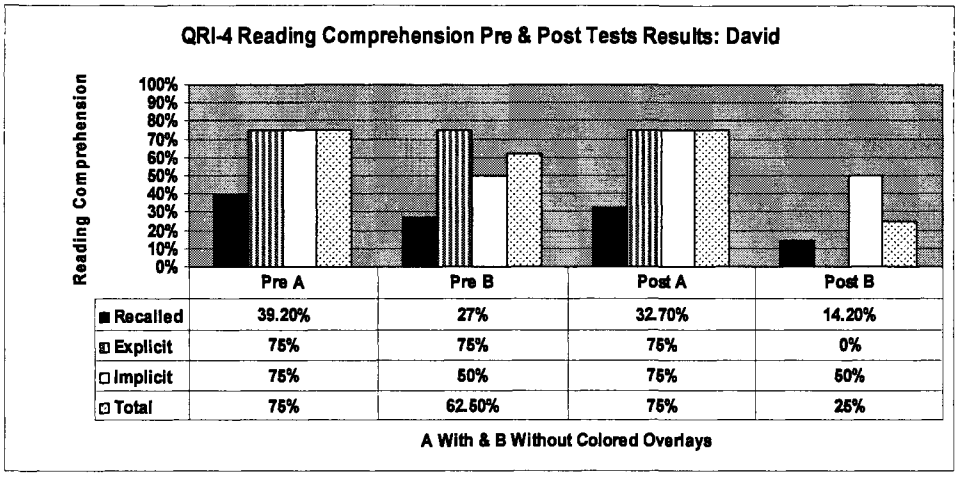


Figure 4.10. QRI-4 Reading Comprehension Pre and Post Tests Results With and Without Colored Overlays: David

In the pretests, Charles read a narrative passage with overlay and an expository passage without overlay. With overlay he recalled 12% of the passage, and without overlay he recalled 10%. In the comprehension questions, he scored 83.3% instructional with overlay, and 33.3% frustration without. With the explicit questions he scored 100% with overlay and 50% without. With the implicit questions, he scored 50% with overlays and 0% without.

In the post tests, Charles read an expository passage with overlays and a narrative passage without overlays. With overlays he recalled 60.7% of the passage, and without overlays he recalled 19.4%. In the comprehension questions, he scored 100% independent with overlays, and 25% frustration without. With the explicit questions he scored 100% with overlays and 37.5% without. With the implicit questions, he scored 100% with the overlays and 0% without. The use of colored overlays with narrative and

expository passages did seem to make a difference in his overall reading performance for comprehension questions. In his use of colored overlays with expository passages, Charles was frustrated in the pretest without colored overlays, but was independent in the post test with colored overlays. In the narrative passages, Charles was instructional in the pretest with colored overlays, but frustrated in the post test without colored overlays. Charles scored a higher level with colored overlays than without, whether the assessment was during the pretesting or during the post testing. With retelling, Charles did not have a consistent pattern of positive results when using colored overlays. With narrative passages, Charles retold more information without colored overlay during the post test (19.4%) when compared to his performance with colored overlay during the pretest (12%). With expository passages, Charles retold more information with colored overlay during the post test (60.7%) when compared to his performance without colored overlay during the pretest (10%). Since Charles performed better during the post test for both narrative and expository passages with or without colored overlay, the pre/posttest order may have had an effect on Charles' performance. See Figure 4.11.

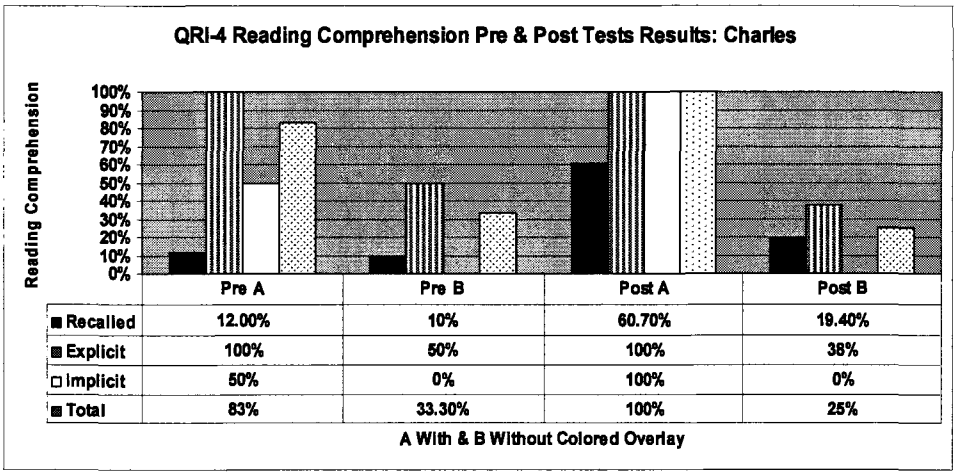


Figure 4.11. QRI-4 Reading Comprehension Pre and Post Tests Results With and Without Colored Overlays: Charles

The comprehension findings indicate that when students read passages with covered overlays, their comprehension scores are higher, both in their retellings and in their answers to comprehension questions. While there were different text types used (expository and narrative) and the familiarity of the text varied, the overall results suggest that colored overlays had an impact on their test scores.

George scored as instructional in comprehension when reading narrative passages both with and without cover overlays. His performance improved in his retelling percentage (by 12.1%) and in his comprehension questions percentage (by 6.3%). This increase in percentage scores may have been a result of his familiarity with the topic. In the narrative passage without overlays, he scored unfamiliar to the topic; and in the narrative passage with overlays, he scored as familiar. However, when George read expository passages, both were determined to be unfamiliar topics. The score for the

expository passage with overlays was at the instructional level, while the expository passage without overlays was at the frustration level. In his retellings, he recalled 46.7% more information with overlays. In his comprehension question scores, he answered 50% more questions with overlays. This suggests that overlays had a positive influence on his ability to read and respond to text.

David scored at the instructional level in comprehension when reading passages with overlays. Whether the passage was narrative or expository, familiar or unfamiliar, the commonality across the two instructional passages was the use of colored overlays. In examining his results by text type, David was familiar with the topic of the narrative passage with overlays, and unfamiliar with the topic of the narrative passage without overlays. He scored at the instructional level for the narrative passage with overlays and at the frustration level for the narrative passage without overlays. His performance improved in his retelling percentage (by 5.7%) and in his comprehension questions percentage (by 12.5%) when reading with overlays. This increase in percentage scores may have been a result of his familiarity with the topic. However, David scored as unfamiliar with the topic for both expository passages. With overlays, he scored at the instructional level, but without overlays he scored at the frustration level. In his retellings, he recalled 25% more information with overlays. In his comprehension question scores, he answered 50% more questions with overlays. This suggests that overlays had a positive influence on his ability to read and respond to text.

Charles scored instructional or independent in comprehension when reading passages with overlays, whether narrative or expository. In both instances he scored as

familiar with the topic of the passage as well. With the passages without overlays, Charles scored at frustration level with both the narrative and the expository passages. In both passages he also scored as unfamiliar with the topic to be read. In his case, the role of familiarity with the text may have been important in helping him make sense of the text. However, the with-overlays scores are compelling in the degree to which he was able to better read and respond to the comprehension tasks. In the narrative passages, his performance with overlay improved in his retelling percentage by 2% and in his comprehension questions percentage by 45.8%. In the expository passages, his performance with overlay improved his retelling percentage by 50.7%, and his comprehension questions percentage by 75%. This suggests that overlays in conjunction with familiarity with the text had a positive influence on his ability to read and respond to text.

While there appears to be clear evidence that colored overlays helped these three students in different ways in rate, accuracy and comprehension, the pre and post data for reading the QRI-4 passages with colored overlays showed interesting patterns. In rate, all three participants increased their WPM performance when using colored overlays from the pretest to the posttest. George and David both had similar patterns for accuracy and comprehension with overlays; for accuracy they both had more errors with the post test than with the pretest, and for comprehension they maintained the same score from pretest to post test. Charles, however, showed improvement from pretest to posttest for accuracy and for comprehension. For Charles, the intervention of reading with colored overlays

across ten running records with colored overlays did seem to impact his post test scores in rate, accuracy and comprehension when reading with colored overlays.

The results demonstrated in this section of the study present additional evidence that the visual processing problems identified by SSS/IS may be important reasons for reading difficulties. The results support previous investigations, which found that the use of colored plastic overlays can be an effective intervention option for students with SSS/IS (Croyle, 1998; Irlen, 1989; Irlen & Robinson, 1996; Kreuttner & Strum, 1990; and Noble, Orton, Irlen, & Robinson, 2004).

The Visual Motor Integration (VMI) Pre and Post Tests Results

The Beery-Buktenica Test of Visual Motor Integration (VMI) is a shape-copying task for measuring the ability to integrate visual input and motor response (also administered were supplemental components for comparison of relatively pure visual and motor performances). The optional assessments are designed to be administered after results from the Short Format as used in this study.

A relationship between sensory, motor skills and the visual perceptual ability of students has become an area of emphasis for remediation of academic deficit. Participants in the present study have shown innate learning disabilities (such as those prevalent in Charles as Kleinfelter's Syndrome, George as dyslexia, and David as ADD), which lead to poor visual-perceptual, visual-spatial, and poor visual-motor abilities (Willis, 2002).

In order to score the results of the student reading evaluations, the researcher included all thirty questions from the reading section of the VMI inventory in the scoring guide. For each question answered correctly, the student received one point toward his or

her overall score. After each question was scored, an overall score between 0-30 was determined. The researcher scored the reading evaluations for the pretest and post test of each student. In addition, the time it took the student to complete each evaluation is noted in the chart. The chart also indicates the performance rate of each student (pretest and post test), which simply states the level of student performance in comparison to other students of the same age as the student. Lastly, the chart includes documentation of the percentile in which the student scored for each exam, indicating the percentage in which the student is placed, based on his performance on the exam. This percentile indicates the percentage of students in the same age group as the student being evaluated, who scored the same as the student being evaluated.

The VMI pre and post intervention comparison of the raw scores of the experimental to the normal value assessed on VMI test was also analyzed. Table 15 shows that there is improvement in raw scores as to the normal value in all three students. This table includes each student's pre and post scores for test time, variable (with or without), mistaken numbers, standard score, and performance level of that score. Results for all students showed that with overlays they can decrease their test-taking time, ranging from 19 seconds to 44 seconds. Also, with overlays the errors were fewer than without overlays. In the pretest, George moved from average without overlays to above average with overlays. In the post test, he moved from above average without overlays to high with overlays. For David, in the pre test he maintained an average level with and without overlays. However, in the post test, David moved from average without overlays

to above average with overlays. Charles maintained a score of average with and without overlay in both the pre and post tests, but still improved, making two fewer mistakes.

Table 15

VMI Pre and Post Tests Results

Student	Test	Time/ Variable	Mistaken	Standard Score	Performance Level
George	Pre	A 2:00	3	27	Above Average
	Pre	B 2:19	5	25	Average
	Post	A 1:40	1	29	High
	Post	B 2:15	3	27	Above Average
David	Pre	A 1:55	6	24	Average
	Pre	B 2:08	9	21	Average
	Post	A 1:16	4	26	Above Average
	Post	B 1:31	6	24	Average
Charles	Pre	A 2:01	7	23	Average
	Pre	B 2:36	12	18	Low
	Post	A 1:44	5	25	Average
	Post	B 2:28	10	20	Below Average

(A) With and (B) Without Colored Overlays

Figures 4.12- 4.14 provide specific information about the number of items correctly identified by each participant in the pre and post tests. In the pretest, George correctly identified 25 items without colored overlays, and correctly identified 27 items with colored overlays. In the post test he correctly identified 27 items without colored overlays and 29 items with colored overlays (see Figure 4.12).

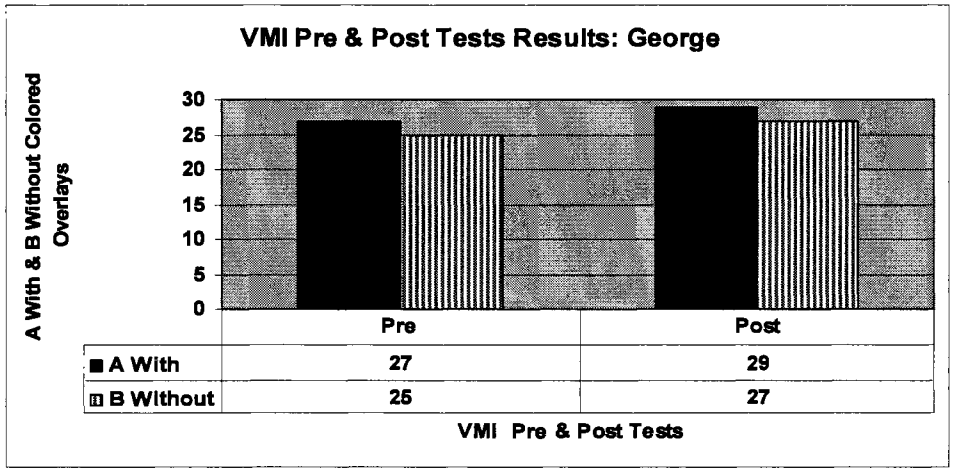


Figure 4.12. VMI Pre and Post Tests Results With and Without Colored Overlays: George

In the pretest, David correctly identified 21 items without colored overlays, and correctly identified 24 items with colored overlays. In the post test he correctly identified 24 items without colored overlays and 26 items with colored overlays (see Figure 4.13).

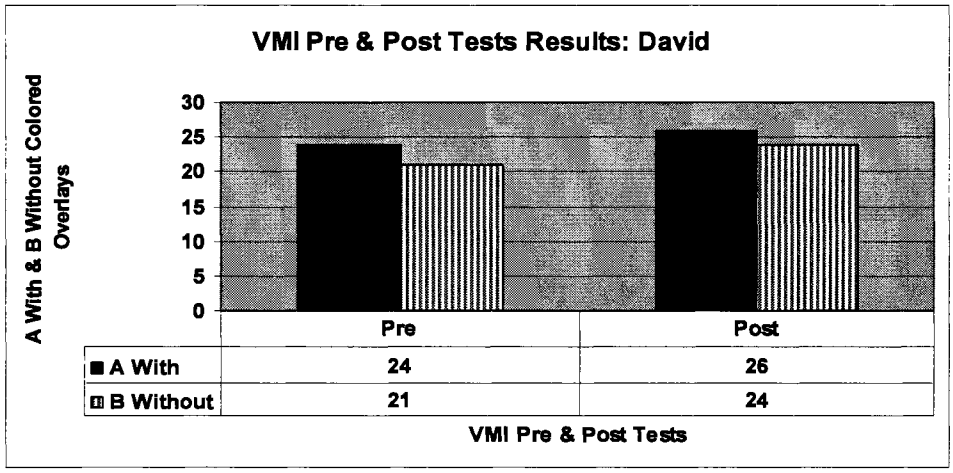


Figure 4.13. VMI Pre and Post Tests Results With and Without Colored Overlays: David

In the pretest, Charles correctly identified 18 items without colored overlays, and correctly identified 23 items with colored overlays. In the post test he correctly identified 20 items without colored overlays and 25 items with colored overlays (see Figure 4.14).

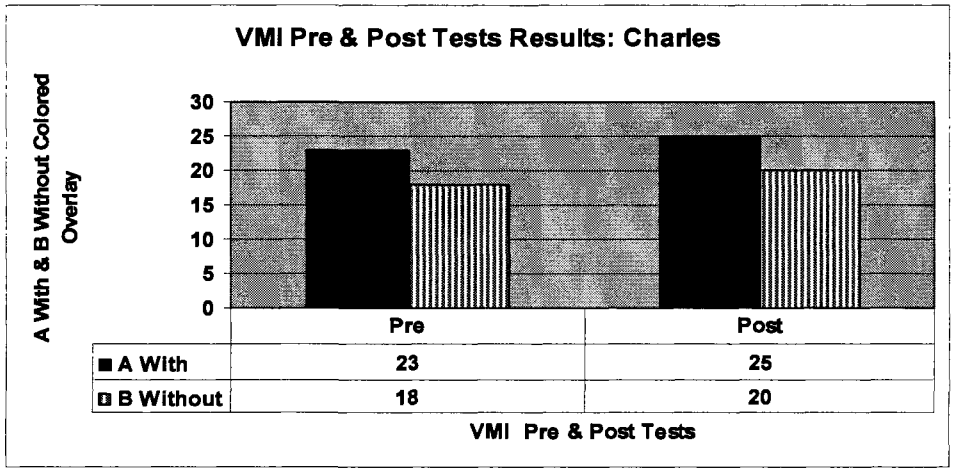


Figure 4.14. VMI Pre and Post Tests Results With and Without Colored Overlays: Charles

In each case, the participants recognized more symbols in the VMI test using colored overlays than without. In each case, the participants increased the number of symbols recognized when comparing pre and post test results both with and without using the colored overlays. It should be noted that the amount of improvement over time is similar (George: increasing two points in pre- and post tests for both with and without colored overlays; David: scored three points higher in the pretest with colored overlays, and two points higher in the post test without colored overlays, increasing his score by two points from the pretest to the post test with colored overlays and by three points from the pretest to the post test without colored overlays (see Figure 4.13). Participants consistently scored higher when using colored overlays than without.

The Elementary Reading Attitude Survey (ERAS) Pre and Post Tests Results

Table 16 represents the scores of each student on the pretest and post test of the ERAS. Individual scores are reported for recreational reading and academic reading. Also included are the full-scale score for each student, which is a combination of the recreational reading score and the academic reading score. Along with each raw score, the table includes the percentile ranking of that score.

Table 16

ERAS Pre and Post Tests Results

Students	Tests	Recreational Reading/40		Academic Reading/40		Full Scale/80	
		Raw Score	Percentile Ranks	Raw Score	Percentile Ranks	Raw Score	Percentile Ranks
George	Pre	25	30	28	66	53	46
	Post	29	48	31	82	60	70
David	Pre	33	72	32	79	65	78
	Post	35	84	35	90	70	89
Charles	Pre	30	51	26	41	56	44
	Post	30	51	32	74	62	64

When comparing pre - and post test scores, George improved overall in his full scale score by 7 points (from 53 to 60) which changed his percentile ranking from 46 to 70. His recreational reading attitude improved by 4 points (from 25 to 29), changing his percentile ranking from 30 to 48. His academic reading attitude improved by 3 points (from 28 to 31), increasing his percentile ranking from 66 to 82. See Figure 4.15.

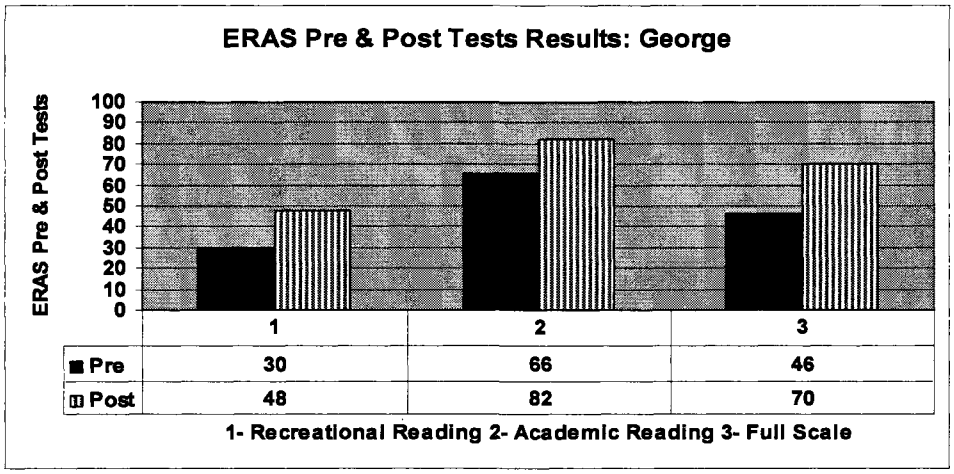


Figure 4.15. ERAS Pre and Post Tests Results of Percentile Ranks: George

David improved overall in his full scale score by 5 points (from 65 to 70) which changed his percentile ranking from 78 to 89. His recreational reading attitude improved by 2 points (from 33 to 35), changing his percentile ranking from 72 to 84. His academic reading attitude improved by 3 points (from 32 to 35), increasing his percentile ranking from 79 to 90. See Figure 4.16.

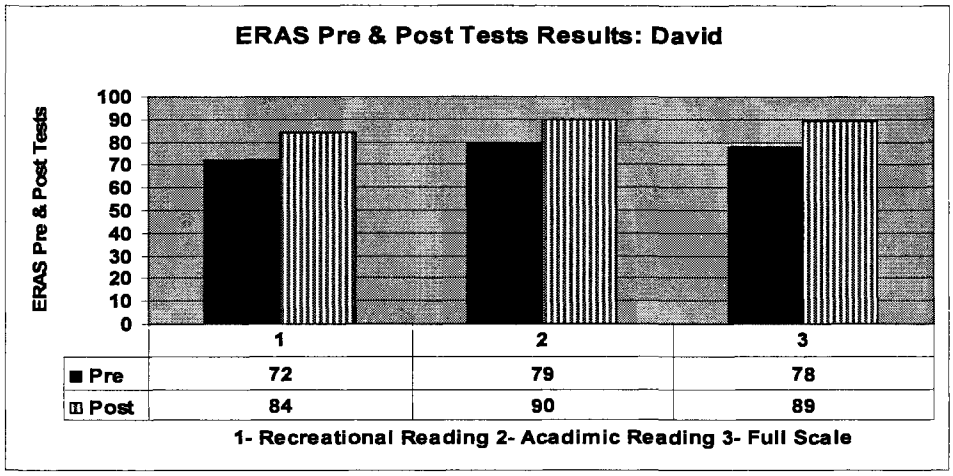


Figure 4.16. ERAS Pre and Post Tests Results of Percentile Ranks: David

Charles improved overall in his full scale score by 6 points (from 56 to 62) which changed his percentile ranking from 44 to 64. His recreational reading attitude remained at 30 points, maintaining the same percentile ranking of 51. His academic reading attitude improved by 6 points (from 26 to 32), increasing his percentile ranking from 41 to 74. See Figure 4.17.

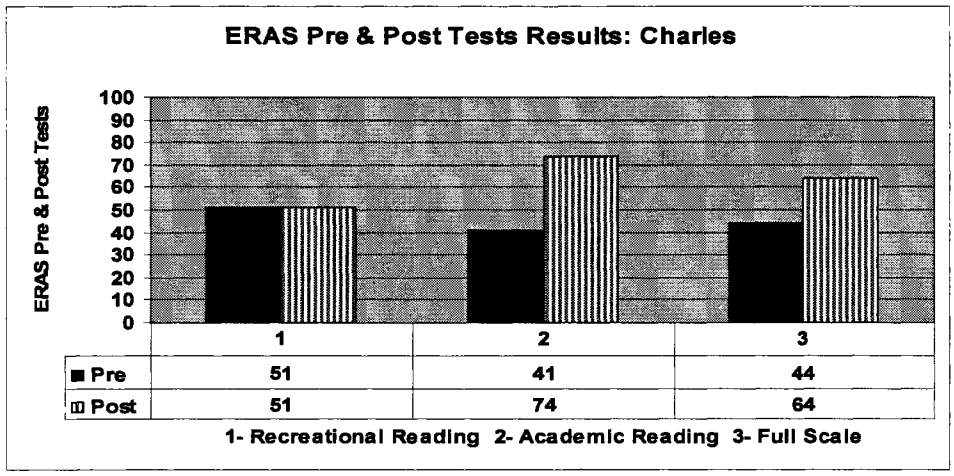


Figure 4.17. ERAS Pre and Post Tests Results of Percentile Ranks: Charles

The Running Records Assessment Results

Each student in the study also received daily running records assessments. They were assessed using Read Naturally (Ihnot, 1999, levels 1-4) grade level appropriate passages as determined by school records. The text structure within all of the passages from Read Naturally were factual in nature, whether biographies of famous figures or descriptions of animals in the wild. These running records documented their reading rate and reading accuracy with and without colored overlays. Each day participants completed two running record assessments. Both passages were read within one setting. This data collection involved three procedures: baseline, intervention, and treatment. Running records were conducted over 16 days on grade- leveled passages taken from the alternating treatments design (ATD).

During the 3 days of the baseline phase, each participant was given 2 passages for running records assessment, both without colored overlays. During the 10 days of the

intervention phase, each participant was given 2 passages for running records assessment, both with and without colored overlays randomly assigned. During the 3 days of the treatment phase, each participant was given 2 passages for running records assessment, both with colored overlays.

The Baseline Phase

Baseline assesment without colored overlays across all participants was used to establish rate and accuracy scores. These data were collected to provide stable baseline information on each student's reading performance. During the 3 days of the baseline phase, each participant was given 2 passages in the running records assessment, both without colored overlays. Tables 17 (George), 18 (David), and 19 (Charles) represent the data for the three days from the baseline phase. These tables provide information on time, number of errors, number of self corrects, rate in terms of WPM (words per minute), rate in terms of CWPM (correct words per minute), error ratio, accuracy, and self correct ratio. The data presented in the following paragraphs are discussed in terms of the two passages assessed for each day, with the data for the first passage presented initially followed by the data from the second passage.

Data from George's baseline phase are represented in Table 17. On day one, reading rate was 55.5 WPM and 53.3 WPM. His reading accuracy was 90.2% and 89.7%. Day two his reading rate was 72.9 WPM and 37.4 WPM, and his reading accuracy was 91.4% and 89.6%. Day three his reading rate was 53.4 WPM and 46.9 WPM, and his reading accuracy was 91% and 90.1%.

Table 17

Running Records Baseline Phase Results: George

Day	Passages	Time	# of Errors	# of Self Corrections	WPM	CWPM	Error Ratio	Accuracy	Self Correct Ratio
Baseline Day 1	B 174	3.8	17	2	55.5	38.5	10.2	90.2%	9.5
	B 176	3.18	18	1	53.3	35.3	9.7	89.7%	19
Baseline Day 2	B 152	2.5	13	1	72.9	59.9	11.6	91.4%	14
	B 194	5.11	20	0	37.4	17.4	9.7	89.6%	N/L
Baseline Day 3	B 190	4.3	17	3	53.4	37.4	11.1	91%	6.6
	B 162	3.2	16	2	46.9	29.9	10.1	90.1%	9

(B) Without Colored Overlays

Data from David's baseline phase are represented in Table 18. On Day one, reading rate was 96 WPM and 83.5 WPM. His reading accuracy was 85.6% and 85.2%. Day two his reading rate was 100.2 WPM and 85.5 WPM, and his reading accuracy was 85.5% and 85%. Day three his reading rate was 97.2 WPM and 82.6 WPM, and his reading accuracy was 87% and 86.8%.

Table 18

Running Records Baseline Phase Results: David

Day	Passages	Time	# of Errors	# of Self Corrections	WPM	CWPM	Error Ratio	Accuracy	Self Correct Ratio
Baseline Day1	B 174	1.50	25	0	96	70	6.9	85.6%	N/L
	B 176	2.5	26	0	83.5	58.5	6.7	85.2%	N/L
Baseline Day 2	B 152	1.31	22	0	100.2	78.2	6.9	85.5%	N/L
	B 194	2:16	29	0	85.5	56.5	6.6	85%	N/L
Baseline Day 3	B 190	1.40	21	2	97.2	76.2	7.7	87%	11.5
	B 162	2.18	25	1	82.6	57.6	7.6	86.8%	26

(B) Without Colored Overlays

Data from Charles' baseline phase are represented in Table 19. On day one, reading rate was 38.4 WPM and 19.1 WPM. His reading accuracy was 78.4% and 67.6%. On day two his reading rate was 39.4 WPM and 21.9 WPM, and his reading accuracy was 72.4% and 72.2%. On day three his reading rate was 34.5 WPM and 30.2 WPM, and his reading accuracy was 73.9% and 72%.

Table 19

Running Records Baseline Phase Results: Charles

Day	Passages	Time	# of Errors	# of Self Corrections	WPM	CWPM	Error Ratio	Accuracy	Self Correct Ratio
Baseline	B 79	2.4	17	1	38.4	21.2	3	78.4%	18
Day 1	B 68	3.33	22	0	19.1	0	4.6	67.6%	N/L
Baseline	B 69	1.45	19	1	39.4	20.4	3.6	72.4%	20
Day 2	B 72	3:17	20	1	21.9	1.9	3.6	72.2%	21
Baseline	B 69	2	18	0	34.5	16.5	3.8	73.9%	N/L
Day 3	B 68	2.15	19	0	30.2	11.2	3.5	72%	N/L

(B) Without Colored Overlays

The Intervention Phase

During the 10 days of the intervention phase, each participant was given 2 passages for running records assessment, one with (A) and one without (B) colored overlays randomly assigned. The intervention phase data results are presented in Tables 20 (George), 21 (David), and 22 (Charles). These tables provide information on time, number of errors, number of self-corrects, WPM, CWPM, error ratio, accuracy, and self-correct ratio.

Data from George's intervention phase are represented in Table 20. On day one, reading rate was 72 WPM with and 45.4 WPM without. His reading accuracy was 93.5% with and 90.1% without. On day two his reading rate was 51.9 WPM with and 48.3 WPM without, and his reading accuracy was 92.5% with and 91.7% without. On day three his reading rate was 53.8 WPM with and 48.1 WPM without, and his reading accuracy was

92.1% with and 90.4% without. On day four his reading rate was 51 WPM with and 42.4 WPM without, and his reading accuracy was 85.8% with and 84.4 without. On day five, his reading rate was 66.6 WPM with and 52.9 WPM without, and his reading accuracy was 93.35 with and 92.15 without. On day six, his reading rate was 47.1 WPM with and 46.4 WPM without, and his reading accuracy was 87.5% with and 84.5% without. On day seven, his reading rate was 61.8 WPM with and 54.4 WPM without, and his reading accuracy was 91.8% with and 82.1% without. On day eight, his reading rate was 49.6 WPM with and 45.6 WPM without, and his reading accuracy was 83% with and 82.5% without. On day nine, his reading rate was 58 WPM with and 57.4 WPM without, and his accuracy was 91.7% with and 82.9% without. On the last day (day ten), his reading rate was 53.7 WPM with and 52.5 WPM without, and his reading accuracy was 90.26% with and 84.3% without.

Table 20

Running Records Intervention Phase Results: George

Day	Passages	Time	# of Errors	# of Self Corrections	WPM	CWPM	Error Ratio	Accuracy	Self Correct Ratio
Intervention Day 1	B 163	3.35	16	3	45.4	29.4	10.1	90.1%	6.3
	A 156	2.10	10	3	72	62	15.6	93.5%	4.3
Intervention Day 2	A 162	3.7	12	13	51.9	39.9	13.5	92.5%	1.9
	B 170	3.31	14	5	48.3	34.3	12.1	91.7%	3.8
Intervention Day 3	B 178	3.42	17	4	48.1	31.1	10.4	90.4%	5.25
	A 166	3.5	18	8	53.8	40.8	12.7	92.1%	2.6
Intervention Day 4	A 155	3.2	22	14	51	29	7	85.8%	2.5
	B 148	3.29	23	11	42.4	19.4	6.4	84.4%	3
Intervention Day 5	B 179	3.23	14	6	52.9	38.9	13.7	92.1%	3.3
	A 140	2.9	9	8	66.6	57.6	15.5	93.3%	2.1
Intervention Day 6	A 161	3.25	20	8	47.1	27.1	8.05	87.5%	3.5
	B 127	2.44	21	3	46.4	25.4	6.05	83.5%	8
Intervention Day 7	B 157	2.53	28	7	54.4	26.4	5.6	82.1%	5
	A 135	2.11	11	10	61.8	50.8	12.2	91.8%	2.1
Intervention Day 8	A 120	2.25	20	6	49.6	29.6	6	83%	4.3
	B 184	4.2	33	5	45.6	12.6	5.57	82%	7.6
Intervention Day 9	B 182	3.10	31	5	57.4	28.4	5.87	82.9%	7.2
	A 181	3.7	15	7	58	43	12	91.7%	3.14
Intervention Day 10	A 154	2.52	15	7	53.7	39.7	10.2	90.2%	3.14
	B 182	3.28	20	7	52.5	29.5	9.1	84.3%	3.8

(A) With and (B) Without Colored Overlays

Figure 4.18 and 4.19 represent George's various changes over ten intervention days in reading rate WPM and reading accuracy (%). He consistently scored higher when reading with colored overlays than without. The highest scores he obtained were during the first day of intervention, scoring 72 WPM and 93% accuracy. The worst rate performance with colored overlays occurred on day six with 47.1 WPM, and his worst accuracy score with colored overlays was on day eight with 83%. Day six followed a one

week break (due to unexpected school assessments and conferences), and on day eight George stated that he was not feeling well. Despite these two interferences, his reading performance in rate and in accuracy with colored overlays was better than without.

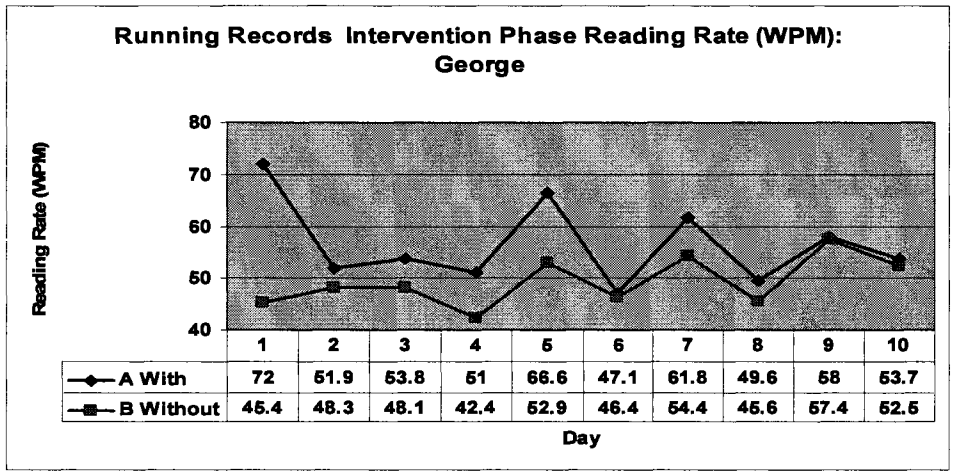


Figure 4.18. Running Records Intervention Phase Reading Rate (WPM) With and Without Colored Overlays: George

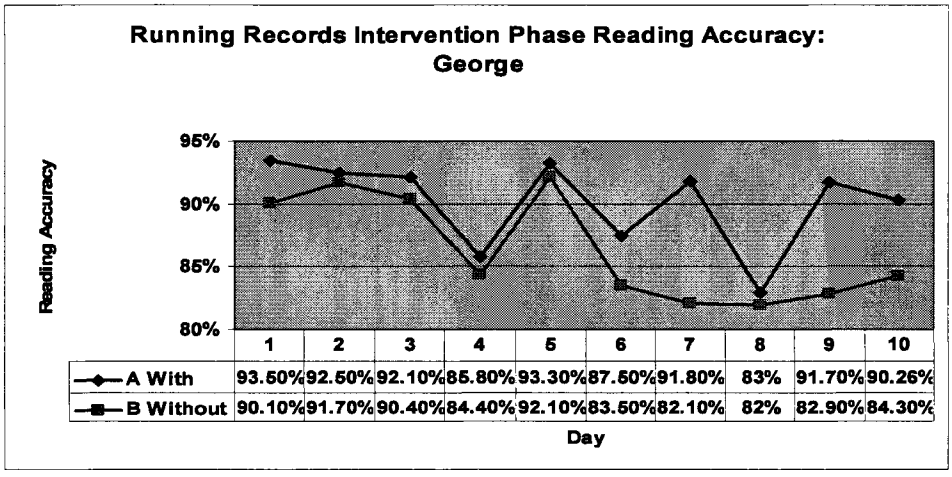


Figure 4.19. Running Records Intervention Phase Reading Accuracy With and Without Colored Overlays: George

Data from David's intervention phase are represented in Table 21. On day one, reading rate was 93.1 WPM with and 85 WPM without. His reading accuracy was 87.1% with and 81.4% without. Day two his reading rate was 92.7 WPM with and 81 WPM without, and his reading accuracy was 85.2% with and 82.7% without. Day three his reading rate was 82.1 WPM with and 79.6 WPM without, and his reading accuracy was 86.5% with and 78.9% without. Day four his reading rate was 88.5 WPM with and 80.7 WPM without, and his reading accuracy was 83.2% with and 80.4% without. On day five, his reading rate was 107.4 WPM with and 106.3 WPM without, and his reading accuracy was 89.3% with and 82.8% without. On day six, his reading rate was 80.2 WPM with and 73.4 WPM without, and his reading accuracy was 83.4% with and 78.8% without. On day seven, his reading rate was 87 WPM with and 85.6 WPM without, and his reading accuracy was 70.3% with and 61.7% without. On day eight, his reading rate

was 86.7 WPM with and 79.4 WPM without, and his reading accuracy was 75% with and 62.5% without. On day nine, his reading rate was 88.7 WPM with and 80.3 WPM without, and his accuracy was 84.06% with and 82.4% without. On the last day (day ten), his reading rate was 88.4 WPM with and 61.3 WPM without, and his reading accuracy was 82.17% with and 74.8% without.

Table 21

Running Records Intervention Phase Results: David

Day	Passages	Time	# of Errors	# of Self Corrections	WPM	CWPM	Error Ratio	Accuracy	Self Correct Ratio
Intervention Day 1	A 163	1.50	21	4	93.1	72.1	7.7	87.1%	6.25
	B 156	1.57	29	2	85	56	5.3	81.4%	12.5
Intervention Day 2	B 162	2	28	1	81	53	5.7	82.7%	29
	A 170	1.50	25	1	92.7	67.7	6.8	85.2%	26
Intervention Day 3	A 178	2.10	24	2	82.1	58.1	7.4	86.5%	13
	B 166	2.5	35	1	79.6	44.6	4.74	78.9%	36
Intervention Day 4	A 155	1.50	29	1	80.7	51.7	5.1	80.4%	30
	B 148	2	26	4	88.5	62.5	5.96	83.2%	7.5
Intervention Day 5	A 179	1.40	19	4	107.4	88.4	9.42	89.3%	5.75
	B 140	1.19	24	2	106.3	82.3	5.8	82.8%	13
Intervention Day 6	B 161	2.11	34	1	73.4	39.4	4.7	78.8%	35
	A 127	1.35	21	4	80.2	59.2	6	83.4%	6.25
Intervention Day 7	A 157	1.33	40	6	87	47	3.75	70.3%	7.6
	B 135	1.50	60	4	85.6	25.6	2.62	61.7%	16
Intervention Day 8	B 120	2.19	69	1	79.4	10.4	2.66	62.5%	70
	A 184	1.23	30	3	86.7	56.7	4	75%	11
Intervention Day 9	A 182	2	29	4	88.7	59.7	6.27	84.06%	8.25
	B 181	1.55	27	3	80.3	53.3	5.7	82.4%	10
Intervention Day 10	B 154	3.3	47	3	61.3	14.3	3.9	74.8%	16.6
	A 182	2.17	36	24	88.4	52.4	5.6	82.17%	2.5

(A) With and (B) Without Colored Overlays

Figure 4.20 and 4.21 represent David's various changes over ten intervention days in reading rate (WPM) and reading accuracy (%). He consistently scored higher when reading with colored overlays than without. The highest scores he obtained were during day five, scoring 107.4 WPM and 89.3% accuracy. The worst rate performance with colored overlays occurred on day six with 80.2 WPM, and his worst accuracy score was on day seven with 70.3%. Both days six and seven followed the one week break (due to

unexpected school assessments and conferences). Despite these two interferences, his reading performance in rate and in accuracy with colored overlays was better than without.

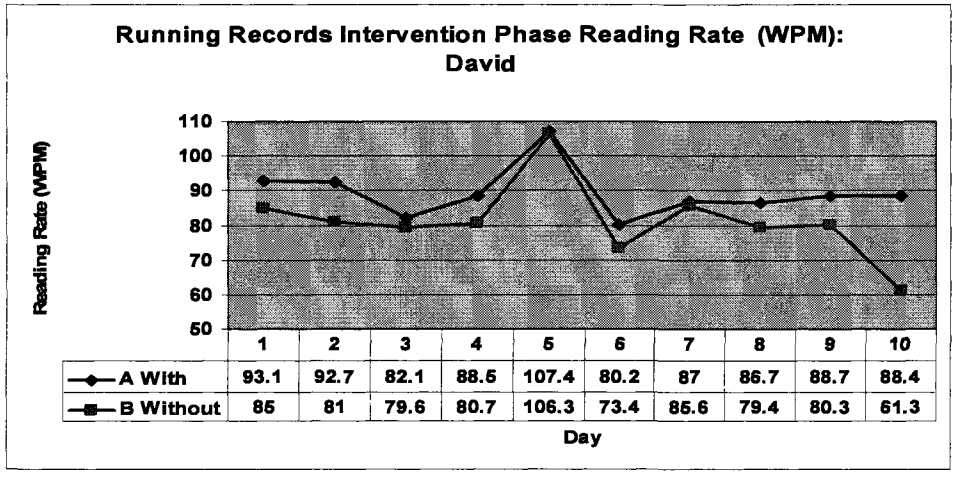


Figure 4.20. Running Records Intervention Phase Reading Rate (WPM) With and Without Colored Overlays: David

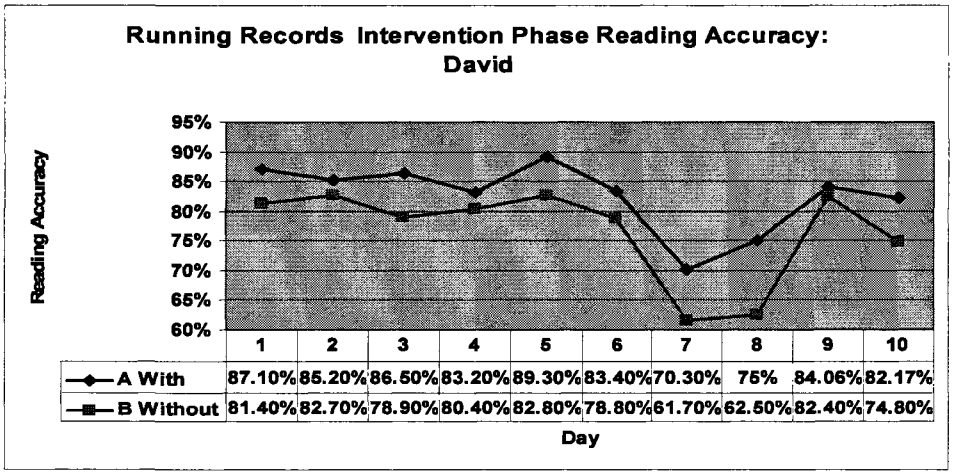


Figure 4.21. Running Records Intervention Phase Reading Accuracy With and Without Colored Overlays: David

Data from Charles' intervention phase are represented in Table 22. On day one, his reading rate was 42.2 WPM with and 32.3 WPM without. His reading accuracy was 82.4% with and 77.1% without. Day two his reading rate was 43.5 WPM with and 35.8 WPM without, and his reading accuracy was 68.9% with and 65.6% without. Day three his reading rate was 52.4 WPM with and 50.5 WPM without, and his reading accuracy was 78.9% with and 77.3% without. Day four his reading rate was 52.7 WPM with and 44.8 WPM without, and his reading accuracy was 79.4% with and 57% without. On day five, his reading rate was 66.4 WPM with and 45.4 WPM without, and his reading accuracy was 81.9% with and 62.5% without. On day six, his reading rate was 55.4 WPM with and 44.4 WPM without, and his reading accuracy was 84.9% with and 66.2% without. On day seven, his reading rate was 60.8 WPM with and 32.6 WPM without, and his reading accuracy was 76.8% with and 56.9% without. On day eight, his reading rate

was 55.5 WPM with and 50.6 WPM without, and his reading accuracy was 77% with and 70% without. On day nine, his reading rate was 54.7 WPM with and 50.8 WPM without, and his accuracy was 64.3% with and 58.3% without. On the last day (day ten), his reading rate was 54.4 WPM with and 52.1 WPM without, and his reading accuracy was 72% with and 61% without.

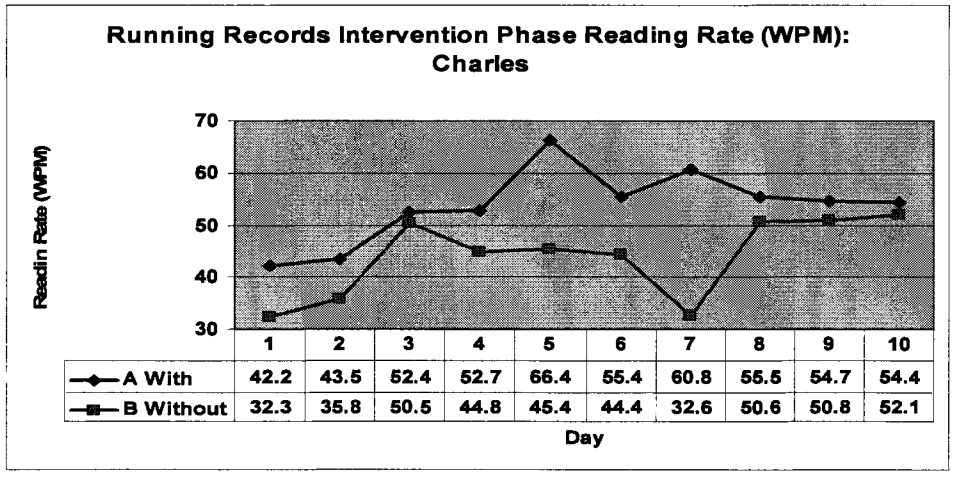
Table 22

Running Records Intervention Phase Results: Charles

Day	Passages	Time	# of Errors	# of Self Corrections	WPM	CWPM	Error Ratio	Accuracy	Self Correct Ratio
Intervention Day 1	B 70	2.10	16	0	32.3	16.3	4.3	77.1%	N/L
	A 74	1.44	13	5	42.2	29.2	5.6	82.4%	4.2
Intervention Day 2	A 74	1.42	23	3	43.5	20.5	3.2	68.9%	8.6
	B 67	1.52	23	0	35.8	12.8	2.9	65.6%	N/L
Intervention Day 3	B 75	1.29	17	1	50.5	33.5	4.4	77.3%	18
	A 76	1.27	16	2	52.4	36.4	4.7	78.9%	9
Intervention Day 4	A 73	1.23	15	1	52.7	35.7	4.8	79.4%	16
	B 77	1.43	33	1	44.8	11.8	2.3	57%	34
Intervention Day 5	B 72	1.35	27	0	45.4	18.4	2.6	62.5%	N/L
	A 72	1.5	13	1	66.4	53.3	5.5	81.9%	14
Intervention Day 6	A 73	1.19	11	2	55.4	44.4	6.6	84.9%	6.5
	B 74	1.40	25	1	44.4	19.4	2.96	66.2%	26
Intervention Day 7	B 79	2.25	34	0	32.6	0	2.3	56.9%	N/L
	A 69	1.8	16	0	60.8	44.8	4.3	76.8%	N/L
Intervention Day 8	A 74	1.20	17	1	55.5	38.5	4.3	77%	22
	B 70	1.23	21	0	50.6	29.6	3.3	70%	N/L
Intervention Day 9	B 72	1.25	30	0	50.8	20.8	2.4	58.3%	N/L
	A 73	1.20	26	1	54.7	28.7	2.6	64.3%	27
Intervention Day 10	A 100	1.50	28	8	54.4	26.4	3.5	72%	4.5
	B 100	1.55	39	6	52.1	13.1	2.5	61%	7.5

(A) With and (B) Without Colored Overlays

Figure 4.22 and 4.23 represent Charles's various changes over ten intervention days in reading rate (WPM) and reading accuracy (%). He consistently scored higher when reading with colored overlays than without. The highest score he obtained for rate was during day five, scoring 66.4 WPM. His highest accuracy score was during day six, scoring 84.9%. The worst rate performance at 42.2 WPM with colored overlay occurred on the first day of intervention when the session was interrupted by the resource teacher whom the child knew. This distraction may have affected his ability to concentrate on the text. Charles' worst accuracy score of 64.3% correct words with colored overlay was on day nine, which took place after a two-week break in the schedule. However, despite these interruptions, across his intervention assessments, his reading performance in rate and in accuracy with colored overlays was better than without.



	1	2	3	4	5	6	7	8	9	10
A With	42.2	43.5	52.4	52.7	66.4	55.4	60.8	55.5	54.7	54.4
B Without	32.3	35.8	50.5	44.8	45.4	44.4	32.6	50.6	50.8	52.1

Figure 4.22. Running Records Intervention Phase Reading Rate (WPM) With and Without Colored Overlays: Charles

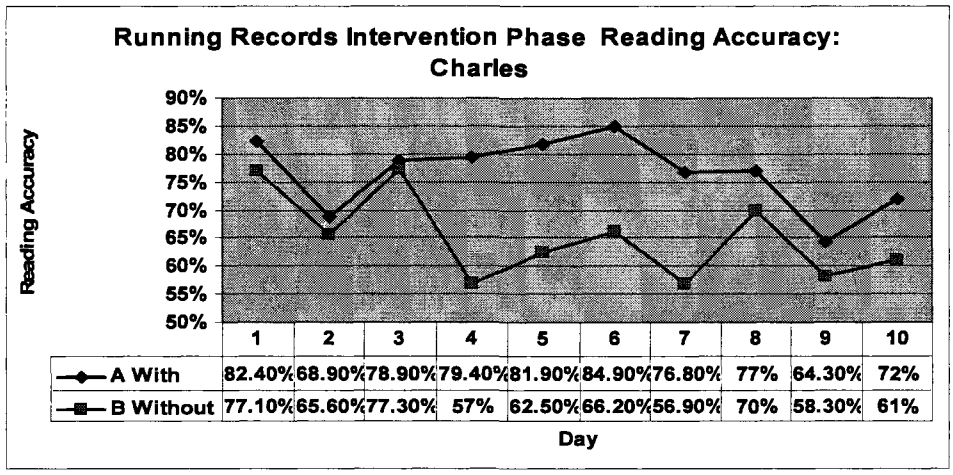


Figure 4.23. Running Records Intervention Phase Reading Accuracy With and Without Colored Overlays: Charles

Additional Analyses

Errors and self-corrections. In analyzing the errors and self-corrections for cueing systems used, Running Records analysis focuses only on substitutions where the original text can be compared to the reader's error. In this analysis of cues, omissions and insertions are not evaluated. The words are analyzed for possible cues by the reader as M (meaning cue of the word or text used to make the error or self correction), S (structure cue of the syntax of the language used to make the error or self correction), and/or V (visual cue of letters and shapes used to make the error or self correction). In the overall analysis of all three participants, 90-95% of the errors and self-corrections were based on visual cues.

Other observations of the use of colored overlays included students paying more attention to the punctuation and hesitating less with mispronunciations, as compared to

no colored overlays, where the readers had more opportunities where they missed punctuation and hesitated more often when approaching an unknown word. The following describes the performance of each participant in their overall errors and self-corrections, and in the analysis of the cueing systems used with substitutions.

George consistently scored a higher accuracy percentage (total errors were less) when reading with a colored overlay. However, the substitution analysis shows less consistency with colored overlays. Of the ten days of intervention, on seven days (days 2, 4, 5, 6, 7, 8, and 10) he had fewer substitution errors when reading with a colored overlay. But on three days (days, 1, 3, and 8) he scored fewer substitution errors when reading without colored overlays. In analyzing his self correction ratios (the number of self-corrections made in comparison to the total number of original errors during reading) George consistently scored a lower self-correction ratio (making a greater number of self-corrections) when using colored overlays (see Table 23).

Table 23

Self-correction Ratio: George

Day	Self-Correction With Overlays (A)	Self-Correction Without Overlays (B)
1	4.3	6.3
2	1.9	3.8
3	2.6	5.25
4	2.5	3.0
5	2.1	3.3
6	3.5	8.0
7	2.1	5.0
8	4.3	7.6
9	3.1	7.2
10	3.1	3.8

David consistently scored a higher accuracy percentage (total errors were less) when reading with a colored overlay. The analysis of his substitutions showed less consistency with colored overlays. Of the ten days of intervention, on seven days (days 1, 2, 6, 7, 8, 9, and 10) he had fewer substitution errors when reading with a colored overlay. But on three days (days, 3, 4, and 5) he scored fewer substitution errors when reading without colored overlays. In analyzing his self correction rate (the number of self-corrections made in comparison to the total number of original errors during reading) David showed the most noticeable difference between reading with colored overlays when compared to reading without colored overlays. His self-correction ratios were consistently lower (making a greater number of self-corrections) when using colored overlays (see Table 24).

Table 24

Self-correction Ratio: David

Day	Self-Correction With Overlays (A)	Self-Correction Without Overlays (B)
1	6.25	12.5
2	26	29
3	13	36
4	7.5	30
5	5.75	13
6	6.25	35
7	7.6	16
8	11	70
9	8.25	10
10	2.25	16.6

Charles consistently scored a higher accuracy percentage (total errors were less) when reading with a colored overlay. In the analysis of substitutions, the use of colored overlays appeared to work best for Charles when compared to the other participants. Of the ten days of intervention, on eight days (days 1, 2, 4, 5, 6, 7, 8, and 10) he had fewer substitution errors when reading with a colored overlay, and one day (day 3) he had the same amount of substitutions when using a colored overlay and when not using a colored overlay. Only one day (day 9) did he have fewer substitutions without the use of a colored overlay; this was the day following a two week break. In analyzing his self correction rate (the number of self-corrections made in comparison to the total number of original errors during reading), Charles was the only participant who did not consistently attempt to self-correct. This usually occurred when reading without colored overlays (day 1, 2, 5, 7, 8, and 9). On day 7, Charles did not self-correct any of his substitutions, with or without a colored overlay. All the remaining nine days of running record intervention, Charles did self-correct when using colored overlays. Of the three passages where Charles self-corrected with and without colored overlays (days 3, 4, and 6), he consistently had lower self-correction rates (corrected more often) when reading with colored overlays (see Table 25).

Table 25

Self-correction Ratio: Charles

Day	Self-Correction With Overlays (A)	Self-Correction Without Overlays (B)
1	4.2	No SCs
2	8.6	No SCs
3	9	18
4	16	34
5	14	No SCs
6	6.5	26
7	No SCs	No SCs
8	22	No SCs
9	27	No SCs
10	4.5	7.5

These results indicate that the participants performed more self corrections when using colored overlays in all cases except Charles on day 7.

The Treatment Phase

During the 3 days of the treatment phase, each participant was given 2 passages for running records assessment, both with colored overlays.

Data from George's treatment phase are represented in Table 26. On day one, reading rate was 46.3 WPM and 45.1 WPM. His reading accuracy was 86.7% (frustration) and 85.8% (frustration). Day two his reading rate was 58.3 WPM and 48 WPM, and his reading accuracy was 95.3% (independent) and 94.4% (instructional). Day three his reading rate was 56.1 WPM and 45.6 WPM, and his reading accuracy was 93.7% (instructional) and 86.1% (frustration).

Table 26

Running Records Treatment Phase Results: George

Day	Passages	Time	# of Errors	# of Self Corrections	WPM	CWPM	Error Ratio	Accuracy	Self Correct Ratio
Treatment Day 1	A 143	3.5	19	11	46.3	27.3	7.5	86.7%	1:2.7
	A 177	3.55	25	8	45.1	20.1	7	85.8%	1:4.1
Treatment Day 2	A 169	3.31	8	22	58.3	50.3	21	95.3%	1:1.3
	A 143	2.27	8	5	48	40	17.8	94.4%	1:3.2
Treatment Day 3	A 159	2.50	10	11	56.1	46.1	15.9	93.7%	1:1.9
	A 166	3.38	23	11	45.6	20.6	7.2	86.1%	1:3.1

(A) With Colored Overlays

Data from David's treatment phase are represented in Table 27. On day one, reading rate was 81.7 WPM and 78 WPM. His reading accuracy was 88.1% (frustration) and 85.3% (frustration). Day two his reading rate was 93.8 WPM and 85.8 WPM, and his reading accuracy was 88.1% (frustration) and 78.1% (frustration). Day three his reading rate was 76.3 WPM and 73.7 WPM, and his reading accuracy was 86.2% (frustration) and 74.6% (frustration).

Table 27

Running Records Treatment Phase Results: David

Day	Passages	Time	# of Errors	# of Self Corrections	WPM	CWPM	Error Ratio	Accuracy	Self Correct Ratio
Treatment Day 1	A 177	2.16	21	5	81.7	60.7	8.42	88.1%	5.2
	A 143	1.45	21	0	78	57	6.8	85.3%	N/L
Treatment Day 2	A 143	1.40	17	4	93.8	68.8	8.4	88.1%	5.25
	A 169	1.48	37	4	85.8	56.8	4.8	78.1%	10.2
Treatment Day 3	A 159	2.5	22	5	76.3	54.3	7.2	86.2%	5.4
	A 166	2.15	42	4	73.7	31.7	3.95	74.6%	11.5

(A) With Colored Overlays

Data from Charles' treatment phase are represented in Table 28. On day one, reading rate was 46.8 WPM and 46.1 WPM. His reading accuracy was 65% (frustration) and 51% (frustration). Day two his reading rate was 55.5 WPM and 43.1 WPM, and his reading accuracy was 70% (frustration) and 65% (frustration). Day three his reading rate was 58.8 WPM and 54.5 WPM, and his reading accuracy was 63% (frustration) and 56% (frustration).

Table 28

Running Records Treatment Phase Results: Charles

Day	Passages	Time	# of Errors	# of Self Corrects	WPM	CWPM	Error Ratio	Accuracy	Self Correct Ratio
Treatment Day 1	A 100	2.8	35	3	46.8	11.8	2.8	65%	12.6
	A 100	2.10	49	2	46.1	0	2	51%	25.5
Treatment Day 2	A 100	1.48	35	0	55.5	20.5	3.3	70%	N/L
	A 100	2.19	30	0	43.1	13.1	2.8	65%	N/L
Treatment Day 3	A 100	1.42	37	1	58.8	21.8	2.7	63%	38
	A 100	1.50	44	0	54.5	10.5	2.27	56%	N/L

(A) With Colored Overlays

Baseline, Intervention, and Treatment Phases Summarized Results

Participants finished two running record assessments and both passages were read within one setting. The data were collected during three procedures: baseline, intervention, and treatment phases. Running records were conducted over 16 days of thirty two on grade- leveled passages (based on their reading achievement) taken from the alternating treatments design (ATD). The following represent outlines of George, David, and Charles regarding their baseline phase reading of both passages without colored overlays, intervention reading on passages without colored overlays and with colored overlays, and treatment phase reading of both passages with colored overlays.

George

The comparison between baseline and treatment running record scores for George are represented in Table 29. Figures 4.24 and 4.25 represent the fluctuation of George's

scores over sixteen days of running records (baseline, intervention, and treatment phases) in reading accuracy and reading rate (WPM). In accuracy, George had mixed results in his performance. Two of his readings during the treatment scored a lower level of performance when compared to the baseline scores (Day 1: 86.7% Frustration for treatment compared to 90.2% Instructional for baseline; Day 3: 86.1% Frustration for treatment compared to 90.1% Instructional for baseline). Two of his readings during treatment maintained a similar level of performance when compared to the baseline scores (Day 1: 85.8% Frustration for treatment compared to 89.7% Frustration for baseline; Day 3: 93.7% Instructional for treatment compared to 91% Instructional for baseline). However, two of his readings during the treatment scored a level higher than the baseline (Day 2: 95.3% Independent for treatment compared to 91.4% Instructional for baseline; Day 2: 94.4% Instructional for treatment compared to 889.6% Frustration for baseline).

When comparing George's rate WPM performance from baseline without colored overlays to treatment with colored overlays, he performed slower with colored overlays for four of the six readings (46.3 compared to 55.5, 45.1 compared 53.3, 58.3 compared to 72.9, and 45.6 compared to 54.4). In two readings his rate increased with colored overlays, averaging ten WPM faster. The delay in rate can be attributed possibly to his increase in the number of self-corrections that occurred during the treatment readings. However, in the two passages where his rate was increase, he also had an increase in the number of self-corrections.

When analyzing his self correction ratios (the number of self-corrections made in comparison to the total number of original errors during reading) George consistently scored a lower self-correction ratio (making a greater number of self-corrections) when he read with colored overlays.

Table 29

Baseline Scores Versus Treatment Scores: George

Day	Accuracy & Level Baseline	Accuracy & Level Treatment	WPM Baseline	WPM Treatment	Self Correction Baseline	Self Correction Treatment	Self Correct Ratio Baseline	Self Correct Ratio Treatment
1	90.2% Ins	86.7% Frus	55.5	46.3	2	11	1:9.5	1:2.7
	89.7% Frus	85.8% Frus	53.3	45.1	1	8	1:19	1:4.1
2	91.4% Ins	95.3% Ind	72.9	58.3	1	22	1:14	1:1.56
	89.6% Frus	94.4% Ins	37.4	48	0	5	N/L	1:3.25
3	91 % Ins	93.7% Ins	46.9	56.1	3	11	1:6.6	1:1.9
	90.1% Ins	86.1% Frus	53.4	45.6	2	11	1:9	1:3.1

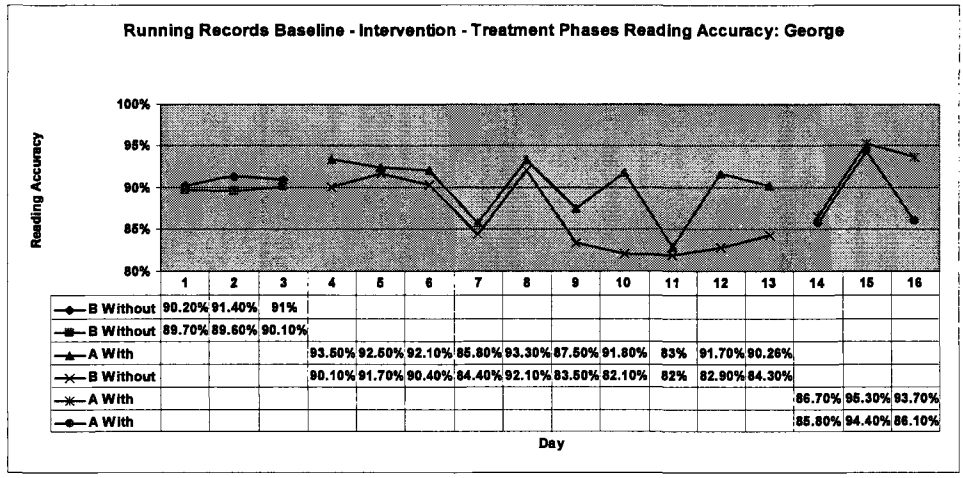


Figure 4.24. Running Records Baseline, Intervention, and Treatment Phases Reading Accuracy: George

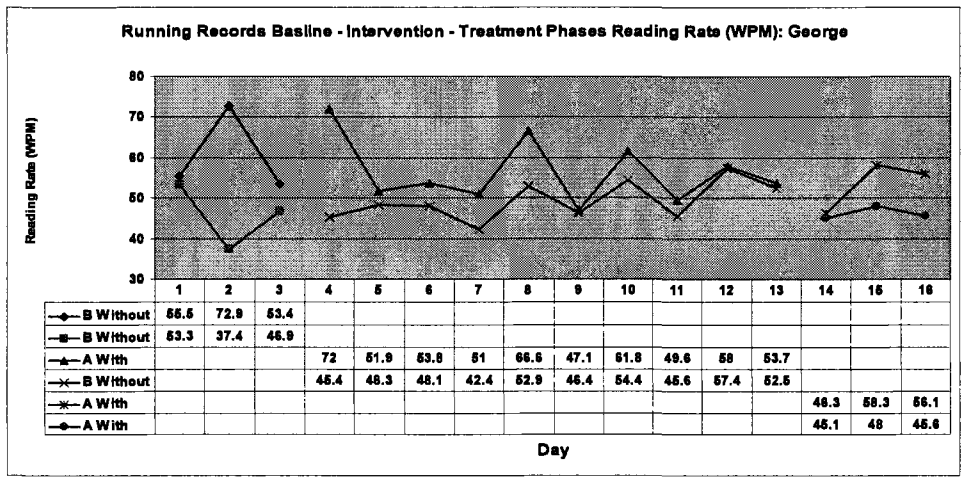


Figure 4.25. Running Records Baseline, Intervention, and Treatment Phases Reading Rate (WPM): George

David

The comparison between baseline and treatment running record scores for David are represented in Table 30. Figures 4.26 and 4.27 represent the fluctuation of David's scores over sixteen days of running records (baseline, intervention, and treatment phases) in reading accuracy and reading rate (WPM). In accuracy, David had all results in his performance were Frustration, with some variance in the percentage in favor of the treatment (Day 1: 88.1% for treatment compared to 85.6% for baseline; Day 2: 85.3% for treatment compared to 85.2% for baseline; Day 3: 88.1% for treatment compared to 85.5% for baseline), and some variance in the percentage in favor of the baseline (Day 2: 78.1% for treatment compared to 85% for baseline; Day 3: 86.2% for treatment compared to 87% for baseline; Day 3: 74.6% for treatment compared to 86.8% for baseline).

When comparing David's rate (WPM) performance from baseline without colored overlays to treatment with colored overlays, he performed slower with colored overlays for five of the six readings (81.7 compared to 83.5, 78 compared 96, 100.2 compared to 93.8, 76.3 compared to 97.2 and 73.7 compared to 82.6). In one reading his rate increased minimally with colored overlays, at .3 WPM faster. The delay in rate can be attributed possibly to his increase in the number of self-corrections that occurred during the treatment readings. In David's self-correction ratios, his baseline data showed four out of six passages had no self-correction, with Day 3 baseline readings showing some self-correction (1:11.5 or one self-correction for every 11.5errors, and 1:26 or one self-correction for every 26 errors). When comparing these baseline results to the treatment results, David self-corrected in five of the six treatment readings (Day 1: 1:5.2; Day 2:

1:5.25 & 1:10.25, Day 3: 1:5.4 & 1: 11.5). These self-correction ratios suggest that David was paying more attention to visual, structure and meaning cues in the text and taking greater time to reread for accuracy.

Table 30

Baseline Scores Versus Treatment Scores: David

Day	Accuracy & Level Baseline	Accuracy & Level Treatment	WPM Baseline	WPM Treatment	Self Correction Baseline	Self Correction Treatment	Self Correct Ratio Baseline	Self Correct Ratio Treatment
1	85.6% Frus	88.1% Frus	83.5	81.7	0	5	N/L	1:5.2
	85.2% Frus	85.3% Frus	96	78	0	0	N/L	N/L
2	85.5% Frus	88.1% Frus	100.2	93.8	0	4	N/L	1:5.25
	85% Frus	78.1% Frus	85.5	85.8	0	4	N/L	1:10.25
3	87% Frus	86.2% Frus	97.2	76.3	2	5	1:11.5	1:5.4
	86.8% Frus	74.6% Frus	82.6	73.7	1	4	1:26	1:11.5

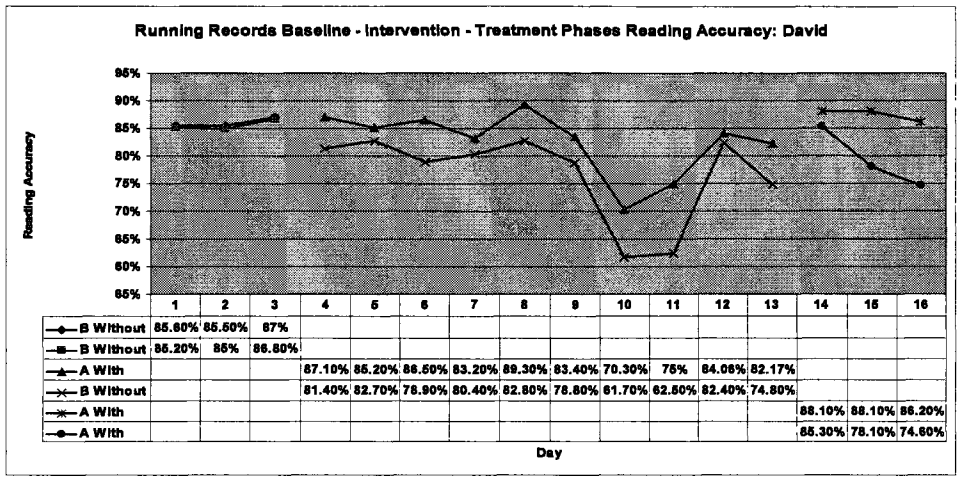


Figure 4.26. Running Records Baseline, Intervention, and Treatment Phases Reading Accuracy: David

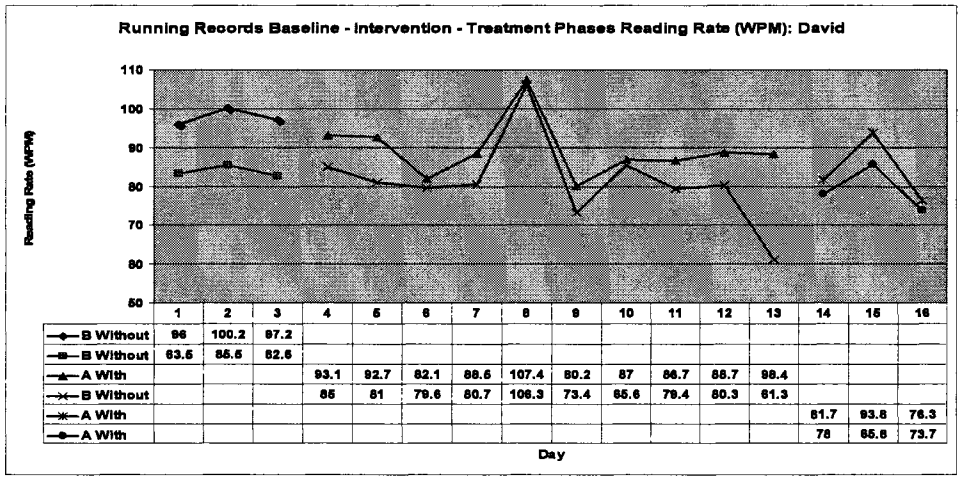


Figure 4.27. Running Records Baseline, Intervention, and Treatment Phases Reading Rate (WPM): David

Charles

The comparison between baseline and treatment running record scores for Charles are represented in Table 31. Figures 4.28 and 4.29 represent the fluctuation of Charles's scores over sixteen days of running records (baseline, intervention, and treatment phases) in reading accuracy and reading rate (WPM). In accuracy, all of his results were at the Frustration level. His readings during the treatment scored a lower level of performance for accuracy when compared to the baseline scores (Day 1: 65% for treatment compared to 78.4% for baseline, 51% for treatment compared to 67.6% for baseline; Day 2: 65% for treatment compared to 72.4% for baseline, 70% for treatment compared to 72.2% for baseline; Day 3: 63% for treatment compared to 73.9% for baseline, 56% for treatment compared to 72% for baseline).

When comparing Charles' rate (WPM) performance from baseline without colored overlays to treatment with colored overlays, he performed faster with colored overlays for all of the six readings (46.8 compared to 38.4, 46.1 compared 19.1, 55.5 compared to 39.4, 43.1 compared to 21.9, 58.8 compared to 34.5,and 54.5 compared to 30.2).

When analyzing Charles' use of self corrections when reading, there was no clear evidence that colored overlays made a consistent difference for him when comparing the baseline and treatment ratios. In fact, Charles self-corrected in three passages in the treatment (Day 1: 1:12.6 & 1:25.5; Day 3: 1:1.38), but he also self-corrected in three passages in the baseline (Day 1: 1:18; Day 2: 1:20 & 1:21). All of these ratios suggest a reader who was not attending consistently to visual, structure and meaning cues in the text.

Table 31

Baseline Scores Versus Treatment Scores: Charles

Day	Accuracy & Level Baseline	Accuracy & Level Treatment	WPM Baseline	WPM Treatment	Self Correction Baseline	Self Correction Treatment	Self Correct Ratio Baseline	Self Correct Ratio Treatment
1	78.4% Frus	65% Frus	38.4	46.8	1	3	1:18	1:12.6
	67.6% Frus	51% Frus	19.1	46.1	0	2	N/L	1:25.5
2	72.4% Frus	65% Frus	39.4	55.5	1	0	1:20	N/L
	72.2% Frus	70% Frus	21.9	43.1	1	0	1:21	N/L
3	73.9% Frus	63% Frus	34.5	58.8	0	1	N/L	1:38
	72% Frus	56% Frus	30.2	54.5	0	0	N/L	N/L

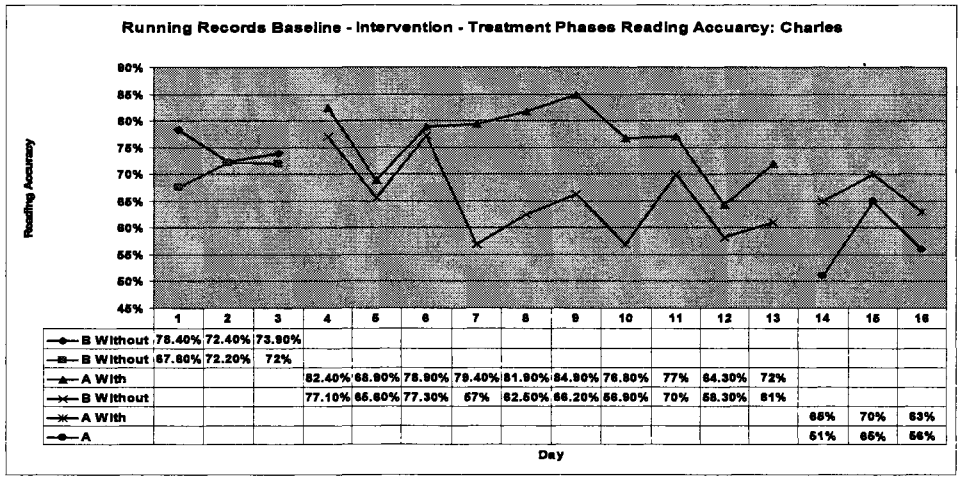
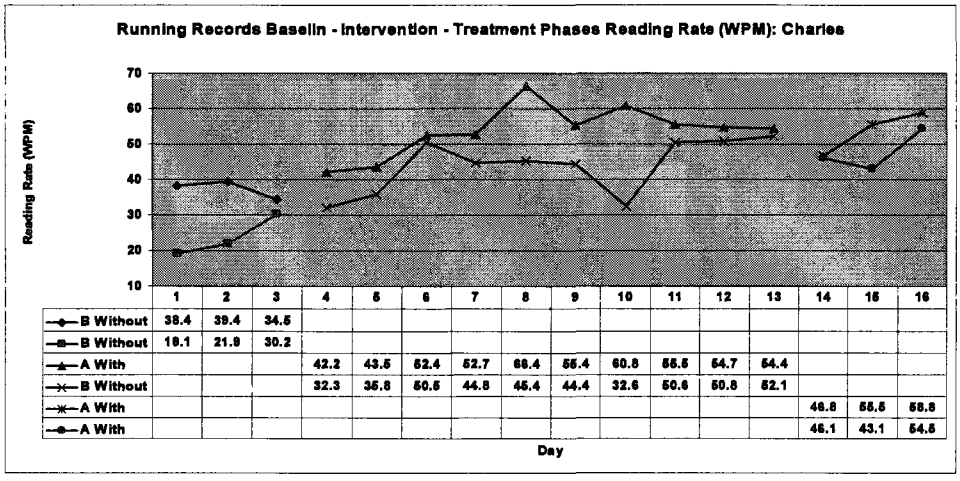


Figure 4.28. Running Records Baseline, Intervention, and Treatment Phases Reading Accuracy: Charles



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
B Without	38.4	39.4	34.5													
B Without	19.1	21.9	30.2													
A With				42.2	43.5	52.4	52.7	66.4	55.4	60.5	55.5	54.7	54.4			
B Without				32.3	35.8	50.5	44.8	45.4	44.4	32.6	50.6	50.8	52.1			
A With														46.8	55.5	55.5
A With														45.1	43.1	54.5

Figure 4.29. Running Records Baseline, Intervention, and Treatment Phases Reading Rate (WPM): Charles

Data results from the running records show a difference in response to colored overlays when comparing immediate effects (during intervention) with effects over time (baseline compared to treatment). Across the intervention running records, the use of colored overlays positively affected the participants in three noticeable ways: through their increase in rate, through their increase in accuracy, and in their ability to make self-corrections. Rate improved in 100% of the running records for all three participants when using colored overlays as compared to running records without colored overlays. Accuracy also improved in 100% of the running records for all three participants when using colored overlays as compared to running records without colored overlays. In comparing running records with colored overlays to those without colored overlays, self correction of errors made when reading was shown to improve consistently for George in

100% of his running records with colored overlays, and in 90% of the running records with colored overlays for David and for Charles.

While there appear to be immediate effects for rate, accuracy and self-correction with colored overlays, there is not a clear pattern in these areas for effects over time with colored overlays when comparing running record baseline data to treatment data. In accuracy, none of the three participants showed any consistent pattern of improvement with the colored overlays. In rate, there were mixed results with Charles showing a consistent improvement in his reading rate with the use of colored overlays, while George and David showed a decrease in their rate for a majority of the passages read with colored overlays. Since self-corrections often increased with the use of colored overlays, this may have affected the rate for George and David. Self-corrections showed the most promise in the comparison of baseline data to treatment data. Two of the participants (George and David) showed an overall consistent increase in the use of self-corrections with colored overlays. However, Charles' results were inconsistent.

An interesting conundrum in the running records was the disconnection between the grade level texts used and level of performance on those graded texts. While the overall pattern showed an improvement in rate, accuracy and self-correction across the intervention running records when using colored overlays, all three participants were not able to obtain an instructional level consistently across these grade level texts chosen at their reading instruction level. According to Clay (2006), a text determined to be at a reader's instructional level should be read with an accuracy score between 90-94%. In the cases of Charles and David, all 20 running records were scored below 90%, indicating

that all 20 texts were hard texts (as termed by Clay) for them to read. However, Charles and David showed an improvement in rate, accuracy and self-correction when using colored overlays. For George, 50% (ten) of his 20 running records texts were at the instructional level, with the remaining 50% considered hard texts. And like the other two cases, his response to colored overlays showed an overall improvement in rate, accuracy, and self correction.

Field Observations

The colored overlays were initially met with great enthusiasm as new tools when first introduced. All three of the participants stated that they liked the colors and liked the task of finding the correct one for their own use later at the end of the study. George and Charles wanted to take the overlays with them from the beginning of the study and asked to try them in class and at home. The following is descriptive information that goes beyond the assessment data in reflecting the participants' responses to the colored overlays.

George

Through using the overlays the researcher observed that George was able to stay more closely aligned directly to the text. He described his reading: by placing the overlays on the page he felt that it gave his reading problems a "break" and he could see more details when reading. George stated that the VMI test symbols seemed more clear and more stable in the pages. With the overlay he was able to see the dots and commas, and more clearly saw o's, and u's, b's and d's, and sometimes p's, j's and i's. Without the

overlay he said that reading requires more "attention" and he stated it was like "fighting to read." He said "I like the overlays. They're fun to use."

David

David stated that without the overlays he saw more "jiggle lines" with white text background and "more puzzling words showed." He is not consistent about using the overlays as with the other two participants. He lost focus easily, part of his attention deficit during the test times. This more frequently happened when he was not using the overlays. Most of his usual procedure of skipping whole lines or missing the ends of sentences while reading decreased considerably with the continued use of the overlays. He mentioned that he liked the overlays "sometimes."

Charles

Charles has other reading difficulties aside from his comprehension and tracking of text. He had difficulty with small-size text, which can give him headaches. He was not adept at describing what he saw with overlays in detail, but he was excited to talk about how he liked it with a wide smile on his face. When viewing text with an overlay, he stated, "Oh my gosh. That is amazing."

Post Study Participant Follow-up

The researcher consulted the classroom teacher to find out any changes in students' use of the colored overlays two months after the end of this study. The researcher gathered the comments of the resource room teacher to supplement the data results of the study and to see the teacher's perceptions of the difference in her students' reading behaviors.

The resource room teacher cited a noticeable and positive change in the reading performances in general of both Charles and George. Also, she noticed a decrease in repetitions and omissions, resulting in improved accuracy, rate, and comprehension (the same reading elements assessed in this study). With her observations and conversations with the students she noted the following:

George: used the colored overlay to read with and said that, "they help me relax while I'm reading;" "less headaches;" "I remember what I read better when I use them" "used the one at home a little bit." That means that the colored overlays are helping him in reading comprehension, understanding, and remembering what he read. But, she also said that "He uses the colored overlays, but only when I ask him to do it. I would like him to get them out on his own because I do believe they make a difference."

David: did not use the colored overlays to read and said that, "I want to use them but I forget all the time and then I don't want to use them, I don't know why." The resource room teacher stated that "David has not chosen to use them. I think (as you knew) his attention problems get in the way of his reading abilities."

Charles: used the colored overlay to read and said that it "helps me read better;" "see better with them;" "used the one at home a couple of times." He usually used the colored overlay on his own when he was working in the resource room and at home. She said, "This really impresses me when all the time he uses the colored overlay when he reads, that he feels they really work. I don't have to remind him to take it out."

Additional Observational Notes Regarding the Assessment Environment

Interruptions

During the scheduled study at the school site, several interruptions occurred. The site for the assessments and intervention was an available room next to the resource classroom and an actual part of the fifth grade classroom. While the initial plans included privacy for the area and a quiet space for assessment, the actual dynamics involved many small interruptions due to class noise and movement, teacher discussions and conversations, and student activities assigned in the area where assessment took place. While these interruptions were distracting to the participants and affected their focus on the tasks at hand, the overall results from the data did show an improvement in their response to the text with colored overlays, despite the interruptions.

Changing Schedule

Three major times the schedule was altered due to the following: teacher request for assessment time, classroom plans for Halloween festivities, and teacher request for a week break for teacher conferences. In addition, some time was altered due to the participants' absences for illness, and for a death in the family. The change in the schedule, especially the week off from the intervention, appeared to affect the participants' response to the tasks with two of the three showing a noticeable decrease in their performance from the previous week (see Table 19: George, Table 20: David, and Table 21: Charles). Even with this dip in their performance, the overall results from the data did show an improvement in the participants' responses to the text with colored overlays when compared to their responses without colored overlays.

Text Choice

The passages used for the running record intervention came from the Reading Naturally program (Ihnot, 1999, levels 1-4) and were recommended by the resource teacher as text that would be appropriate for the participants. Passage choice included information from the school records on reading level achievement by each of the participants. Each passage chosen was at the designated grade level for appropriate reading performance demonstrated in class assessments. In addition, the length of the passages was short, designed for a struggling reader to complete within one setting. The layout of the text included a picture that coincided with the content of the text. While these variables made the text choice appropriate, the design of the passage also included numbering for each line of text and a layout that was black and white. In the observations it appeared that the physical appearance of the passages was not conducive to student interest. In addition, the topics did not appear to be of interest to the students as well. This may be in part due to the readability focus of each passage, which created a text with shorter sentences and fewer syllables which may have seemed contrived or artificial to the participants. Text choice was not available to the participants; rather texts were chosen by the researcher for the reading tasks.

CHAPTER 5

CONCLUSION

This chapter is an overview of the study. It presents a summary of the investigation, findings, implications of the data, recommendations for future research, and participant follow-up.

Summary

The study was initiated to investigate the effects of using colored overlays on students identified with Scotopic Sensitivity Syndrome (SSS) or Irlen Syndrome (IS) when using colored overlays as an intervention (immediately and over time) to assess reading performance (rate, accuracy, and comprehension); to measure visual-motor integration; and to assess attitude toward reading. Particularly, the study asked the following questions:

1. Is there a difference in reading rates and accuracy on a daily basis with identified students reading text without and with colored overlays?
2. Is there a difference in reading rate, accuracy and comprehension over one semester with identified students reading text without and with colored overlays?
3. Is there a difference in visual-motor integration over one semester with identified students reading text without and with colored overlays?
4. Is there a difference in attitude towards reading over one semester of using colored overlays with identified students?

Three students participated in this study, one from 3rd grade, one from 4th grade, and one from 5th grade. All students were from a NK-12 Laboratory School at a Midwest

Teaching University. This study used the Alternating Treatments Design (ATD) as a type of single-participant design to determine the effectiveness of two treatment conditions; (a) reading with colored overlays, and (b) reading without colored overlays. This design involved four major procedures: the screening procedure, the pre-test procedure, the intervention procedure (baseline, intervention, and treatment), and the post-test procedure.

The instruments used in this study were the following:

- Irlen Reading Perceptual Scale (IRPS) for SSS screening;
- Qualitative Reading Inventory-4 (QRI-4);
- The Running Record Taken From An Observational Survey of Early Literacy Achievement;
- Beery-Buktenica Developmental Test of Visual-Motor Integration, 5th Edition (VMI); and,
- Elementary Reading Attitude Survey (ERAS).

The Pilot Study Results

The discussion in the previous chapter focused on presenting the results of the data and interpreting those results. During the pilot study, findings on rate and accuracy indicated that there was an increase in WPM as an immediate effect of using colored overlays. Results showed an effect in the high number of WPM while reading with colored overlays versus without colored overlays, and that reading with colored overlays was more accurate than without colored overlays. Results from the actual study are as follows.

The Screening Results

Screening using the IRPS (Irlen, 2003) indicated that all three participants had SSS/IS with different levels of syndromes. George was an excellent candidate of SSS/IS by scoring 18 points out of 34 possible, considered moderate to high scores in both reading difficulties and reading discomfort. David was a good candidate of SSS/IS by scoring 16 points out of a possible 34, considered moderate to high scores in both reading difficulties and reading discomfort. Charles was an excellent candidate of SSS/IS by scoring 22 points out of 34 possible. These are considered moderate to high scores in both reading difficulties and reading discomfort. George chose double green as his final preferred overlays; he reported moderate to considerable improvement as determined by the IRPS guidelines. David chose double green as his final preferred overlays; he reported slight to moderate improvement. Charles chose single turquoise as his final preferred overlays; he reported considerable improvement.

The Pre and Post Tests Results

The following sections describe the results of the pre and post assessments including data for QRI-4, VMI, and ERAS.

The QRI-4 Pre and Post Tests Results

QRI-4 assessments included measures of oral reading level accuracy, rate (WPM) and comprehension performance (including explicit and implicit comprehension of text). Students read two graded passages out loud with/without colored overlays. The researcher administered the QRI-4 as an oral reading pretest and post test assessment using narrative and expository passages alternately, both with and without color overlays.

Reading accuracy. Accuracy results were inconsistent across the three participants. All three participants performed higher in percentage scores when reading with colored overlays than without. However, these differences were not consistently significant to change the reading performance level. George maintained an instructional level in his accuracy performance in pre- and post tests when using colored overlays across narrative and expository text structures, but his accuracy performance decreased from pre- to post test without colored overlays across text structures. However, with colored overlays, David and Charles did not maintain an instructional level in their accuracy performance nor did they improve in their reading performance level with colored overlays. David 's scores dropped from an instructional level with pretest passages across conditions and across text structure types to a frustration level with post test passages across conditions and across text structure types. Charles was at the frustration level in his accuracy performance across all four of the pre- and post test passages. For all three participants, performance across the passages suggests that the different types of text structure (narrative and expository) did not appear to affect accuracy performance nor did their prior knowledge of the concepts presented in the passages. Comparing pretest to post test scores for reading with colored overlays, George and David had an increase in the number of errors in the post test scores compared to their pretest scores, while Charles showed a decrease in his number of errors with his post test score (though not significant to change his frustration performance).

Reading rate (WPM). All three participants increased their rate when using colored overlays as compared to without colored overlays. When describing the rate

performance in terms of rate grade level performance as determined by common range of rate performance (Leslie & Caldwell, 2006), George and Charles showed a significant change in grade level performance in their rate when using colored overlays as compared to without colored overlays. David did not show a significant grade level change, maintaining a fifth-grade performance across his reading rate. However, David did show an increase in rate when using colored overlays as compared to without. For two of the participants (George and David), their pre- post test scores showed an increase in rate when using colored overlays but a decrease in rate without colored overlays. Charles showed an increase in rate both with and without colored overlays for his post test scores, but had a higher rate with colored overlays than without.

Reading comprehension. Comprehension was assessed in two formats, recall of text and response to specific comprehension questions. Results from the comprehension assessment were inconsistent when comparing recall results with results from the comprehension questions. Recall performance showed no consistent pattern of improvement in comprehension in the pre- and post tests with the use of colored overlays. Results show an increase in recall from pre- to post tests with colored overlays for George (66.6% to 89%) and for Charles (12% to 60.7%) but a decrease in recall for David (39.2% to 37%). George and David show a decrease in their recall performance from pre- to post tests without colored overlays, but Charles showed an increase in recall without colored overlays. When comparing the performance within pretest and post test results (as a form of immediate effect), recall with colored overlays was consistently higher than without colored overlays across all three participants.

Comprehension questions were scored for total score and for explicit and implicit scores. Total scores for the comprehension questions were less conclusive than scores relating to explicit and implicit comprehension. Total score performance with colored overlays on narrative passages was consistently higher than performance without colored overlays on narrative passages for all three participants. However, performance with colored overlays on expository passages was inconsistent, with George scoring the same (instructional) with and without colored overlays, David scoring one level higher with colored overlays (instructional) than without (frustration), and Charles scoring two levels higher with colored overlay (independent) than without (frustration). Across all participants, total comprehension performance with colored overlays was either instructional or independent, but never at the frustration level. Comprehension scores for question type showed a consistent pattern of higher performance for all participants with explicit questions both with and without colored overlays. However, performance in explicit comprehension was inconsistent across the pre- and post tests when using colored overlays. Implicit comprehension consistently showed higher scores with the use of colored overlays for all participants.

Results from reading comprehension questions indicate a more consistent pattern of improvement with the use of colored overlays for all three participants. For George and David, they scored at the instructional level for comprehension with colored overlays, whether the text was narrative or expository and whether the text was familiar or unfamiliar. With colored overlay, Charles scored at the instructional level for the familiar narrative passage and at the independent level for the familiar expository passage. The

familiarity of the text may have played a role in his increased scoring in comprehension. For passages without overlays, George scored at the frustration level for an unfamiliar expository text, but at the instructional level with a familiar narrative text. Both David and Charles scored at the frustration level for both passages (unfamiliar) without overlays, whether they were narrative or expository.

Another possible confounding variable with the passage results is the issue of familiarity of the passage content. George and David scored unfamiliar for three of the four passages, but both scored familiar for their post test narrative passages with colored overlays. However, in the expository pretest passages with colored overlays, both George and David scored unfamiliar with the content but performed higher in rate, recall and responses to comprehension questions than in their unfamiliar post test expository passages, suggesting that unfamiliarity did not make a difference for them. This is less clear for Charles, who scored familiar with passage content and performed significantly higher in comprehension with colored overlays when compared with passages without colored overlays where he had an overall lower performance and also scored unfamiliar with content.

The VMI Pre and Post Tests Results

Results for all students showed that with overlays they decreased their execution times for the VMI test, with the difference ranging from 19 seconds to 44 seconds. Also, with overlays, the errors were fewer than without overlays. In the pretest, George moved from average without overlays to above average with overlays. In the post test, he moved from above average without overlays to high with overlays. For David, in the pretest he

maintained an average level with and without overlays. However, in the post test, David moved from average without overlays to above average with overlays. Charles maintained a score of average with and without overlay in both the pre and post tests, but still improved, making two less mistakes. The results of the VMI assessment suggest that colored overlays help the participants with SSS/IS better identify symbols.

The ERAS Pre and Post Tests Results

The results from the ERAS suggest that the use of colored overlays does positively impact attitude toward academic reading for all three participants. Two participants (George and David) also increased their percentile ranking for recreational reading. George improved overall in his full scale score by 7 points (from 53 to 60) which changed his percentile ranking from 46 to 70. His recreational reading attitude improved by 4 points (from 25 to 29), changing his percentile ranking from 30 to 48. His academic reading attitude improved by 3 points (from 28 to 31), increasing his percentile ranking from 66 to 82. David improved overall in his full scale score by 5 points (from 65 to 70) which changed his percentile ranking from 78 to 89. His recreational reading attitude improved by 2 points (from 33 to 35), changing his percentile ranking from 72 to 84. His academic reading attitude improved by 3 points (from 32 to 35), increasing his percentile ranking from 79 to 90. Charles improved overall in his full scale score by 6 points (from 56 to 62) which changed his percentile ranking from 44 to 64. His recreational reading attitude remained at 30 points, maintaining the same percentile ranking of 51. His academic reading attitude improved by 6 points (from 26 to 32), increasing his percentile ranking from 41 to 74.

The Running Records Assessment Results

Each student in the study also received daily running record assessments. They were assessed using Read Naturally (Ihnot, 1999, levels 1-4) grade-level appropriate passages as determined by school records. These running records documented their reading rate and reading accuracy with and without colored overlays. Each day participants completed two running record assessments. Both passages were read within one setting. During the 3 days of the baseline phase, each participant was given 2 passages for running records assessment, both without colored overlays. During the 10 days of the intervention phase, each participant was given 2 passages for running records assessment, both with and without colored overlays randomly assigned. During the 3 days of the treatment phase, each participant was given 2 passages for running records assessment, both with colored overlays.

The Baseline Phase

George's baseline day one reading rate was 55.5 WPM and 53.3 WPM. His reading accuracy was 90.2% and 89.7%. Day two his reading rate was 72.9 WPM and 37.4 WPM, and his reading accuracy was 91.4% and 89.6%. Day three his reading rate was 53.4 WPM and 46.9 WPM, and his reading accuracy was 91% and 90.1%.

David's baseline day one reading rate was 96 WPM and 83.5 WPM. His reading accuracy was 85.6% and 85.2%. Day two his reading rate was 100.2 WPM and 85.5 WPM, and his reading accuracy was 85.5% and 85%. Day three his reading rate was 97.2 WPM and 82.6 WPM, and his reading accuracy was 87% and 86.8%.

Charles' baseline phase is represented in Table 18. On day one, his reading rate was 38.4 WPM and 19.1 WPM. His reading accuracy was 78.4% and 67.6%. Day two his reading rate was 39.4 WPM and 21.9 WPM, and his reading accuracy was 72.4% and 72.2%. Day three his reading rate was 34.5 WPM and 30.2 WPM, and his reading accuracy was 73.9% and 72%.

The Intervention Phase

George consistently scored higher when reading with colored overlays than without. The highest scores he obtained were during the first day of intervention, scoring 72 WPM and 93% accuracy. The lowest rate performance with colored overlays occurred on day six with 47.1 WPM, and his lowest accuracy score with colored overlays was on day eight with 83%. Day six followed a one week break (due to unexpected school assessments and conferences), and on day eight George had stated that he was not feeling well. Across the ten days of intervention, his reading performance in rate and in accuracy with colored overlays was better than without.

David consistently scored higher when reading with colored overlays than without. The highest scores he obtained were during day five, scoring 107.4 WPM and 89.3% accuracy. The lowest rate performance with colored overlays occurred on day six with 80.2 WPM, and his lowest accuracy score was on day seven with 70.3%. Both days six and seven followed the one week break (due to unexpected school assessments and conferences). Across the ten days of intervention, his reading performance in rate and in accuracy with colored overlays was better than without.

Charles consistently scored higher when reading with colored overlays than without. The highest score he obtained for rate was during day five, scoring 66.4 WPM. His highest accuracy score was during day six, scoring 84.9%. The lowest rate performance with colored overlay occurred on the first day of intervention with 42.2 WPM, and his lowest accuracy score with colored overlay was on day nine with 64.3%. There does not appear to be any noticeable reason for these performances. Across his intervention assessments, his reading performance in rate and in accuracy with colored overlays was better than without.

The Treatment Phase

George's treatment day one reading rate was 46.3 WPM and 45.1 WPM. His reading accuracy was 86.7% (frustration) and 85.8% (frustration). On day two his reading rate was 58.3 WPM and 48 WPM, and his reading accuracy was 95.3% (independent) and 94.4% (instructional). On day three his reading rate was 56.1 WPM and 45.6 WPM, and his reading accuracy was 93.7% (instructional) and 86.1% (frustration).

David's treatment day one reading rate was 81.7 WPM and 78 WPM. His reading accuracy was 88.1% (frustration) and 85.3% (frustration). Day two his reading rate was 93.8 WPM and 85.8 WPM, and his reading accuracy was 88.1% (frustration) and 78.1% (frustration). Day three his reading rate was 76.3 WPM and 73.7 WPM, and his reading accuracy was 86.2% (frustration) and 74.6% (frustration).

Charles' treatment day one reading rate was 46.8 WPM and 46.1 WPM. His reading accuracy was 65% (frustration) and 51% (frustration). Day two his reading rate was 55.5 WPM and 43.1 WPM, and his reading accuracy was 70% (frustration) and 65%

(frustration). On day three his reading rate was 58.8 WPM and 54.5 WPM, and his reading accuracy was 63% (frustration) and 56% (frustration).

Results Summary of the Running Records

Across the intervention running records, the use of colored overlays positively affected the participants in three noticeable ways: through their increase in rate, through their increase in accuracy, and in their ability to make self-corrections. Results from contrasting the running records from baseline and treatment data are inconsistent with the intervention data. For rate, George and David scored higher in rate without colored overlays, while Charles scored better with colored overlays. For accuracy, 50% of the accuracy scores with overlays improved for George and David, while Charles scored higher in accuracy without colored overlays. In self correction, George (100%) and David (83%) consistently improved their use of self correction when using colored overlays while Charles improved 50% of the time in his use of self-correction when using colored overlays.

Summary of the Whole Study Results

Across the various elements of this study, colored overlays were used in various contexts with different assessment to examine the efficacy of their use with students experiencing reading difficulties who were diagnosed with SSS/IS. Results from pre- and post tests and intervention showed inconsistent improvement with the use of colored overlays. The following section reviews the original research questions and the subsequent answers to those questions as supported by the data results.

1. Is there a difference in reading rates and accuracy on a daily basis with identified students reading text without and with colored overlays?

   Yes, there appears to be an immediate positive effect on the use of colored overlays with passages that were read during the intervention phase of this study. The three participants consistently scored higher in rate and in accuracy in their running records performance with colored overlays than without.

2. Is there a difference in reading rate, accuracy and comprehension over one semester with identified students reading text without and with colored overlays?

   No, there does not appear to be a consistent effect on rate, accuracy or comprehension across all three participants as determined by their their pre- and post test data in the QRI-4, as well as their baseline and treatment data from their running records. The data were inconsistent, showing some positive results and some negative results in the use of colored overlays.

3. Is there a difference in visual-motor integration over one semester with identified students reading text without and with colored overlays?

   The answer is a qualified yes. All the participants scored higher with colored overlays than without in their pre- and post tests for VMI. With colored overlays their scores did increase from pre- to post tests. However, the scores without colored overlays increased as well from pre- to post tests. Two of the three participants improved their performance levels with colored overlays, but this was true without colored overlays as well. Performance with colored overlays were at higher levels than without in 10 of the 12 assessments.

4. Is there a difference in attitude towards reading over one semester of using colored overlays with identified students?

   Yes, there was an increase in the three participants' full scale percentile rankings on overall attitude toward reading, and an increase in their percentile rankings on academic reading. There were less conclusive results in their response toward recreational reading, where two of three participants showed some increase in their percentile ranking while one maintained the same score. No participants showed a decrease in their attitude toward reading.

Limitations of the Study

Colored overlays are controversial tools and questions still exist about the efficacy of the overlays as a tool to use when children have reading difficulties. Colored overlays in the present study were used to examine their effect on reading rate, reading accuracy, comprehension, VMI scores, and ERAS percentile rankings for students with SSS/IS, Dyslexia, ADD, and Klinefelter's Syndrome. This section presents the limitations of the present study both in the participation selection and in the dynamics of the data collection site.

- Students participating in the study were limited to those diagnosed with SSS/IS.
- Students in this experiment did not consider reading a pleasurable experience, so their reading with the colored overlays was only intermittent. This was also due to the design of the study, which had the students use colored overlays only during the data-gathering contact time.

- The classroom where the data were gathered was often crowded and had a great amount of noise which, when it occurred, interrupted the target student's ability to read and stay focused on the task.
- Participants were not always available at prearranged meeting times so these meetings had to be rescheduled to ultimately achieve the scheduled sequence of researcher-participant interactions.
- School-based interruptions in the schedule through teacher conferences and holiday celebrations affected the consistency of presentation over time.

Recommendations for Future Research

There are several topic areas in which further research on the use of colored overlays would be especially useful in eventually helping to facilitate educational practice.

While this study showed inconclusive results for the use of colored overlays overall, it would be interesting to replicate this study in an environment controlled for noise and interruptions, increasing the length of the study for using the colored overlays both within the school day and outside the school day. This research should also incorporate a focus on issues of comprehension using authentic text that has been written by authors for a specific audience and purpose, that is visually pleasing and attractive, and that enables participating students to choose texts to read for real purposes that are of interest to them. There are now other colored overlays on the market produced by different companies. This study should be replicated with another brand name of these colored overlays and participant reading performances between companies compared.

Students who have been screened for SSS/IS, and who have chosen colored overlays that are most beneficial for visual perception, should be encouraged to use the colored overlays for independent reading and visual activities. This appears to be especially true for young readers between ages 4 to 8 years old. Further research on using this intervention with younger students should be pursued.

Longitudinal research should be conducted where a student uses colored overlays daily over an extended period of time. This could evaluate long-term effects in reading performance and attitudes toward reading. This could provide a consistent evaluation of the relationship between this intervention and reading performance.

One of the most significant arguments in the literature is that learning-related vision problems should be evaluated by an optometrist/ophthalmologist who provides diagnostic and management services in this area (Solan, Ficarra, Brannan, & Rucker, 1998; Eperjesi, Fowler & Evans, 2002). For further research, it would be interesting if an educational researcher investigating the use of colored overlays worked in partnership with a clinical ophthalmologist to research data on students while they are using the overlays.

Considering that this treatment is based upon color, its effectiveness with colorblind students could provide insight into how treatment actually affects the perception process. It could also provide additional information into the characteristics of colorblindness.

Educators need to have a clearer picture of the effects of this intervention on students who have both SSS/IS and identified learning disabilities. Formal research

should be done in this area that will include observations of students' reading and actions in a classroom setting.

While there is some quantitative research on the use of colored overlays, there is a need for empirical evidence to show the efficacy of using colored overlays both in a clinical setting and in the classroom. There is also a need for additional qualitative studies that integrate both qualitative and quantitative research to examine the viability of alternative forms of reading instruction intervention such as colored overlays on classroom practice. Such qualitative studies should examine the efficacy of colored overlays through case study observations of targeted children's actions and interactions with text over time, classroom observations of teaching with colored overlays, and studies examining the family reactions and follow up to the use of colored overlays over an extended period of time.

The final recommendation for future research is to focus more on the reason for variance in reading rate (WPM). The present study demonstrated a great variation in reading performances. Further research should focus on why changes happened, how to avoid problems, and what effect colored overlays may or may not have on these factors.

Conclusion

While this study showed inconsistent and mixed results for the use of colored overlays, there were some interesting positive effects in the area of attitude toward reading and in immediate effects on rate and accuracy. Results were inconclusive on the long term effects of the use of colored overlays over time. The lack of consistent results

in this study suggests that there is not a clear clinical significance for the use of colored overlays.

Many questions remain concerning SSS/IS as an educational issue worthy of serious consideration. It would be helpful if school administrators would investigate ways of including SSS/IS screening in a series of tests and devote long-term effort to research. Although using colored overlays to improve academic performance remains controversial, and has included criticism from the optometric, ophthalmologic, education, and legal communities, there have been some positive results with use of colored overlays among children with known reading delays both in the current study as well as other published studies (Christenson, Griffin & Taylor, 2001; Solman, Cho & Dain, 1991; and Wilkins, & Wilkinson 1991).

The results of the present study were unable to show clear evidence of the impact of colored overlays overtime, nor of the consistency of the use of colored overlays on overall reading improvement. However, the three unique students with learning disabilities who participated in this study did respond positively to colored overlays in their own personal responses and reactions to their use. This included the immediate effects on rate and accuracy, their performance on implicit comprehension, in their response with visual-motor integration, and in their attitude toward reading. If colored overlays are to be considered as an effective part of an instructional program, much more research is needed to show the efficacy of their use.

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APPENDIX A

PARENTAL CONSENT FORM FOR SCREENING AND RESEARCH

PARENTAL CONSENT FORM FOR SCREENING AND RESEARCH

School: The Malcolm Price Laboratory School
Date: 8/26/2008

Dear Parent:

Many individuals with reading problems have difficulty reading or are inefficient readers who skip lines and lose their place or have poor comprehension. Many of these individuals have visual perceptual problems that account for these reading difficulties. This problem is called Irlen Syndrome/Scotopic Sensitivity Syndrome (SSS). Individuals with SSS see distortions on the printed page which can cause strain, fatigue, a slow reading rate, and poor reading comprehension. These perceptual problems can be reduced or eliminated through the Irlen Method. This reading-based assessment determines the best colored plastic overlay to be used over reading material. This is one strategy among many to help individuals overcome reading problems. Many children and adults have found rapid and significant help through the use of colored overlays when they read.

Your child has the opportunity to be screened for SSS with your written permission. Please sign the form below and return it to the school. If you have any questions, please contact:
Name: Hanan Ali Bagabas
Phone Number: 319 2660144
Email: hbagabas@uni.edu
Mailing Address:
3902 heritage RD
Cedar Falls, IA 50613

Please return this portion to your child's teacher by_____

I give permission for_____(Student's Name) to be screened by a trained Irlen Screener at the school to determine whether this student has symptoms of Irlen Syndrome/Scotopic Sensitivity Syndrome. I understand that the school will provide colored overlays if my child has symptoms of SSS. I also agree that any further diagnostic testing or remediation (including tinted glasses) that I wish to have completed will be at my own discretion and expense.
Information from this testing may be used for research purposes. Only the researcher will be allowed to view this information, and all personal information will be kept confidential.

By signing below, I understand that information from my child's screening may be used for research purposes, and I give my permission to use it for this purpose.

Signature of Parent_____ Date_____

APPENDIX B

PARENTAL PERMISSION TO CONDUCT RESEARCH

PARENTAL CONSENT FORM TO CONDUCT RESEARCH

Price Lab School has agreed that Hanan Ali Bagabas may screen your child for Irlen Syndrome/Scotopic Sensitivity Syndrome, a perceptual processing deficit that may be affecting your child's ability to succeed in reading and other visually intensive activities. Irlen Syndrome is corrected with the use of colored overlays/filters. If your child is identified as having Irlen Syndrome, s/he will be given a colored overlay to use during all reading activities at school and home.
Hanan Ali Bagabas is a doctoral student at the University of Northern Iowa and part of her dissertation research is conducting a study to determine the relationship between colored overlays and improvements in your child's reading ability. Your child will be given a standardized test to determine his/her reading ability before using the overlays and then again after two months of working with the overlays at school. Your child's scores on these tests will be used for research purposes only and will not be released to his/her teacher or school. Your child may be audio-recorded to aid the researcher.

Participation in this study is voluntary. Deciding whether or not to allow your child to participate will not adversely affect your child's relationship with his/her teacher or school.

All information will remain confidential. To protect your child's anonymity, your child will be given an ID number at the start of this project, and only this ID number will be used to label his/her standardized tests. These standardized test scores will be used for research purposes only and will be discarded five years after the final report is completed.

You can choose whether you would like your child to take part in this project. If you volunteer your child, you may withdraw her/him at any time. If you have any questions or concerns about the research, please contact:
Name: Hanan Ali Bagabas
Phone Number: 3192660144
Email: hbagabas@uni.edu
Mailing Address:
3902 Heritage RD
Cedar Falls, IA 50613

You are not waiving any legal claims, rights, or remedies because of your participation in this project.

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to let my child participate in this study.

Name of Child_____ Name of Parent_____
Signature of Parent _____ Date_____

APPENDIX C

STUDENTS CONSENT FORM FOR SCREENING AND RESEARCH

STUDENTS CONSENT FORM FOR SCREENING AND RESEARCH

University of Northern Iowa

Research Title: The Effectiveness of Colored Overlays on Reading Achievement and Attitude toward Reading

Principal Investigator: Hanan Ali Bagabas

I, _____, know that Mrs. Bagabas will be involving us in 6 weeks screening and testing our reading. This is something that some students will be doing as part of what we are learning in class. I also know that Mrs. Bagabas plans to do some research about reading which will involve examining information about us and how well we are reading with and without the fitting colored overlay. She hopes to use this research to help students learn more to read better.

I agree that it will be OK for Mrs. Bagabas to examine this information about me for her research. My mom, dad, or the person who takes care of me has said it is alright for me to take part in this research. They have told me that it is okay to be screened, and examined by Mrs. Bagabas.

I am doing this because I want to. I have been told that I can stop taking part in the data gathering activity at any time. If I ask to stop of decide I don't want to do this activity at all, nothing bad will happen to me.

Yes, I DO want to take a part in Mrs. Bagabas research:

Signature_____Date_____

No, I DO want to take a part in Mrs. Bagabas research:

Signature_____Date_____

APPENDIX D

THE IRLEN READING PERCEPTUAL SCALE (IRPS)

Irlen® Reading Perceptual Scale (IRPS)

By Helen L. Irlen

Name _____ Sex: M❑ F❑ Age____ Phone No. _____

Address _____ City _____ State ____ Zip _____

Grade_____ Examiner _____ Tele.# _____ Reading Rx Yes No

Reason for Evaluation _____ Testing Date _____

PROFILE SHEET

	N/A	SLIGHT	MODERATE	SEVERE
SECTION 1				
Reading Difficulties	0	1 2 3	4 5 6 7	8 9 10 11 12 13 14 15 16 17
Reading Discomfort	0	1 2 3	4 5 6 7	8 9 10 11 12 13 14 15 16 17

SECTION 2

Box A
Box B
Pumpkin
Penguin
Musical Lines

Black: jiggle dance move blurry 3D close in change crooked wave cross disappear

White: stands out brighter dimmer colours flicker flash sparkle glow glare

Physical Symptoms:

Span of Recognition	0	1 2 3	4 5 6 7 8	9 10 11 12
Pointing Task	0	1 2 3	4 5 6	7 8 9 10 11 12 13 14 15 16 17

SECTION 3

Overlay Colour(s) _____ Glare/Non Glare Parent _____ (G/NG)

White Page	Amount of Improvement with Overlay			
Bright/Glary	N/A	Slight	Moderate	Considerable
Uncomfortable	N/A	Slight	Moderate	Considerable
Blurry	N/A	Slight	Moderate	Considerable
Moving	N/A	Slight	Moderate	Considerable
Poor Spacing	N/A	Slight	Moderate	Considerable
Other Distortions		Slight	Moderate	Considerable
		Slight	Moderate	Considerable
Slow & Hesitant	N/A	Slight	Moderate	Considerable
Error Rate	N/A	Slight	Moderate	Considerable
Strain & Fatigue	N/A	Slight	Moderate	Considerable
Short Attention Span	N/A	Slight	Moderate	Considerable
Weak Comprehension	N/A	Slight	Moderate	Considerable

SECTION 4

Distortion Page(s) _____

Comments _____

APPENDIX E

RUNNING RECORD FORM

RUNNING RECORD SHEET

Name: _____ Date: _____ D. of B.: _____ Age: _____yrs ____mths

School: _____ Recorder: _____

Text Titles	Running words / Error	Error rate	Accuracy	Self-correction rate
1. Easy _____	_____	1: _____	_____ %	1: _____
2. Instructional _____	_____	1: _____	_____ %	1: _____
3. Hard _____	_____	1: _____	_____ %	1: _____

Directional movement _____

Analysis of Errors and Self-corrections
Information used or neglected [Meaning(M) Structure or Syntax(S) Visual(V)]

Easy _____

Instructional _____

_____

Hard _____

_____

Cross-checking on information (Note that this behavior changes over time)

_____

_____

Analysis of Errors and Self-corrections
(see *Observation Survey* pages 30-32)

Page		E	SC	Information used	
				E MSV	SC MSV

APPENDIX F

BEERY-BUKTENICA DEVELOPMENTAL TEST OF VISUAL- MOTOR INTEGRATION (VMI)

The Beery™ VMI Developmental Test of Visual Perception

Visual Perception

Fifth Edition

by Keith E. and Natasha A. Beery

Ages 2 through 18

TURN

Name: _____ Sex: ○ F ❑ M
Last First

School: _____ Grade: _____

Examiner: _____

Test Date: ____ year ____ month ____ day

Birth Date: ____ year ____ month ____ day

Chronological Age: ____ years ____ months

(Count more than 15 days as one month.)

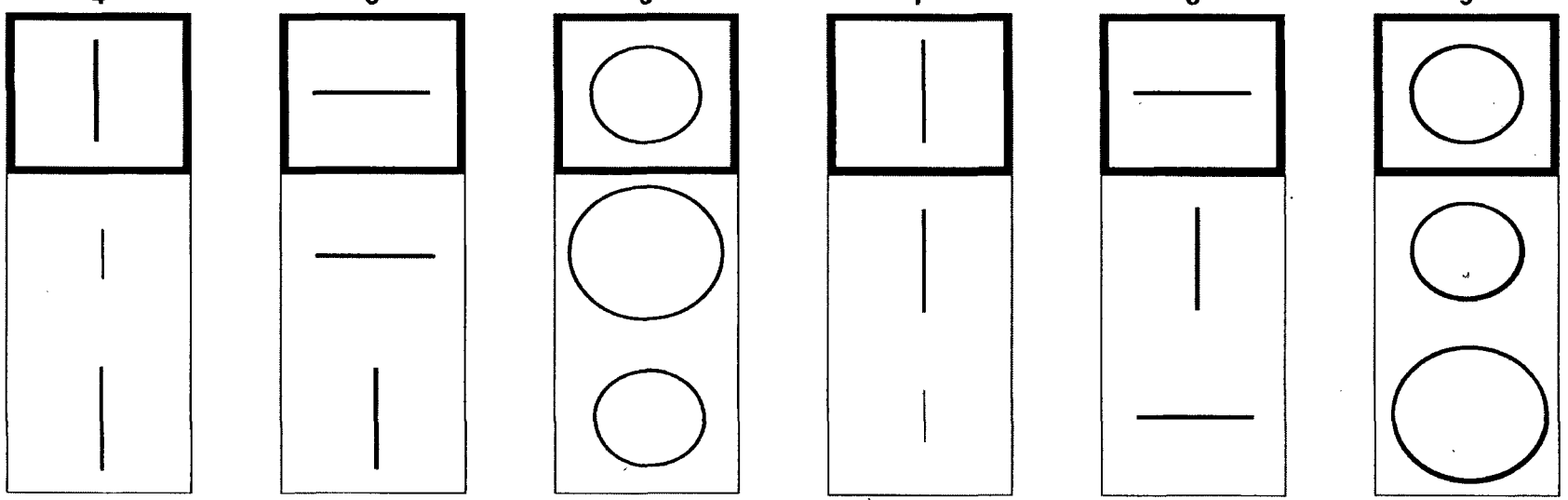
Task 1. Points to one body part on self when asked: __ eye __ hair __ ear
Task 2. Points to at least 2 of 3 outline pictures: __ cat __ dog __ pig
Task 3. Points to 6 of 8 pictured body parts when asked:
__ hair __ nose __ ear __ foot __ mouth __ hand __ tummy __ eye

Visual Perception Raw Score: _____ (Also enter on the front of the Beery VMI test booklet.)

See the Beery VMI manual (fifth edition) for administration and scoring instructions.

Start timing here.

4 5 6 7 8 9



Product Number
46218/46219

APPENDIX G

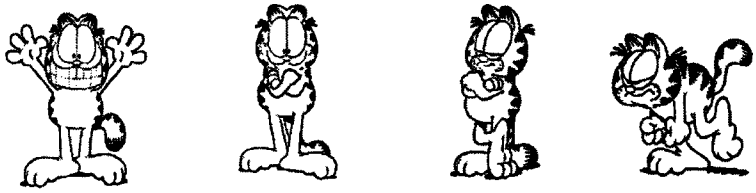
ELEMENTARY READING ATTITUDE SURVEY (ERAS)

Elementary Reading Attitude Survey

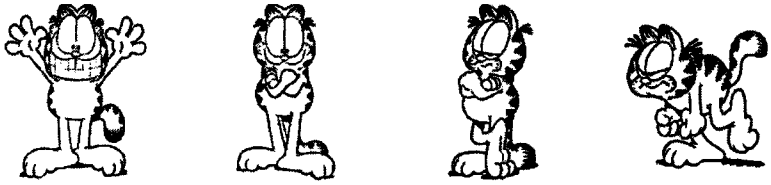
School_____ Grade_____ Name_____

Please circle the picture that describes how you feel when you read a book.

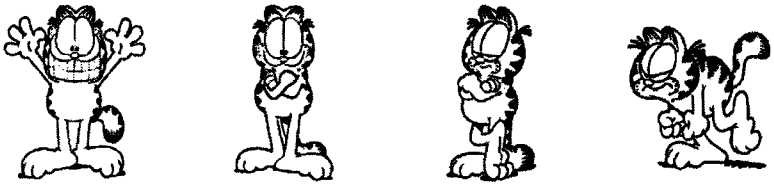
1. How do you feel when you read a book on a rainy Saturday?



2. How do you feel when you read a book in school during free time?



3. How do you feel about reading for fun at home?



4. How do you feel about getting a book for a present?