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**TEACHING AND LEARNING
RESEARCH EXCHANGE**

The Efficacy of
Vision Therapy in the
Kindergarten Setting

Louise McCulloch
Judy Richards
Dr. Barbara Patterson

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Research Coordinator
Dr. Stirling McDowell Foundation
2317 Arlington Avenue
Saskatoon SK S7J 2H8
Telephone: 1-800-667-7762 or (306) 373-1660

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Introduction: Studying the Elephant Thoroughly

THE STORY OF THE BLIND MICE AND THE ELEPHANT

In the farthest reaches of the desert there was a city in which all the mice were blind. A king and his army were passing through that region, and camped outside the city. The king had with him a great elephant, which he used for heavy work. The mice of the city had heard of elephants, but never had the opportunity to know one. Out rushed 6 young mice, determined to discover what the elephant was like.

The first young mouse, in his haste, ran straight into the side of the elephant. He spread out his arms and felt the animal's broad, smooth side. He sniffed the air, and thought, "This is an animal, my nose leaves no doubt of that, but this animal is like a wall." He rushed back to the city to tell of his discovery.

The second young blind mouse, feeling through the air, grasped the elephant's trunk. The elephant was surprised by this, and snorted loudly. The young mouse, startled in turn, exclaimed, "This elephant is like a snake, but it is so huge that its hot breath makes a snorting sound." He turned to run back to the city and tell his tale.

The third young blind mouse walked into the elephant's tusk. He felt the hard, smooth ivory surface of the tusk, listened as it scraped through the sand, then as the elephant lifted the tusk out, he could feel its pointed tip. "How wonderful!" he thought. "The elephant is hard and sharp like a spear, and yet it makes noises and smells like an animal!" Off he ran.

The fourth young blind mouse reached low with his hands, and found one of the elephant's legs. He reached around and hugged it, feeling its rough skin. Just then, the elephant stomped that foot, and the mouse let go. "No wonder this elephant frightens the king's enemies," he thought. "It is like a tree trunk or a mighty column, yet it bends, is very strong, and strikes the ground with great force." Feeling a little frightened himself, he fled back to the city.

The fifth young blind mouse ran up the elephant's tail. "I don't see what all the excitement is about," he said. "The elephant is nothing but a frayed bit of rope." He ran down the tail and ran after the others.

The sixth young blind mouse was in a hurry, not wanting to be left behind. He heard and felt the air as it was pushed by the elephant's flapping ear; then grasped the ear itself and felt its thin roughness. He laughed with delight. "This wonderful elephant is like a living fan." And, like the others, he was satisfied with his quick first impression and headed back to the city.

But finally, an old blind mouse came. He had left the city, walking in his usual slow way, content to take his time and study the elephant thoroughly. He walked all around the elephant, touching every part of it, smelling it, listening to all of its sounds. He found the elephant's mouth and offered the animal a treat, then petted it on its

great trunk. Finally he returned to the city, only to find it in an uproar. Each of the six young mice had acquired followers who eagerly heard his story. But then, as the people found that there were six different contradictory descriptions, they all began to argue. The old mouse quietly listened to the fighting. "It's like a wall!" "No, it's like a snake!" "No, it's like a spear!" "No, it's like a tree!" "No, it's like a rope!" "No, it's like a fan!"

The old mouse turned and went home, laughing as he remembered his own foolishness as a young mouse. Like these, he once hastily concluded that he understood the whole of something when he had experienced only a part. He laughed again as he remembered his greater foolishness of once being unwilling to discover truth for himself, depending wholly on others' teachings. But he laughed hardest of all as he realized that he had become the only one in the city who did not know what an elephant is like.

[T]his story comments on the folly of attempting to use the physical senses and logic to comprehend spiritual matters. The blind men thus can be seen as representing our physical senses and logical tendencies."

(Strang, 2006)

Knowing in part may make a fine tale, but wisdom comes from seeing the whole.
(Young, 1992)

APPROACHING THE ELEPHANT

Educators, like mice, are curious. The researchers had been presented with the idea that visual efficiency skills might be contributing to reading problems and vision therapy could be a possible remediation tool to improve reading capabilities in students. Although Speech/Language and Fine Motor abilities were being assessed in Kindergarten, visual efficiency skills were not. The researchers set out to explore visual efficiency skills and vision therapy, sometimes feeling like blind mice, but in the end discovering there is more to the elephant than meets the eye.

Learning in Kindergarten is based on experiencing and exploring the school environment as well as learning pre-reading skills, such as basic phonemic awareness, alphabet and number recognition, fine motor coordination, and oral language comprehension all of which depend on primarily visual efficiency skills. In reflecting on this research project, both the Kindergarten teacher and Special Education teacher felt like blind mice trying to learn about and describe an elephant. We had to learn much about how the eye works and how all people learn to use their eyes accurately to read. We had to familiarize ourselves enough with the language of optometrists and ophthalmologists in order to read and critique the articles, as well as to understand the history of vision therapy and recognize the controversy within it. We were educators, not experts in eye efficiency or inhabitants of the medical realm, yet we wanted to understand and know in order to improve our students' ability to acquire the reading process.

Dr. Barbara Patterson of Atrium Optometric Group (Saskatoon, Saskatchewan) was our partner in this research study. Dr. Patterson had made a presentation to the Learning Disabilities Working Committee (at the time a committee represented by five school divisions) concerning visual efficiency skills and their importance in the

reading process. She acted as a liaison and interpreter in the world of visual efficiency skills. Dr. Patterson was exploring ways that educators could liaise with optometrists to improve service delivery to children. Optometrists do not have the time or means to screen all children, and they are finding inconsistent results in home practice sessions. Dr. Patterson hypothesized that the school might be the best place to screen and provide consistent remediation for children with visual efficiency problems. It is school-based vision therapy with children that our research was designed to explore.

Three representatives on the Learning Disabilities Working Committee volunteered to complete the Literature review: Marilyn Stehr, Arlene Pederson and Louise McCulloch.

Our primary goal was to consider vision therapy from a fresh viewpoint, one focusing on education and best practice, and to be as objective as possible. We began with a review of the literature and soon found that although we learned a great deal, only part of our learning came from what the research had to say. (Mrs. Pederson and Mrs. Stehr worked only on the Literature Review – not the research.)

We initially decided to look at only quantitative studies that emphasized vision therapy on children or in the school setting. We also wanted to target recent studies, i.e., those written from 1985 to the present. However, we found it difficult to obtain articles for the literature review. Many of the articles concerning school children with reading problems did not use the same descriptors or descriptions that are used in the world of education. Also, although we started out trying to conduct research that was quantitative in nature, we soon found that the answers to questions about best practices are not always found in quantitative studies. A truly quantitative experimental design was almost impossible to achieve in a school setting.

It took over a year to collect the articles for review. We consulted the Medical Sciences research librarian at the University of Saskatchewan, but she had never heard of vision therapy, and many of the journals cited in the abstracts or identified through online search engines were not in the stacks. We ended up spending several hours online to various medical data bases and were able to get several articles through the Canadian Institute for Scientific and Technical Information (CISTI).

We obtained useful vocabulary, historical data, and information on the mechanics of the eye and eye function through two optometric textbooks. A recently published article in an optometrists' journal (Vidyasagar, 2004) provided new information on eye function, as identified with brain scans. We found that optometrists were more than happy to donate abstracts of various published research articles, but many were not pertinent to school settings, and many were available in abstract only – meaning we could not get a hold of the original article.

To get the ophthalmologist point of view, we approached the University of Saskatchewan Ophthalmology Department and received some articles directly from the professors. At least three of these articles were too old for our study. Moreover, they were not quantitative in nature but merely statements of policy. In a final search for information, we e-mailed a form letter to several of the major ophthalmology departments around the world describing our study and requesting any published or unpublished research on the topic of vision therapy. In response, we received a strong quantitative joint study from Israel, and we also started a

dialogue with a British researcher who had just finished a review of vision therapy for the Royal College of Ophthalmologists.

In the end, we chose twenty-six articles on vision therapy that were of worth from both the optometrist's and ophthalmologist's point of view. We had come to realize that these groups are engaged in what appears to be a research war over vision therapy. Many of the articles and emails that we read from both optometrists and ophthalmologist were quite visceral in their language and presentation, using large print and exclamation marks to make their points. As optometrists stated adamantly that vision therapy was good practice, ophthalmologists were equally strong in their statements against it.

When vision therapy was first researched by optometrists, ophthalmologists published many critiques of their research that dismissed it as a form of therapy for improving reading skills. Since then the optometrists have based further research on those criticisms, trying to be more quantitative in their research approach. They have also countered the criticisms with the charge that ophthalmologists are afraid of losing business to the optometrists. The ophthalmologists are now stating that optometrists will lose their credibility as professionals if they pursue vision therapy.

An e-mail from Dr. Bruce Evans of the British Ophthalmology Association cleared up much of the controversy for us. He explained that there are two kinds of vision therapy, and often both optometrists and ophthalmologists around the world confuse them. The fact that both groups use different language for describing treatments and therapies also tends to cause confusion.

- The first kind of vision therapy dates back to the origins of optometrics. Orthoptic vision therapy is used to treat weaknesses in eye co-ordination (e.g., decompensated heterophoria) and weaknesses of the focusing muscle (accommodation). These problems are more common than usual in children with learning difficulties. Orthoptic vision therapy corrects accommodative (focusing) problems, convergence dysfunctions (double vision), refractive errors (thus avoiding the need for glasses), vergence amplitudes (to bring eyes into alignment), strabismus (eye misalignment caused by muscle imbalance – don't point at same object together), and amblyopia (lazy eye – eyes do not focus equally or maintain proper alignment).
- The second kind of vision therapy is Behavioural Vision Therapy (BVT). BVT strives to correct eye-hand coordination. It works to improve visual processing skills, learning efficiency, and visual-motor integration. As well, BVT provides remediation related to those skills tested through the *Test of Visual Perception Skills (TVPS)*: discrimination, form constancy, form closure, figure/ground, spatial relations, visual memory and sequential memory skills. BVT uses a variety of trampoline, balance beam, and motor-visual input exercises to promote integration of eye-hand skills.

Behavioural vision therapies were first postulated by Skeffington (Jennings, 2000) who believed that visual perceptual motor abilities influenced cognitive and adaptive skills, such as reading, writing, and other activities of daily life. Dr. Patterson has pointed out that vision therapy branches into three areas: Orthoptics (or VE), the Behavioural (often referred to as VIP), and a third model that integrates both of the first two branches and includes motor skills.

Jennings (2000), a member of the Royal College of Ophthalmologists, has suggested that there is only one good experimental design that all vision therapy researchers should follow:

Rigorous proof of the effectiveness of a therapy requires a randomized, double masked, placebo controlled experimental design in which subjects are randomly allocated to either the treatment or the control group and neither the subject nor the investigator knows who is being given the active treatment. The “treatment” given to the control group must be known to be harmless and ineffectual but not less convincing and impressive to the patient than the therapy being evaluated. (p. 20)

Jennings (2000) further states that few such studies exist because clinicians are uncomfortable about depriving the control group, which usually consists of children in school, of the treatment. Patients are often unwilling to become involved in trials when informed they are in the control group. Parents, also, are unwilling to give their consent for research participation knowing their child might be in the control group, or in a treatment group receiving a placebo.

We concluded that the type of randomization required by Jennings is nearly impossible to achieve in a normal school setting. It is difficult to respect confidentiality of the information being gathered in this setting, and it is also difficult to truly randomize equally, notwithstanding the search for a placebo that is “harmless and ineffectual but not less convincing and impressive”. There are too many variables flying around in a classroom, many of which cannot be controlled. However, in the Kindergarten setting the researchers could control the one variable of vision therapy more confidently than other grade levels. Kindergarten is the first step in formal direct teaching of the reading process. Therefore, the earlier visual efficiency skills are assessed and remediated for reading the better for the student. Although we strove in our literature review to find studies that used Jennings’ experimental design, we did not find one completely randomized, placebo controlled, double masked study published by either optometrists or ophthalmologists. Some studies came close to meeting these criteria, but either they did not randomize or they did not use a placebo.

Literature Review: The Seven Blind Mice

(SEE APPENDIX A FOR DEFINITIONS OF VT WORDS)

WHAT IS VISION THERAPY? THE FIRST BLIND MOUSE RUNNING IN HASTE

The American Optometric Association Special Report (1988, p. 346):

Vision therapy (also called vision training, orthoptics, eye training, and eye exercises) is a clinical approach for correcting and ameliorating the effects of eye movement disorders, non-strabismic binocular dysfunctions, focusing disorders, strabismus, amblyopia, nystagmus, and certain visual perceptual (information processing) disorders.

Vision therapy involves non-surgical therapeutic procedures designed to modify visual function. It involves a series of exercises, or the use of optical instruments to guide and train the eye to perform optimally. Sometimes computer programs are used in testing and remediation as part of vision therapy. Vision therapy is not used simply to strengthen eye muscles, but to treat functional deficiencies so the patient can have “optimal efficiency and comfort” (p. 95). Since 1988 the American Optometric Association (2002) has supported the efficacy of vision therapy “in modifying and improving oculomotor, accommodative, and binocular system disorders” (p. 101). All vision therapy vocabulary is identified and explained in Appendix A.

HOW DO WE READ? THE SECOND BLIND MOUSE GRABBING THE TRUNK

The advent of Positron Emission Tomography (PET scans) and Magnetic Resonance Imaging (MRI's) have allowed vision researchers to map the movements of the eye during reading and to determine more accurately where some vision problems in reading are occurring. During reading the eyes make a series of movements, called saccades, with intervening fixations on each letter. During a fixation, the information on the letter is processed and peripheral information, such as word length, is used to direct the successive eye movements. A saccadic movement consists of small rapid jumps to the right of two to four degrees, and across each line. A larger saccade of ten degrees occurs as the return sweep to the beginning of the next line. A letter or word must be in the range of the fixation for cortical processing to occur. It does not occur during a jump. Vision is clear during fixations, but blurry during the jump for approximately 50 milliseconds before and after the saccade. The brain integrates spatially and temporally units of visual information obtained during fixations across saccades to form continuous visual perception. The brain, therefore, compensates and extrapolates to give us the illusion of the “sweep” of reading. As a result, as Dr. Patterson has explained this process to us, we do not view our world like a poorly recorded video. If these pathways are not functioning properly, however, there are indications, e.g., the page or print swirls with eye movements.

In summary, eye movements during reading are controlled by saccades and fixations, two sequential, independent, parallel processes that determine the timing and location of eye movements during reading. Vidyasagar (2004) suggests we need to think of the eye, when it is reading, as an “attentional spotlight” with landing sites and launch sites. Information can only be processed during landing (fixation). We need “optimal landing position” in text reading, but it is not needed as much in reading individual words, such as those on word cards. Vidyasagar (2000) states that to be successful in reading, the brain needs to develop a “reading rhythm”, in which we are launching from the beginning of one word, processing through each letter, jumping to the next word, and landing on the beginning letter of that word, all smoothly and automatically.

It is important to clarify a difference in definition between educators and optometrists and ophthalmologists when it comes to the term “dyslexic”. Ophthalmologist research provided for this study tended to describe dyslexia as any kind of reading problem. In education, dyslexia is a particular condition defined by the International Dyslexia Association (2005):

Dyslexia is a specific learning disability that is neurological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. (p. 1)

In accordance with this second definition, research on developing readers with problems in reading has focused on what is going wrong with eye processes, i.e., it examines whether or not the eyes are accurately launching and landing when reading takes place. It is extremely important to note that in education, there are multitudinous reasons why a student might be having difficulty learning to read, and only one of those reasons might involve a diagnosis of dyslexia. However, every student must be able to scan a line of print from left to right, and accurately identify the letter sounds in order to read efficiently or fluently.

Vidyasagar confirmed that it requires more effort for the eye to learn to read, than it does to engage in reading once efficient reading is established. Skilled readers make fewer fixations and regressions (going back over the word), and they make more brief fixations than poor readers. Skilled readers regress only to correct misreading or verify semantics. Poor readers have varied saccadic eye movements, and unorganized fixation strategies. Poor readers have difficulty in using their attentional spotlight, and launching or landing at the correct point in the word.

Vidyasagar, using the educationally accepted definition of dyslexia, found dyslexics tended to read peripherally to the right (4.5 degrees), with longer fixations, shorter saccades, and more fixations per line. He also proposes evidence that difficulty in reading causes abnormal eye movements. For instance, Vidyasagar’s research indicated dyslexics have difficulty with diffusion of attention. When looking at a letter, dyslexics tend to have eye movements that move away from the letter like a ripple in a pond rather than scanning smoothly from left to right. Dyslexics have a type of unilateral left-sided neglect due to right cortical dysfunction. They tend to scan to the right and are over-distracted by stimuli to the right of the visual hemi-field (Vidyasagar, 2004).

To summarize, all problem readers often have difficulty visually landing accurately on the left, long enough to process the information and subsequently send that information to the brain. It has also occurred to the researchers that, if a reader needs more time in visual landing to process the information being read, then short-term visual memory is also a factor in developing accurate and smooth reading. Vidyasagar's PET scans found that dyslexics tended to radiate visually outward on all sides rather than scan from left to right. It was shown in many of the articles in the literature review that dyslexics tend to scan to right rather than land on the first letter to the left, and then scanning right.

THE HISTORY OF VISION THERAPY: THE THIRD BLIND MOUSE AND THE IVORY TUSK

In the latter half of the nineteenth century, the practice of orthoptics was started by the French ophthalmologist, Javal, who was seeking a non-invasive way of treating strabismus. Orthoptics means "straightening of the visual axes" aimed at strabismus, the first sign that vision is not working properly. In 1852 du Bois Reymond, and in 1854 MacKenzie of France, also worked on orthoptics. Still, it was Javal who formulated the sequential steps and procedures involved. In 1896 the British ophthalmologist, Priestly Smith, visited Javal and took his methods to England. Dr. Claud Worth, another ophthalmologist, expanded and invented the amblyoscope to assist sensory fusion training procedures. Worth recognized that in most forms of eye muscle imbalance, therapy does not address weak muscles but boosts signals to the muscles.

In 1904 Valk, an ophthalmologic surgeon at Manhattan Eye and Ear Hospital, suggested orthoptic treatment should be tried before surgery to treat vision problems. In 1912 Dr. David Wells, ophthalmologist at Boston University Medical School wrote the first textbook on stereoscopic eye exercises. In 1928 A. M. Skeffington wrote a monograph on "*Procedure in Ocular Examination*" (Press, 1996, p. 3), which was used in a landmark textbook by R. H. Peckham. In the late 1920's the Congress of Optometry, based on the work of Skeffington with the Optometric Extension Program (OEP), published a series of papers under OEP that became the first published journal on vision therapy. In the 1920's and 1930's there were many collaborative efforts involving Skeffington, and many papers published through the OEP. In 1940 the first Visual Training Conference was held in St. Louis, at which information was shared with other ophthalmologists. In 1937 the British Orthoptic Society was formed. In 1938 the American Orthoptic Council started the formal education and certification of orthoptists, usually in hospital settings. In the 1940's there were many records of young men trying to enlist in the army, failing the vision test, and receiving aid from optometrists in the form of visual efficiency exercises.

In the 1940's and 1950's Fred Brock pioneered the training of persons with strabismus, using out-of-instrument training, i.e., no stereoscopes or amblyoscopes were used. This treatment was used more often with large phorias and insufficient vergences. In some cases of training strabismus, you induce diplopia; in children, suppression serves a viable function. Also, at this time vision therapy with children was started, especially through the Gesell Institute of Child Development in the U.S. In the 1950's and 1960's there was a further movement of patients to optometrists who provided vision training. There was also an explosion of professional literature on vision training during these years. Moreover, the manufacture of instrumentation for vision training, which aided in the dissemination of procedures and techniques, was started by Bernell Corporation, Keystone Company, and home vision therapy activities by Bernard Vodnoy.

In the late 1960's, in education, the public and professionals were interested in a unified model for working with children, especially in areas of sensori-motor and perceptual-motor development. At this time, educators received perceptuo-motor remediation called the Frostig Program, which closely resembled visual training activities. As educators found that the Frostig Program failed to deliver widespread changes in student performance, they began to dismiss vision therapy.

In the 1960's and 1970's came occupational therapy and the model of intersensory integration, and it was then that visual training or visual therapy gained ground. It fit with the multidisciplinary and interdisciplinary care model. In the 1970's the process of certifying clinical expertise in vision therapy was started by the College of Optometrists in Vision Development, and the American Academy of Optometry. Also, residency programs were found in colleges in New York and Pennsylvania. The *Journal of Optometric Vision Development* became the official publication of the College of Optometrists in Vision Development in the 1970's.

The 1980's and 1990's saw the advent of computer-generated vision therapy activities, and more specific instruments and techniques.

Even though vision therapy began with an ophthalmologist, as the theories of behavioural vision training evolved through the work of Skeffington in the 1960's, ophthalmologists started to publish policy statements and papers that opposed vision therapy. They saw the behavioural aspects of vision therapy as copying occupational therapist routines, and they stated that behavioural vision therapy had no strong quantitative research base.

However, in 1993 the editor of the *Binocular Vision and Eye Muscle Surgery Quarterly* (Romano, 1993) completed a survey of the members of the American Association for Pediatric Ophthalmology and Strabismus and the International Strabismological Association. Romano (1993) found that 64% of American doctors, and 85% of international doctors, recommended using vision therapy before surgery. Romano speculated that there were three reasons for the difference between the views of U.S. and international ophthalmologists: 1) insurance companies outside the U.S. do not compensate for eye muscle surgery as well as they do in the U.S., 2) U.S. surgeons do not get the same fee for orthoptic treatment as they do for surgery, and 3) surgeons may be reluctant to administer orthoptics and reluctant to send patients elsewhere to get the treatment. As Dr. Patterson has suggested to us, surgery is a quick fix while therapy is extremely time consuming, labour intensive, and demanding in that it requires the cooperation of both child and parent to complete the home activities. Results in therapy can be slow.

THOSE IN FAVOUR: THE FOURTH BLIND MOUSE FEARS BEING STOMPED ON

The research that promotes vision therapy is supported by mostly optometrists, although we found at least two supportive studies by ophthalmologists.

Swanson (1972) surveyed optometrists and gathered 100 cases of learning disorders that were treated with vision therapy. In them, students were given twelve one-hour vision therapy sessions. Swanson claimed that in 93% of the cases, the treatment was successful, and the success was verified by subsequent tests

and by parents or teachers in the form of a personal communication or improved report card.

Cohen (1988), who stated that the goal of vision therapy is to eliminate visual problems and reduce the frequency and severity of symptoms, completed a large review of vision therapy literature. His opinion was that the research provided sufficient scientific evidence for the efficacy of vision therapy in modifying and improving oculomotor, accommodative, and binocular system disorders.

Christenson, Griffin and Wesson (1990) also published a literature review that found at least two broad areas of vision which impact reading. The first area was visual efficiency skills, including binocular, accommodative, and oculomotor efficiency. The second area was visual perceptual motor skills, involving the learned ability to process, integrate, and act on the information through the visual pathways. This article discussed a definition of dyslexia comparable to the one used in educational research. In the research Christenson, Griffin and Wesson found evidence that individuals with reading disabilities have visual processing deficits. They further concluded that vision therapy was shown to be effective for normalizing dysfunctions of saccadic eye movement, binocular vision and accommodation. The authors suggested that students with poor reading, writing, and spelling skills should be screened by an optometrist as a matter of practice. Another key idea in this article was that the demands on the eye are higher for those learning to read than for an already accomplished reader.

One of the more interesting studies came from Israel. Atzmon, Nemet, Ishay, and Karni (1993) completed a large study on vision therapy in collaboration with the Orthoptic Clinic, Assaf Harofeh Medical Center, Sackler School of Medicine, Tel-Aviv University, and the Israel Ministry of Education. The purpose of the study was to provide economical methods of treating learning disabilities and settle the controversy over orthoptics and vision therapy. Grade two students in 26 schools in Jerusalem were given standardized reading tests, and 120 of them, or approximately 16% of the total, were referred to the study as having a reading disability. These students were pre-tested for visual skills, and it was found that all of them had poor fusional convergence amplitudes. They were randomly matched and divided into three groups of 40 children each: an orthoptic treatment group, a conventional reading tutoring group, and a no-treatment control group. Those students in the orthoptic treatment and reading tutoring groups each received 40 daily sessions of 20 minutes, carefully matched in terms of time and effort. The results showed that 62 of the students in 31 matched pairs had equal, statistically significant marked improvement in their reading performance on all the tests. The authors concluded that orthoptic treatment was as effective as reading tutoring in treatment of reading disabilities. What made the study by Atzmon et al. most interesting was that almost half way through the treatment sessions, the authors found out that the parents of the students in the control group had secretly taken their children to receive private, individual, reading tutoring of some kind. Thus the participants of the control group were unable to adhere to the no-treatment plan because their parents were concerned that their children would fail without some intervention.

A criticism of the study by Atzmon et al. came in the form of a letter from an ophthalmologist (Tongue, 1993). She stated the study was not valid because it was not possible for the authors to classify the subjects' reading disability simply on the basis of failure on a reading test. Further, she pointed out that the control group was eliminated and maturation of the students was not accounted for, and she suggested that the study needed a masked control group.

Tranel (1994) wrote that some patients' complaints go beyond problems with acuity or clarity of vision. Ophthalmologists need to consider that although no defect of the eye may be present, reading difficulties may persist. Time is needed to conduct a battery of perceptual tests in order to rule out brain damage or other neural dysfunctions of the eye.

Kulp and Schmidt (1996) published information on the efficient reading functions of the eye and a review of the quantitative research on vision therapy. They believed that there is a relationship between oculomotor efficiency and reading skills. They stated that many visual difficulties have been shown to be related to reading ability. Kulp and Schmidt suggested that a test needs to be developed to discover if a reading problem is a problem with eye movement or a system deficit within the brain.

The Evans, Drasdo, and Richards (1999) study was published by an ophthalmological journal. It used a matched group design and found dyslexia to be associated with binocular instability (vergences), reduced amplitude of accommodation, and reduced contrast sensitivity.

The policy statement of the American Academy of Optometry and the American Optometric Association (Williams, 1999) states:

Learning to read and reading for information require efficient visual abilities. The eyes must team precisely, focus clearly, and track quickly and accurately across the page. These processes must be coordinated with the perceptual and memory aspects of vision, which in turn must combine with linguistic processing for comprehension. (p.1)

The goal of VT is the automation of these skills. A child may be able to perform the necessary functions but only with much effort and concentration, and may be unable to concentrate on the content of what is being read. American optometrists' organizations believe inefficient or poorly developed vision requires attention. Vision therapy is prescribed to treat diagnosed conditions of the visual system. Vision therapy promotes integration and automatic response with other systems enabling people to reach their full potential. The goals of vision therapy are to achieve visual outcomes, alleviate symptoms, meet patients' needs, and improve the quality of their lives.

Sloan, Hanson, Shelley-Tremblay and Ficarra (2003) published a study using a sample of grade six students. Twenty-three of the students were better than average, non-disabled readers, and twenty-seven of them were moderately disabled readers as identified on a Gates-MacGinitie Test. Visual tests used with these students were vergences, accommodative facility, cover tests, near point of convergence and binocular fusion at near. The results showed that visual testing was an efficient procedure to identify students whose reading disability may be associated with inadequate visual processing and visual attention skills. The authors discussed previous research in which a population of moderately disabled readers in grades four to six, with reading comprehension skills between the 16th and 31st percentiles, had basic decoding skills, but lacked efficient visual processing and oculomotor skills. Vision therapy made significant improvements in reading comprehension, visual attention, and eye movements for these students.

Adler's (2002) study questioned whether vision therapy was an effective method for treatment of convergence insufficiency. It involved 92 children, using binocular exercises, base in and base out fusional range work, and vergences practice. Before treatment, many of the children complained of words appearing to jump around, text appearing to change size, text with colours around it, and headaches or excessive blinking. Adler reported a 72% cure rate of these symptoms after vision therapy.

Maples and Bither (2002) published a review of the literature concerning ADHD children. The review found that ADHD children had visual symptoms of greater severity than the control groups. The authors concluded that ADHD children need to have their visual efficiency skills checked and managed before long-term medications are considered. They also suggested that although vision therapy was successful with ADHD children, it was not necessarily the sole influence responsible for alleviating symptoms.

Cook, Knueppel, and Torgerson (2002) reported on an "American Optometric Association Scope of Practice Survey", which asked optometrists in 1997 about vision therapy. They found that 35% of optometrists offered vision therapy as opposed to 50% of practitioners who had offered it ten years earlier. The authors acknowledged that ophthalmologists still refuse to recognize the use of vision therapy for treatment of learning-related vision problems or as an alternative to strabismus surgery. In their opinion, many optometrists who do not offer vision therapy are afraid of losing their patients to other optometrists. Many optometrists who are still offering vision therapy are thriving because of public and professional awareness of learning-related vision problems in children and an interest in finding alternative health procedures.

The most recent article we were able to obtain was by Vidyasagar (2004), who reviewed the literature concerning visual pathway problems to the brain. Vidyasagar has tracked the serial visual searches of dyslexics and concluded that a deficit anywhere along the nerve pathways of the eye to the brain can seriously affect the gating functions essential for reading a text. He questions whether the attentional deficits 'accompany' the reading difficulties or are 'instrumental' in causing the reading difficulties.

The researchers of this study quickly realized that the optometrists did not always specify what type of vision therapy they were using in their research. Neither did the ophthalmologists specify what type of vision therapy they were discussing. Compounding the confusion was the fact that only one article had a clear definition of dyslexia that was similar to the education model. Otherwise the articles described reading problems in general terms or in terms of poor scores on "reading tests" that were not described or specified.

THOSE WHO ARE AGAINST: THE FIFTH BLIND MOUSE AND THE FRAYED BIT OF ROPE

Russell and Wick (1993), both optometrists, reported that patients with idiopathic accommodative insufficiency showed no improvement in accommodative facility or amplitude after four weeks of vision therapy. They found that compliance with the patient home program was an issue, and that glasses plus therapy was more successful than just vision therapy. This study emphasized the need to evaluate patients during the case history and clinical examination phases so that an accurate diagnosis can be made.

The *American Optometric News* (1993) published a joint study by ophthalmologists that suggested vision therapy should be a primary course of treatment for learning or reading disabled children with convergence insufficiency, using orthoptics. If their reading ability does not improve significantly after four to six months, the study suggested that other interventions should be considered.

A literature review by Sloan (1993), an optometrist, found that optometrists do not treat dyslexia, but treat children who manifest some type of visual dysfunction. Visual problems do contribute to the learning disability, but no credible scientific evidence shows a higher incidence of ocular anomalies among children who experience reading difficulties. Sloan defined vision therapy as a perceptual therapy that includes visual processing and retrieval, inter-sensory integration, and sensory-motor integration. However, Dr. Patterson argues that these are second order visual functions that still require VT to get the information into the brain.

The American Academy of Pediatrics (1998) published a subject review that stated no scientific evidence supports the view that correction of subtle visual defects can alter the brain's processing of visual stimuli. Their view was that, statistically, children with dyslexia or related learning disabilities have the same ocular efficiency skills as children without such conditions.

Olitsky (1999) voiced the idea that dyslexia is a language based disorder and therefore treatment should be directed at this etiology. He believes that the research reports showing the benefits of vision therapy are provided by groups that have a vested interest, usually financial, in proving its validity. Olitsky states that he found no scientific evidence validating vision therapy as a way of treating reading problems. In his view, parents should be warned about vision therapy and consider that dyslexia is a complex disorder with no quick cure.

Hoyt (1999) discussed the difficulty in defining a reading disability. He found in his review of the literature a lack of normal age-matched controls and pointed out that it is inappropriate to use normative data obtained from adult eye movement studies. Hoyt suggested that a large study group is needed with assessment of objective eye movements, and age-matched control groups.

Koller (1999) suggested an "ophthalmologist's approach" to the issue of vision therapy and learning differences. He stated that children with language based disorders require homework, a tutor, a trained certified reading teacher, and a speech-language pathologist. A multidisciplinary team approach involving the pediatrician with the school would assist the learning process.

The policy statement of the American Academy of Ophthalmology (2001) included an accurate description of vision therapy, clearly stating that there are two types. It further stated that there is no consistent scientific evidence that supports behavioral vision therapy, orthoptic vision therapy or colored overlays and lenses as effective treatments for learning disabilities. The policy noted several studies demonstrating that eye movements and visual perception were not critical factors in the reading impairment found in dyslexia. The ophthalmologist view suggested that brain processing of language plays a greater role. Again, the research supporting vision therapy was criticized for not including well-performed, randomized, controlled trials, involving too many variables that confound the data, providing no standard definition for what techniques comprise vision therapy, and not accounting for maturational changes or the fact that children receiving vision therapy were also receiving other forms of instructional enhancement.

Behavioral vision therapy studies, in peer reviewed literature, were found to be inconsistent.

The policy statement also included several cautions about using vision therapy. Health insurance often does not cover the costs of the therapy, which involve approximately \$500 for testing and ten therapy sessions. Also, vision therapy may provide false hope and raise the expectations of educators, patients, and families, delaying other treatment plans. It was pointed out that treatments described as vision therapy differ in each study, as does the length of time the therapy is given. Moreover, the experimental groups being studied were not screened for conditions such as ADHD, nonverbal learning disabilities or high function autism. The control groups are often not adequately described or there is no control group at all. Finally, given the small numbers of subjects in these studies, there was no masking of the therapists, testers, or observers to minimize bias.

Hoyt (2001), a medical doctor, also suggested that learning disabilities are language based not vision based. He found no scientific evidence that vision therapy corrects the problem. He suggested that family history may be important, as dyslexia is genetic and inherited. In his view, it is important that learning disabilities in children be diagnosed early, and their phonemic awareness checked, since this factor is a more solid indicator of learning disabilities.

Kushner and Doolittle (2002) stated that vision therapy was costly, time consuming, and labour intensive. They were concerned that if only vision therapy is used in a child's younger years, there is a high risk of leaving another disorder uncorrected, which might not be treatable when the child is older.

Olitsky and Nelson (2003) summarized the problems with vision therapy research as follows:

- It fails to differentiate between normal variation.
- It has no association with cause and effect.
- It lacks matched comparison groups.
- It fails to provide a placebo treatment group.
- It has the misconception that isolated visual skills are a factor in reading problems.
- It relies too heavily on anecdotal reports.
- It fails to control for nonspecific gains (e.g., increased time and attention to the child).
- Its results are often duplicated.

Olitsky and Nelson recommended that treatment of learning disabilities should involve a multi-disciplinary approach, involving educators, psychologists, and physicians. The pediatrician should be involved in the treatment to oversee the best interests of the child. Vision therapy should be discouraged as eye problems are rarely the cause for poor performance in school.

CONSIDERATIONS: THE SIXTH BLIND MOUSE NOT WANTING TO BE LEFT BEHIND

The literature on vision therapy reveals that both ophthalmologists and optometrists have strong views on the subject, and the two groups are involved in a research war. We found that the criticisms concerning the inadequacies of the experiment

models to explore the vision therapy issue apply to the published research both for and against vision therapy.

Moreover, it was difficult for us, as educators, to read the varying definitions of dyslexia and learning disabilities as viewed by ophthalmologists and optometrists. Educators have been left out of the research picture of vision therapy, when our expertise and knowledge would have been useful. Although the researchers we encountered in the literature were using the concept of a “cure” for reading problems, any teacher could have told them that reading problems are never cured, only strategized for and remediated. The child is taught how to circumvent the reading problem, whether it stems from visual, eye-hand, phonemic, or comprehension issues, through the teaching of reading strategies and cueing systems. In fact, the idea of a multidisciplinary team closely fits the model of educational delivery, especially in this province, Saskatchewan. Our policy of School^{PLUS} (Tymchak, 2001) tries to promote more multidisciplinary collaborations (e.g., Health and Education working together) to meet students’ needs through the school system.

Two articles we found on school-based delivery were from Wenzel (1996) and Yawn, Kurland, Butterfield, and Johnson (1998). They suggested that using the elementary school is the most cost-effective strategy for addressing children’s health needs. The school is the core of the community and can reach children and their families in a way that most other community based agencies or institutions cannot. The elementary school years are also the time when active intervention can yield life-long benefits for the health of children. These studies saw the school was the best place for basic eye assessment, therapy or follow-up care, because of the financial concerns for parents in driving to other care facilities, system problems, an unawareness of common visual abnormalities, and the lack of coverage for vision therapy through most insurance programs. They suggested that schools can be a central resource, but only with the assistance of other health agencies.

The Royal College of Ophthalmologists of London (2004) has recognized orthoptic vision therapy and recommended a universal screening service for all children aged four and five, at a school or pre-school facility. Further, optometrists should provide the screening service.

The Regence Group, a large medical insurance company in the U.S. that includes Blue Cross and Blue Shield, funds orthoptic vision therapy. It recognizes that orthoptic treatments have been useful in the treatment of learning disabilities, attention deficit disorders, dyslexia, traumatic brain injury, mild cognitive disorders or other reading disorders.

DECISIONS: THE OLD BLIND MOUSE TAKING THE TIME TO STUDY

In developing our own study of vision therapy, we were aware that we could not produce the ideal experimental design that would meet Jennings’s criteria. In our view, it is not possible, physically or conceptually, to carry out such a study in any school. Instead, we attempted to develop the best design possible that would be acceptable to the parents and our school division. The design involves nonequivalent groups and data gathered through pretest and posttest activities. Randomly assigning matched subjects and using a placebo were not attempted with so few participants. We concluded that we were not engaging in a pure quantitative research study, but in action research, which seeks to improve

upon a practice. At present in our school division the Kindergarten screening process already includes a small visual screen.

Our study is based on qualitative data gathered from the reflections of the stakeholders involved in the study and a focus group. We have used only orthoptic vision therapy treatments with the students, at no cost to their parents. An optometrist was involved in providing training for the researchers with respect to using assessments, diagnosing the students, formulating the treatment plan, carrying out remediation, and using final test results. We tried to keep the remediation simple, with pre and post testing transferable to a desired learning outcome or activity in the classroom. The question of whether or not vision therapy is a best practice for educators in the Kindergarten setting was discussed in a focus group of all stakeholders at the end of the first and second years of testing.

We recognized that we may not know what the elephant is like until the end. However, educators know that it takes a holistic, multimodal endeavour, by a multidisciplinary team, for some students to successfully acquire the reading process. The current Kindergarten curriculum includes a strong phonemic awareness approach (auditory) through the *Lindamood Phoneme Sequencing Program for Reading, Spelling, and Speech* (1998), *Animated Literacy Approach to Integrated Language Arts Instruction* (2002), and Speech/Language programs. It builds on fine motor skills (tactile) programs and supervision provided by the Occupational Therapist in our school division. As teacher-researchers, we felt it was our goal to complete the picture for Kindergarten by seeking out and screening an intervention process that covers the visual component of learning to read, thus improving overall educational practice. For us, a happy ending to the story of *The Blind Mice and the Elephant* would be that the mice regained their sight, and were able to see the elephant for what it truly is.

Trial Methodology

This study was action research conducted at a small rural elementary school in Saskatchewan with an enrollment of approximately 165 students ranging from Kindergarten to Grade Five. The school has a six day schedule, with one class of Kindergarten students meeting on Days 1, 3 and 5 and a second Kindergarten class meeting on Days 2, 4 and 6. Both classes were taught by the same teacher, and in each one, there was a different teacher associate. The Kindergarten students were gradually phased into full day attendance during the first three weeks of school. The first vision therapy trial included twenty-nine Kindergarten students, and the second trial included twenty-eight.

The students were pre-tested in early October before the staff had any preconceived ideas about their academic potential. The Special Education teacher, who was trained by Dr. Patterson of Atrium Optometric Group, administered a battery of tests to all the students in three major categories.

The first category involved tests of the students' eye movements and focusing skills. They included:

1. *Monocular Acuities (using the Bernell Eye Chart)*: Using a picture version of the eye chart at 20 feet, the student covered one eye and read the chart down to the 20/30 line. This activity was repeated with the other eye covered. Then the student put on glasses with a small plus correction, covered one eye and read the chart again. The other eye was then covered, and the procedure repeated. The purpose of the glasses was to reveal hyperopia and particularly any anisometropia or inequality between the eyes. If students could read the chart with the plus correction glasses on, they were deemed to have failed the test (i.e., they needed to be assessed by an optometrist for glasses).
2. *Cover Test*: Using an occluder paddle, the teacher sat facing the student, asked the student to look into her eye, and moved the paddle from one eye to the other, looking for excessive blinking or eye turning. A tongue depressor with a small target (picture) could be used to maintain fixation.
3. *Piaget Left-Right Concepts Test*: The teacher asked students to show her their right hand, then their left leg, point to their left ear, left hand, right leg, and lastly point to their right eye.
4. *Polarized Suppression Test (with mini Bernell Chart)*: The same picture eye chart, only in a small card form, and a polarized striped overlay were used. The student stood three feet away from the chart, put on polarized tinted glasses and named the pictures. Both eyes had to work together to track across the page. This test revealed suppression of one eye or the other.
5. *Near Point Convergence*: Using a white painted Popsicle stick with a small letter on one end, the teacher moved the stick forward and backward from the students' eyes, asking the student to keep their eyes on the letter (they did not have to name the letter). The teacher looked for squinting or straining and eyes "breaking" or losing focus before 3 centimeters from the face (/0011 for fatigue after 10X).

6. *Accommodative Complitude*: A Dioptre rod with a chart (a stick with a card that slides up and down the stick) was used in the first trial. It was placed lightly on the end of the student's nose. The teacher asked the students to look at the card and say when they could clearly see the picture on the card (picture is approximately 1 centimeter square, and the same as on the Bernell charts used earlier). The teacher then slid the card along the rod and the students indicated when they could see the picture clearly (no fuzziness). In the second trial an accommodation component was not used for reasons explained later in this report.

The second category of tests included the *Beery-Butenika Visual Motor Integration Test*, (Beery, 1997) and the *Test of Visual Perception Skills* (Gardner, 1982). Both were already used in the regular Kindergarten screening profile as second level testing for students who appeared to have vision problems. The VMI was used also to discern fine motor issues and identify students who had difficulty with eye-hand coordination.

In the third category were tests of accommodation, fusion, saccades, vergences, phoria, pursuits and fixed disparity. In the first trial we used a computer program recommended and purchased through Atrium Optometric called the *HTS – Computerized Home Therapy System* (Cooper and Bortel, 2002), which included an accompanying therapy package for our use (institutional version, good for 100 users). The students sat 16 inches from the screen and for some tests needed to use red/green glasses, corrected glasses and flippers (corrected lenses with handles instead of arms over the ear).

Each category of test was administered on different days, with an attempt to keeping the testing time to approximately ten minutes at a time for each student.

For the second trial, the tests and vision remediation that were proven the most effective from the first trial was administered. The computer test was not used for reasons to be discussed later. Instead, Dr. Patterson gave the researchers a Stereopsis to test for binocular function. The students wore polarized tinted glasses and pointed to various stimuli in a book chart format.

Once all the test results were recorded, a meeting was set up with Dr. Patterson at the offices of Atrium Optometric Group to review the scores. Dr. Patterson did not meet the children or observe the testing. After reviewing the results from the first trial, she identified ten students, drawn from both the Kindergarten classes, who had the greatest deficit in visual efficiency skills. In the second trial, she identified eleven students for treatment. Dr. Patterson then advised the Special Education teacher as to the type of remediation that was needed and trained her on how it should be administered. In the first trial, the Special Education teacher then trained the two teacher associates to implement the remediation for the students.

The remediation consisted of a series of warm-up activities lasting approximately five to ten minutes. The first activity, pencil push-ups, consisted of exactly the same procedure as the near-point test, using a pencil instead of the painted Popsicle stick. The next warm-up activity required the students to follow a pencil moving in different directions in front of their faces, using eyes only. Lastly, the students worked in an *I Spy* (1992) book, looking for objects with the teacher associate holding a flipper with two different corrections attached. The flipper was changed back and forth in order to train the eye to accommodate and adjust easily. In the

first trial approximately ten minutes was spent on the computer using the vision therapy program, which included activities involving saccadic pursuits, autoslide vergences, and accommodative rock.

The researchers set up three categories of remediation for Trial II. First, the students participated in a warm-up activity of pencil push-ups and looking for objects in the *I Spy* books using a flipper with 1.5 and 2.0 sides. Next the students completed one page in a *Saccadic Workbook*, (Shearar, 1990) timed for one minute. Finally, the students completed a page in a visual tracking workbook that focused on their ability to draw on the lines, and they “read” through a Lora’s Card, Directional Arrow card, and Ann Arbour card. The criteria were set at ten effective pencil push-ups, one completed square in the *Saccadic Workbook* (Shearar, 1988) in one minute, and number correct in the visual tracking exercises. The students were assessed daily on how well they were meeting the criteria, progressing toward the criteria, and needing support to complete the activities, with the teacher pointing or assisting in scanning. The Ann Arbour instructions indicated how the remediator could increase the level of difficulty in an activity as the student met certain criteria. For instance, as the student was able to read one line of shapes accurately (right eye only, then left eye only), the student was asked to read two lines. When the student could read accurately all the shapes on the lines in the section, then the student was timed while reading as many as he or she could in one minute.

Remediation started the end of January and finished middle of May. Post-testing occurred the last week of May. Appendix D depicts the differences from start of remediation to end of remediation. This period was approximately 20 days, depending on student absences or school events, and keeping in mind the Kindergarten classes met every other day. All the students received one practice session with all the activities before recording began. All the treatment students demonstrated improvement over the twenty sessions.

In the first trial the treatment group consisted of six students from one class and four from the other class. In the second trial, the treatment group included six students from one class and five from the other. In order to ensure privacy and avoid interruptions, the treatments were administered in the Learning Centre, which was located across the hall from the Kindergarten classroom.

The remaining nineteen students in the first trial and the remaining seventeen students in the second trial did not receive any visual remediation. The Kindergarten program was not changed in any way for either these students or the treatment groups of ten and eleven students. All the Kindergarten students participated in a regular phonemic awareness program (*Animated Literacy*), fine motor tasks, Speech and Language intervention, and any other activities that were part of the Kindergarten program.

During the first trial, Speech and Language remediation was received by five students in the treatment group and four students who were not in the treatment group, fine motor group remediation was received by two students in the treatment group and one student who was not in the treatment group, and enrichment in early reading skills was received by one student in the treatment group and six students who were not in the treatment group. During the second trial, Speech and Language remediation was received by two students in the treatment group and seven students who were not in the treatment group, fine motor group remediation was received by four students in the treatment group and

four students who were not in the treatment group, and enrichment in early reading skills was received by six students who were not in the treatment group.

The post-testing phase of the study used the same battery of tests given in the pre-testing phase. The tests were given to all the Kindergarten students. In addition, data was collected concerning the progress in the Kindergarten program of the students in both the treatment and non-treatment groups. A post-treatment interview was conducted with the treatment group students, and reflections were gathered from the teacher associates and the Kindergarten teacher. The Special Education teacher also contributed her reflections on the research and testing process. Dr. Patterson was given copies of the results of the post testing to analyze.

Finally, two focus group meetings were held with stakeholders, with the discussions recorded and the results summarized in this report. The first focus group consisted of a school division representative, the Kindergarten teacher, the Special Education teacher, Dr. Patterson, a parent of a treatment group student, an occupational-therapist, and one of the teacher associates who administered the remediation. This group met in September after the first trial was completed, and its job was to discuss whether or not vision therapy is an effective practice in schools and what kind of policy would need to be in place to implement vision therapy. The discussion was based on the literature review and a draft analysis of the initial testing data. The second focus group meeting was held at the conclusion of the second trial after Dr. Patterson had time to review all of the testing results. This group consisted of representatives from the school division office and the Learning Disabilities Working Committee, Dr. Patterson and the researchers. The time of year for the meeting placed constraints on who could attend that were not experienced at the first focus group meeting.

It is planned that the first and second trials used in this study will be repeated each year until all the students involved complete Grade Three. The treatment group will be tested at the end of each year using the *Woodcock-Johnson III Achievement* (2001) test and all the vision tests. Anecdotal data will be kept on the treatment group's progress, both in developing visual skills and academic abilities, and examined to determine if any student needs further support through the special education program. In Grade Three, all the students will receive the *CAT-3* (Canadian Test Centre, 2000) tests and a repeat of the vision tests to compare their progress.

Data Analysis and Interpretation

To guide our analysis of the data we asked seven key questions:

1. Which assessments were the best determiners of problems of visual efficiency skills (tracking and teaming) in the reading process?
2. How effective were the remediation techniques in improving visual efficiency skills in the treatment group?
3. How much time was given to the pre and post testing phases and to the remediation?
4. How much staff time and effort were involved in testing and remediation?
5. Did vision therapy result in improved visual efficiency skills in the treatment group?
6. Did the visual efficiency skills of the treatment group improve more than the visual efficiency skills of the students who were not in the treatment group? Does vision naturally improve simply by maturation?
7. What were the treatment group's reflections on the process? What were the reflections of the teacher and the teacher associates?

The data and observations accumulated in this study have been organized under headings related to these questions.

WHICH ASSESSMENTS WERE THE BEST DETERMINERS?

In the first trial, tests that did not show significant changes using the ANOVA calculations included the cover test, accommodation test, and the Piaget Left/Right test. Perhaps due to lack of experience in the tester, the accuracy of the cover text appeared to be compromised by the tendency of students to be curious about the occluder paddle, which made it difficult to tell if their eyes were truly shifting. Problems were also experienced with the accommodation test since the students were not accurate in telling the tester when they could see clearly the figure on the card, and thus stop its movement on the Dioptre rod. Student scores on this test were measured by age level, and both the treatment and non-treatment groups scored lower in the post-testing. Use of the Piaget Left/Right test was eliminated because the Kindergarten teacher did not emphasize this skill in class during the year and both groups performed low in post-testing.

The computer program also proved to be less effective than predicted. Atrium Optometric Group had hoped that it would provide schools with an easy method of testing and remediation. However, the program did not show significant results with the Kindergarten students in this study (ANOVA, refer to Appendix C). In fact, no students in either the treatment or non-treatment group passed all the computer tests. Many students did not have the fine motor skills needed to work the arrow keys on the keyboard. Often the student simply pointed in the

direction for the correct answer and the tester pushed the appropriate key. Many of the figures used in the tests were so small that students could not distinguish the fine details that would have helped them to make a correct choice. A joystick would have made the selection easier, since the students would then only have had to point the stick in the correct direction to indicate their answers. In the therapy section of the computer program, the figures were larger and easier to work with. However, in post-testing the treatment group did not perform significantly better than the group that did not receive treatment, and again, no student passed all of the tests. The greatest impediment to success was that many of the tasks were time sensitive. Although the students in the treatment group performed more accurately in post-testing, they still failed the test due to time constraints.

The tests that demonstrated significant results in the first trial were the monocular acuities, the near-point, the polarized suppression, the *VMI* and the *TVPS* tests. Significance was demonstrated in the ANOVA scores, percentages, averages, and meaningful scores. We had predetermined the meaning of scores as follows: 20% improvement meant great significance, 10% improvement meant moderate significance and 5% meant small significance. In the previous year a 20% improvement had been noted on the *VMI* test scores for students who had vision therapy through home or at school. Zero improvement meant that a student made no improvement from pre-test to post-test. We attempted to use methods of interpreting the test scores that could be easily understood and replicated by other teachers.

The most significant results were noted in the monocular acuities test. The treatment group scores improved 140% from pre to post-test, while the scores of the non-treatment group improved only 59%. On the *VMI*, the Integration test score improved 10% from pre to post-test for the treatment group, and declined by 1% for the non-treatment group. The *VMI* Visual and Motor scores for the treatment group showed slightly greater improvement than the non-treatment group, with 1% and 6% improvement respectively. Surprisingly, the Visual Score for the *VMI* showed the smallest improvement between the two groups. The *TVPS* treatment group's scores improved 17%, while the control group's scores improved only 5% from pre to post-testing. In the polarized suppression test the treatment group scores were 28% improved and the non-treatment groups scores improved by 19%. Dr. Patterson stated this may possibly indicate stronger fusional abilities and therefore less suppression.

The near-point test was also significant in that the treatment group improvement scores on the post-test were 21% less than those of the non-treatment group, in spite of the fact that the members of treatment group received direct practice in this skill every time they came to remediation while the non-treatment group had no practice whatsoever. The non-treatment group scored 92% improved from pre to post-testing, while the treatment group only scored 71% improved.

Another way to review the scores of these tests is provided in the following table, which contrasts the average raw scores for both the non-treatment and treatment groups.

Table 1: Trial I – Average Scores of Groups

Test/Total Score	Non-Treatment	Treatment Group	Differences/Group Group
Monocular: (3) Pretest Posttest	1.7 2.8	1.0 2.4	Non-treat. improved 37% Treat. Improved 47%
Pol. Sup.: (20) Pretest Posttest	15 17.8	10 12.8	Both improved equally by 14%
Near-Point: (10) Pretest Posttest	3.95 7.58	3.8 6.5	Non-treat. improved 37 % Treat. improved 27 %
TVPS: (Quotient in S.S.) Pretest Posttest	97.8 102.58	79.3 92.8	Non-treat. improved 3.9 % Treat. improved 11.3 %
VMI: (S.S.) Integrated Pretest Posttest	80.1 79.5	67.5 73.7	Non-treat. down by .6 % Treat. improved by 5.4 %
Visual Pretest Posttest	93.0 99.6	83.3 88.2	Non-treat. improved by 6 % Treat. improved by 4.5 %
Motor Pretest Posttest	100.0 104.5	99.4 99.4	Non-treat. improved by 3 % Treat. down by .3 %

The treatment group demonstrated a higher percentage in improved scores than the non-treatment group in the monocular acuities, *TVPS*, and *VMI-Integrated* tests. Both groups improved the same in the Polarized Suppression test. The treatment group scored less improvement than the non-treatment group in the near-point, *VMI-Visual* and Motor tests.

In considering the second part of this question, i.e., which tests indicated problems with visual efficiency skills in the reading process, such as tracking and teaming, we needed to consider whether the tests translated into activities in the classroom. Atrium Optometric Group maintained that all of the tests relate to skills needed to acquire the visual component to the reading process. Certainly, if we were to choose without looking at the scores, the near-point test measured the eye's ability to make changes from near activities to far such as copying from the board. It gave the tester the indication of convergence insufficiency. The Polarized Suppression test measured the fusional ability of the eyes. The *VMI* indicated the coordinated activities of the eye and hand in reproducing basic shapes on a page, which relates to copying letters from one source to another. The *TVPS* measured perceptual skills, which include discriminating from one shape to another, memory of shapes, and the ability to discern a specific shape when it is changed slightly or hidden in a complicated background.

We did take a sample of all students' skill in printing their names and drawing themselves at both the beginning and the end of the year. All the pictures showed marked improvement from October to June in the precision with which the students formed the letters of their names and the details in their drawings. As this improvement could be due to maturation rather than vision therapy, we did not include it as data for this study. However, we will compare these data to similar data gathered from the next trial.

In the second trial the tester was more experienced in administering the tests and in recognizing eye changes. The accommodation test (Dioptre Rod) was eliminated, and the Stereopsis book was used instead of the computer program. Dr. Patterson advised that she would look for a more practical accommodation test method for future use. We reinstated the Piaget Left/Right test because the Kindergarten teacher planned to teach this skill directly in class during the year.

Professor Randi Duncan of the Faculty of Educational Psychology at the University of Saskatchewan was asked for his opinion of the statistical results in Appendix B. From the ANOVA statistics Trial II of the Kindergarten I class, he pointed out that the pre-Monocular, pre-Polarized Suppression, pre-Visual VMI, and pre/post TVPS scores were significant. The pre-Monocular, Polarized Suppression Test (Bernell) and Visual VMI scores showed significant differences between the non-treatment and treatment groups. However, the post scores in those tests indicted no significant difference between the groups. The pre-TVPS and post-TVPS scores showed significant differences between the non-treatment and treatment groups. The Kindergarten I class demonstrated a 15% improvement in TVPS perceptual quotient score over the year, and the treatment group demonstrated a 16% increase over the year.

He also found that the Kindergarten II class scores were significant for pre-Bernell, pre and post- VMI-I, and pre/post TVPS. The post Bernell scores did not indicate significance, but the post VMI-I and TVPS scores did. Table 3 shows these scores as percentage changes from pre to post scores for all the tests for both Kindergarten classes.

Table 2: Trial II – Percentage Change in Control and Treatment Groups; Pre to Post-Testing

Group	Mono	NrPT	Bernell	CvrT	Piaget	Stereop.	VMI-Int.	VMI-Vis.	VMI-Motor	TVPS
Non-treatment	-5%	40%	-4%	-3%	-5%	2%	5%	0%	6%	16%
Treatment	30%	92%	25%	-4%	16%	4%	8%	21%	9%	14%
Difference	35%	52%	29%	2%	21%	2%	3%	21%	3%	-2%

The researchers maintained the same understanding of meaningful scores established in Trial I, i.e., 20% meant great significance, 10% meant moderate significance, and 5% meant small significance. Table 3 outlines the percentage improvements based on average scores for both Kindergarten classes, the non-treatment and treatment groups. Overall, the non-treatment group scores improved 5% from pre to post-testing. The treatment group scores improved 21% over all the tests from pre to post-testing. The treatment group improved the most on the Near Point test (92%), on which the non-treatment group improved 40%. On the Monocular Acuties test, the treatment group improved its scores by 30% and the control group by 5%. On the VMI Visual test the treatment group improved by 21% and the non-treatment group did not show improvement from their pretest scores. The treatment group showed improved scores over the non-treatment group in every test except the TVPS, in which the non-treatment group improved 16% and the treatment group improved 14%. However, one needs to consider that this test measures perceptual skills, which include visual memory, visual figure ground, and visual discrimination. The VMI Visual test indicates only visual efficiency, i.e., the students must track and locate a similar

shape. The Polarized Suppression test, which is called Bernell on Table 3, also closely follows what a student may be asked to do in acquiring reading skills, namely, recognize the shape and visually track across left to right (no finger pointing was allowed). The treatment group scores improved 25% while the non-treatment group scores improved 4%.

Table 3: Average Scores of Groups Trial II

Test/Total Score	Non-Treatment Group	Treatment Group	Differences/Group
Monocular: (4) Pretest Posttest	3.63 3.44	2.50 3.25	Non-treat. down 5% Treat. improved 30%
Stereopsis.: (19) Pretest Posttest	18.19 18.56	16.0 16.67	Non-treat. improved by 2% Treat. Improved by 4%
Near-Point: (10) Pretest Posttest	6.56 9.19	4.42 8.50	Non-treat. improved 40 % Treat. improved 92 %
Bernell: (20) Pretest Posttest	19.14 18.63	14.67 18.33	Non-treat. down 4% Treat. improved 25%
Cover Test: (20) Pretest Posttest	19.38 18.88	19.17 18.33	Non-treat. down 3% Treat. down 4%
Piaget: (6) Pretest Posttest	4.06 3.88	4.25 4.92	Non-treat. down 5% Treat. improved 16%
TVPS: (Quotient in S.S.) Pretest Posttest	99.50 115.50	82.42 93.92	Non-treat. improved 16 % Treat. improved 14%
VMI: (S.S.) Integrated Pretest Posttest	82.50 86.88	70.42 76.17	Non-treat. improved 2 % Treat. improved by 8%
Visual Pretest Posttest	109.06 108.69	83.67 101.17	Non-treat. improved by 0 % Treat. improved by 21 %
Motor Pretest Posttest	97.25 103.00	90.67 99.08	Non-treat. improved by 6 % Treat. down by 9 %

In the second trial the researchers found that all the tests were easy to administer and the instructions or protocols were easy for the students to follow. The students especially enjoyed using the Stereopsis book. There was much giggling as they looked for the shapes in the boxes or pointed out the animals “coming towards” them.

HOW EFFECTIVE WERE THE REMEDIATION TECHNIQUES?

When we first saw results of vision therapy on students almost two years ago, Atrium Optometric Group had sent a home therapy package that included paper and pencil activities and tracking pages that used letters or numbers. Also included were pencil push-ups and I Spy books. For this study Atrium suggested that the researchers try using more involved remediation. It wanted the researchers to pilot a computer program to test and remediate students in the school setting. Dr. Patterson thought that the computer program would be easy and effective for teachers to use.

Other frustrations with the computer program concerned the design of the program and the technical support for it from *HTS*, which is based in Arizona. *HTS* provides the vision home therapy to optometrists, who in turn can sell it to parents or institutions for use in remediating vision problems. The testing part of program is available on a CD that is easy to administer and provides an automatic printed overview of the student’s performance on each test. However, the remediation part of the program is available on a floppy disk, and we found that each practice run on each day takes up considerable space on the disk. Although we had informed *HTS* of our study and how many students were in the treatment group before we started remediation, we ran out of space on the data disk twice and had to stop that portion of the remediation while we awaited delivery of new disks from Arizona to Atrium Optometric and then to us. Only at the end of our study did *HTS* inform us that we needed a disk for each student. Also, we found that we could not print off the data giving the results of the remediation for each student without purchasing another computer program that would allow us to do that. Since the *HTS* program does not convert to a common computer program for printing, we had to send the disks by courier to Arizona so that the data could be printed for us.

HTS will not sell to a school directly, insisting that the program had to be purchased by an optometrist and then sold to us. The company is committed to the model in which a care practitioner makes the diagnosis and chooses the program. It is concerned that the general public will misdiagnose or overlook an underlying pathology. As a result, if a school were to use the program, the local optometrist would first need to recommend, purchase and then sell the program to the school. The remediator would need to have an individual blank trial disk for each individual student.

After viewing the results, Dr. Patterson believes that the *HTS* program for remediation is valid for older students, but may not be effective for Kindergarten students or students younger than Grade 3.

The first treatment group demonstrated improvement in the pencil push-up and visual tracking activities over the year; however, it did not score as well in comparison to the non-treatment group in post-testing (average score for non-treatment group was 7.58 and average score for the treatment group was 6.5). One might argue that without practice, the difference in post-test scores between the

two groups might have been greater than 1.08. Progress in finding objects in the *I Spy* books was recorded anecdotally for each treatment student. All these students demonstrated improvement over the year. The computer program's limitations have been reported above.

An interesting area of improvement was demonstrated in the *VMI*-Integrated score, which is the overall standard score of the test and demonstrates a student's ability to coordinate eye and hand movements to reproduce a shape. Over the last three years, in using this test with Kindergarten students, I have found that it is hardest to provide effective remediation of the integration of eye/hand skills, especially if the student's vision and motor scores are higher. However, the treatment group demonstrated a 10% improvement in the post-test integrated score, while the non-treatment group's scores declined by 1%. The treatment group also scored higher improvement in post-testing in the *TVPS*, which measures visual perception skills.

From the data, (see appendix C) pencil push-ups, visual tracking, Lora's Card, Ann Arbour Card and saccadic activities were effective remediations. All of the students improved significantly (over 80%) over the course of the treatment.

HOW MUCH TIME WAS NEEDED FOR VISION THERAPY?

In Trial I the average time taken for a student to complete the pre-tests was 34 minutes, and the post-tests took 36 minutes per student. Table 2 shows the breakdown of the minutes for both classes combined.

Table 2: Average Number of Minutes for Both Classes Trial #1

Test	Pre	Post
Monocular, Cover, Near Point, Accommodation, Polarized Suppression, Piaget	7.0	5.1
Computer	10.19	9.0
<i>VMI</i> and <i>TVPS</i>	16.26	22.0
Total: All Tests	33.45	36.1

Therefore, for the twenty-nine students in the first trial, it took approximately seventeen hours to carry out both the pre and post-testing. This equated to four full days of testing for pre-tests and another four full days for post-tests. Release time for the Special Education teacher to do this testing was provided by the research grant from the McDowell Foundation. Any students who were away during the release time were tested during the Special Education teacher's preparation times.

The remediation in the first trial required the teacher associate to work approximately fifteen to twenty minutes with each student in the treatment group, depending on how quickly each student went through the computer component activities. On the days she worked with Kindergarten One, she spent one hour and twenty minutes. On the days for Kindergarten Two, two teacher associates

worked, one with two students and the other with four students, for approximately the same amount of time. Times for pulling students out of class were arranged when the other students had center time or no direct teaching was happening. Eventually, the activities were split up and each student spent some time in the morning and some in the afternoon to ensure pull-out time was minimal.

For Trial II, the average overall time to complete the pre-tests was 20 minutes per student, and the average overall time for the post-tests was 24 minutes per student. Table 6 breaks down the minutes for both classes combined.

Table 6: Average Number of Minutes for Both Classes Trial #2

Test	Pre K1/K2	Post K1/K2
Monocular, Cover, Near Point, Polarized Suppression, Piaget, Stereopsis	5:38 /6:04	6:09/5:46
VMI and TVPS	14:22/14:33	18:27/18:06
Total: All tests	20:11/20.26	23:52/24:27

It took approximately 11 hours for both the pre and post-testing of the 28 students in the second trial, which equates to two full days of testing for pre-tests and another two for post-tests.

The remediation provided in the second trial required a teacher associate to supervise the written activities and the Special Education teacher to do the point and say activities. The Special Education teacher, directly trained by Dr. Patterson, was administering the crucial part of the vision therapy as requested after the first trial. There were six students from each Kindergarten class in the treatment group. A group of three students would come to the learning centre at a time. They would rotate through the activities, with the teacher associate supervising the written activities with two students and the Special Education teacher working with one student at completing the point and say activities. Each group would be in the learning centre for fifteen minutes, then the next group would come.

Whereas one hour and twenty minutes was needed out of the Kindergarten day during the first trial, the students in the second trial needed only fifteen minutes a day for vision therapy.

HOW MUCH STAFF INVOLVEMENT WAS NEEDED TO PROVIDE VISION THERAPY?

To carry out the vision therapy in Trial I, the Special Education teacher did the testing and two teacher associates were trained to do the remediation in case one was ill. The same staff needs were experienced as in Speech and Language remediation or Occupational Therapy, i.e., one person was needed to test and another to carry out the remediation.

In the second trial, the Special Education teacher and one teacher associate needed to work together for 30 minutes a day. It was felt that there was no need to separate tester and remediator in this trial in order to make the study valid. Dr. Patterson had requested that the best trained person administer the therapy as well as the testing. Thus therapy activities were divided between the teacher associate and the Special Education teacher and administered at the same time.

DID VISION THERAPY IMPROVE VISUAL EFFICIENCY SKILLS IN THE TREATMENT GROUP?

In Trial I, in the overall post-test scores of the seven targeted tests mentioned in question one, the treatment group demonstrated improved visual efficiency skills on 80% of the tests. The non-treatment group demonstrated improved skills on 89% of the tests. On the TVPS, however, the treatment group improved its scores by 14 points, and the non-treatment group improved its scores by 5 points. Most of the vision therapy was administered through the computer, and recorded on the program. The computer program indicated that all the students receiving remediation experienced steady growth.

In Trial II the researchers were more efficient at gathering the data for the remediation process. Considering the post-test scores for the ten tests for each student, 100% of the Kindergarten 1 treatment group showed overall improvement and 75% of the Kindergarten 1 non-treatment group showed overall improvement. The Kindergarten 2 treatment group demonstrated 86% overall improvement while the non-treatment group demonstrated 44% overall improvement.

To connect this improvement to in-class activities or the reading process, the researchers collected data on upper and lower case letter recognition and letter sound identification. These data may be found in Appendix E. Letter sound identification statistics were not kept at the beginning of the year as this skill is directly taught in the Kindergarten program. By the end of June 89% of the students could identify the correct sound for 22 out of 26 letter sounds. Table 5 represents the upper and lower case letter recognition average scores out of 26 letters and improvement percentages.

Table 5: Averages Letter Recognition (out of 26 Letters)

Letters	Non-treatment /26	Treatment /26
Upper: Pre Post	18 26	16 24
Lower: Pre Post	16 26	13 25
% Improvement: Upper Lower	26% 54%	37% 82%

In upper case recognition, the non-treatment group improved 26% from pre to post-testing, and in post-testing this group could recognize all the upper case letters. The upper case recognition of the treatment group improved 37% from pre to post-testing, and 67% could recognize all the upper case letters while 33% could recognize 24 or more letters. In lower case recognition, the non-treatment group improved 54% from pre to post-testing and in post-testing, and fifteen out of sixteen students could recognize all 26 lower case letters. For the treatment group, lower case recognition improved 82% from pre to post-testing, 67% could recognize all the lower case letters, and 33% could recognize 25 or more letters. The graphs for upper and lower case recognition for all the Kindergarten students show that all the students could recognize 24 or more of the 26 letters by the end of June.

WAS IMPROVEMENT DUE TO VISION THERAPY OR MATURATION?

In Trial I, the only instructional difference between the treatment and non-treatment groups was the vision therapy that the treatment group received. The treatment group demonstrated its highest level of improvement on the Monocular Acuity test; an 81% improvement over the non-treatment group in post testing, which suggests that the improvement is due to more than maturation. In the Polarized Suppression test, the treatment group scored 9% higher than the non-treatment group. The *TVPS* and the *VMI-Integrated* scores also were 12% and 10% higher, respectively, for the treatment group in comparison to the non-treatment group.

As described earlier, in the Cover, Near Point, Accommodation, and Piaget tests, both groups scored equally in pre and post-testing. In the computer tests both groups scored low. The non-treatment group had higher improvement in the Near Point test, even though the treatment group had received practice. This result might be explained by an inability in the students to make the transition from the pencil used in practice to the painted Popsicle stick used in the testing.

Again in Trial II, the only instructional difference between the treatment group and non-treatment group in both Kindergarten classes was the vision therapy. Both groups consisted of students who were also receiving Fine Motor and Speech/Language remediation. Both groups received the same phonemic awareness program (*Animated Literacy*), and were taught other in-class Kindergarten curricula. The age spans of both groups were similar. Yet in Trial II, the treatment group test scores improved 21% overall from pre to post-testing, whereas the non-treatment group test scores improved only 5%. In October the treatment group could recognize 62% of the upper case letters and 50% of the lower case letters of the alphabet, while the non-treatment group could recognize 69% of the upper case letters and 62% of the lower case. By June, all the Kindergarten students were able to recognize 24 or more of the 26 letters of the alphabet, both upper and lower case. The treatment group had made an improvement of 37% from pre to post-testing in recognizing of upper case letters while the non-treatment group had improved 26%. The treatment group had made an improvement of 82% in recognizing lower case letters, while the non-treatment group made a 54% improvement in this area. By the end of June the researchers could not differentiate between the treatment group and the non-treatment group in terms of letter recognition – all students in both groups had attained the learning outcome of recognizing 24 or more letters of the alphabet.

The first trial ANOVA analysis indicates that there were significant differences between the treatment and non-treatment groups in the Kindergarten 1 class pre-

testing of the Bernell, Monocular, Visual VMI, and TVPS scores. However, the post scores in those tests indicated no significant difference between the groups except in the post TVPS, in which the treatment group scores showed 14% improvement in comparison to the non-treatment group improvement score of 16%. As Professor Duncan pointed out, if the goal was to improve the treatment group so that these students performed at the same level as those in the non-treatment group, then these results might be a positive indication that both groups were now performing similarly.

The significance of improvement in test scores, as defined by the researchers, is shown in Tables 7 and 8.

Table 7: Researcher-Defined Significance of Improvement Scores: Trial I

Group	20% or More (Great Significance)	19 - 10% (Moderate Significance)	9% or Less (Small Significance)	Scores Went Down
Treatment	Monocular (140%) Nrpt. (71%) Bernell (28%)	VMI – M (10%) TVPS (17%)	VMI-I (9%) VMI-V (6%)	
Non-Treatment	Monocular (59%) NrPT (92%)	Bernell (19%)	VMI-V (5%) VMI-M (4%) TVPS (5%)	VMI-I (-1%)

Table 8: Researcher-Defined Significance of Improvement Scores: Trial II

Group	20% or More (Great Significance)	19 - 10% (Moderate Significance)	9% or Less (Small Significance)	Scores Went Down
Treatment	Monocular (30%) Nrpt. (92%) Bernell (25%) VMI-V (21%)	TVPS (14%) Piaget (16%)	VMI-I (8%) VMI-M (9%) Stereopsis (4%)	CovrTest -4%)
Non-Treatment	Nrpt (40%)	TVPS (16%)	VMI-I (5%) VMI-M (6%) Stereopsis (2%)	Monocular -5% Bernell - 4% VMI-V 0% CvrTest -3% Piaget -5%

In Trial I, the treatment group had more significant scores in the 20% range than the non-treatment group, and it scored much higher than the non-treatment group on the TVPS. In Trial II, the treatment group improvement scores were more significant than those of the non-treatment group, showing significance in nine out of ten tests as opposed to significance in five out of ten tests for the non-treatment group. The treatment group also had fewer improvement scores in the negative numbers, with one out of ten tests providing negative numbers as opposed to five out of ten tests for the non-treatment group.

It is the researchers' opinion that the improvement in visual efficiency skills was not due to simple maturation because the non-treatment group did show the same improvements.

WHAT REFLECTIONS ON THE PROCESS WERE PROVIDED BY THOSE INVOLVED?

THE TREATMENT GROUP

The treatment group was given a survey at the end of the testing phase. Each student in the group was interviewed one-on-one by the Special Education teacher in the resource room. All students were asked three questions and then required to draw a picture of their favourite part of doing the eye exercises. The answers were recorded by the teacher.

The three questions were:

1. What was your favourite part about working on the computer and doing eye exercises?
2. What didn't you like about working on the computer and doing the eye exercises?
3. Do you think you see things better now? How do you know?

TRIAL I:

Each student had a favourite activity on the computer. The one mentioned most often was the arrows game, in which the student had to push the arrow key that matched the blue one on the screen. One student preferred the squares with the dots because he was good at doing it. However, most didn't like this activity because the dots were hard to find. Others didn't like the vergences test because it took the longest time on the computer. One student liked it when the graph showed up at the end of the program, because "I see how I went up". Two students liked the *I Spy* books activity the best.

The answers to question three varied:

I can see things in the classroom better now, like the games on the computers.

Yes, I can see the farm animals in the farm center better.

Yes, I can see on the computers better in the classroom and here.

Yes, my writing. I can see it when I make my /s/. I used to make the stem too short at the bottom.

Yes, my brain is telling me everything better. Everywhere I go looks better and clearer.

Yes, because I see the arrows better. They're less fuzzy and blurry.

Yes, because my brain tells me. I know when I'm riding my skateboard because I can see where I'm going. I can see my friends.

Yes, things look bigger.

All students were asked their opinion about being pulled out of class to do the vision therapy. All reported that they didn't mind coming out of class and found the computer activities fun. One student commented that now when its center time, "we all pretend we put the glasses on and are doing the testing". Another student stated that when he put the tinted glasses on, it "looks like I'm in a different world." Clearly the treatment group found the one-on-one time fruitful and fun.

TRIAL II:

When asked about their favourite part of doing eye exercises, the treatment students in Trial II were divided. Five mentioned the paper/pencil workbook, three mentioned the pencil push-ups, two mentioned the see and say activities and one cited the I Spy activity with the flipper.

When asked about the part they didn't like, five said the pencil-push-ups, three mentioned the Lora's Card/Arrows Card activities, and one mentioned the paper/pencil activity. Two students said they liked everything.

When asked if they thought they see things better now and how did they know, the students responded as follows:

Yes, I can see yards better.

Yes, when one eye is covered, this eye can see,

Yes, I see movies better;

Yes, because (now) I look closely,

Yes, I can see everything better. Like T.V., game box, everything,

Kind of. My eyes get blurry. If my eyes are looking at something for a long time they get blurry,

Yes, pictures on paper are better;

Yes, I sometimes wear my glasses at home but not here. I can see my toys better at school and at home. Sometimes, I can't see my toys better here.

Yes, because my eyes feel better. They don't get sore.

Yes, I can every part of my bike now. I am not blind,

Yes, I can see letters better.

KINDERGARTEN TEACHER

The Kindergarten teacher's reflections on Trial I included the history of our discussions and thinking around vision therapy. Her greatest challenge was "finding time for vision therapy in an already busy day". Her reflections are given in full below:

When the study began, I had been teaching kindergarten at my school for five years. During that time, our school division had developed and implemented a kindergarten-screening program designed to identify students at risk. The program included fine motor, speech and language, behavior, dental, and phonemic awareness assessments. In addition, a public health nurse checked the students for near or far sightedness. Based on my classroom observations, I believed that an area of screening was missing, the area of visual effectiveness and visual/motor integration. I was observing students with difficulty identifying one letter from another; remembering letter names, being able to copy letters and other shapes from the white board onto paper, and being able to track printed work from left to right and top to bottom. Louise McCulloch and I had been looking at various ways to help these children, and in the winter of 2003 decided to make a formal study of the efficacy of using vision therapy in the kindergarten setting.

In mid October, I completed the fine motor screening and the initial kindergarten skills assessment that forms the basis of the kindergarten report card. I was particularly interested in the area of letter and sound and identification and felt vision therapy might help students with this.

Finding time for vision therapy in an already busy day was one of the biggest problems for me. There were times when the students needed to be in the room for direct teaching or whole-class activities. Eventually, a schedule was developed and the students spent about ten minutes in the morning and fifteen minutes in the afternoon with the Instructional Assistant who conducted the remediation. This usually happened during centre-time, a learning-centered time to play. The students appeared willing to go to their sessions, and did not appear to miss out on any classroom learning.

The kindergarten teacher's reflections on Trial II indicated that she had a more positive attitude towards the students being pulled from class for the therapy. Knowing what to expect and the shorter remediation time helped to minimize the problem she had with this.

These reflections come after the second year of offering a vision therapy program to our Kindergarten students. Knowing what to expect this time around helped me in several ways. Right at the beginning of the year, I identified times that would work best for the students to be pulled out of class for therapy. The problem of finding time for therapy did not seem to be as large a problem as a result. Having seen the positive results from the previous year, I had a more positive attitude toward the children being out of the classroom.

I believe that the students in Kindergarten received the best we could provide in terms of vision, speech/language, fine motor and phonemic awareness screening and remediation. I believe that vision therapy was an important part of the program. As a grade one teacher now, with the same students I had last year, I am enjoying the results of what I feel was a very worthwhile study.

TEACHER ASSOCIATES

The instructional assistant provided written comments on what she and the students did in carrying out various visual therapy exercises, and she shared her perceptions of the impact of the vision therapy on particular students in both trials. Given below are her observations about the students following the second trial:

Student A: His daily performance was very inconsistent. He usually responded better early in the day. For much of the time his glasses did not fit properly and he could look over top of the lenses with his left eye. They were repaired towards the end of the sessions. He tried very hard during the pencil push ups and visual tracking. His left eye would turn out, even though he would try to stay focused. In the I Spy warm up activity, he could spot the objects the majority of the time. His biggest limitation was his limited vocabulary. He was a very independent worker on the computer. He could move from one program to the next without assistance. Most days he was hard to keep on task until the last game.

Student B: He was always a willing participant in the sessions. He would always try to do his best job. His performance in the warm ups exercises improved significant from the start to the end. Initially his eyes could not cross as the stick approached his nose. His right eye started to move after 9 sessions. Eventually both eyes would stay focused. In Visual tracking he needed prompting to keep his eyes on the stick. He could consistently find the objects in the I Spy, with his limitation being his vocabulary.

Student C: She was always willing to leave the class for vision therapy. She would start off strong and did well on the warm up activities. She could consistently find the objects in the I Spy warm up. She would start to lose her focus on the computer games and often by the last one, it would seem that she was guessing. Her focus improved greatly by the end of the sessions.

Student D: She was usually reluctant to leave the class for the sessions, however, her performance in the warm up activities was strong throughout. She excelled at finding the objects in the I Spy book. She needed to be kept on task when on the computer, especially towards the 4th or 5th game. She did improve in this regard towards the end.

Student E: She was always willing to come out and work, but would constantly ask "how much longer" or "when will be finished". She did well on the warm ups, although some days her left eye would turn out and not stay focused during the pencil push ups. She liked the I Spy warm up and did well on it. She would show good concentration on the computer until the 4th or 5th game. She struggled with Accommodative Rock and would always seem to be guessing. This did not change until the last few sessions.

Student F: He did not like to go out of the class for vision therapy. He was difficult to keep on task and was easily distracted. He struggled to keep his head still in visual tracking. He could find the objects in I Spy most of the time, but usually needed extra prompting due to his limited vocabulary. He had to be monitored on the computer to ensure that he was not pushing other buttons. His ability to focus varied from day to day. He usually performed better early in the day.

Student G: He was a willing participant in vision therapy. He was consistently strong in the warm ups and on the computer. He was able to stay focused until the end of the sessions.

The instructional assistant also provided the following general observations from her experience in providing vision therapy to students:

- Most of the children performed better and were more eager early in the day.
- The environment was not ideal, as the computer should be on a lower table with an adjustable chair.
- The computer should be situated in a location where it can be accessed at all times of the day. At [our school] this would probably be the library.
- The children grew tired of the games as they did not change from the beginning of the sessions until the end. A variety of activities on the computer may have made it easier to keep the children's interest.
- The program itself is difficult to use with only being allowed on 1 computer. The format of having only so many runs led to problems. New disks were not accessible without phoning for confirmation numbers. We lost at least five days of computer sessions due to the program glitches.

SPECIAL EDUCATION TEACHER

Given in full at the end of this section are the Special Education Teacher's reflections on both trials.

Her reflections on Trial I focus on the history, research, and testing aspects of the project. She found that there were too many tests in the first trial to be practical in an everyday school situation, one in which there was no grant money to provide release time for the tester. However, she was impressed with the increased awareness that the students displayed and the vocabulary they were using to describe how they were seeing. Treatment students were using the words "blurry", "fuzzy", and "clear" by the end of the remediation, and paying more attention to how they were seeing something. She found that the computer program did not seem to transfer readily to an in-class activity and it often provided practice in skills, not only in isolation, but at a level above the ability of Kindergarten students. When the Special Education teacher logged into the program as a twelve year old, she still could not pass all of the tests. Finally, she discusses a problem with the VMI scores for both groups being lower than expected, which might be attributed to post testing at the end of May instead of earlier in the month.

Her reflections on Trial II discuss the ease with which she could test and remediate in the second Trial. The testing was done early in the year, and time was taken to ensure all the students were confident about their other programs before starting the vision therapy. Remediation was easy to administer and short in duration. Post testing was completed the first week of May, which seemed to avoid the interference with end-of-year activities experienced the previous year.

In the Fall of 2002, I made a suggestion to the Kindergarten teacher concerning her class that year. The Kindergarten screening process suggests the Special Education teacher use the VMI as a tool to find the skill level of students who appear weak in the area of eye/hand coordination. I felt the VMI is an easy test to give, and it could be given to all the students, in the spirit of catching all the students who may need help.

Also, that Fall the Special Education teachers were given an in-service by Atrium Optometric Group concerning vision therapy, and the importance of screening for tracking and teaming skills when trying to discern reading problems. In addition, Dr. Patterson came to the Learning Disabilities Working Committee (with representatives from four school divisions) and presented information on vision therapy and suggested that maybe a partnership could be established between the educators and Optometry to screen and remediate students. The committee was concerned about the research base for vision therapy and I, with two other members, offered to do a literature review on the subject.

When the VMIs on the Kindergartens were assessed, several had low vision scores that were lowering the integration score. I suggested to the parents that they needed to find out their child's tracking and teaming abilities through an optometrist's assessment. Some went to Atrium Optical, completed the assessments and began paying for vision therapy. This was a concern for me because I did not feel comfortable referring parents for testing and therapy with a cost involved.

A few months later two of the parents came to me and said there was a homework component to the vision therapy, and they were having trouble completing the practice at home consistently. I contacted Dr. Patterson and asked permission for the school to do the therapy. Dr. Patterson was also concerned about the inconsistency of the homework plan and agreed. The therapy consisted of pencil push-ups, following a wavy line with a pencil, tracking along a row of letters and circling the one underlined, and following arrows on a page. In addition the students played a bean bag toss game and followed a bead along a line. I used these activities with all the students who had scored low on the VMI test. At the end of the year, I post tested this group and the scores had gone up 20% or more from the pre tests.

The Kindergarten teacher and I had many discussions concerning vision therapy over the next year. The Kindergarten screening process has a fine motor component which includes remediation, why not for vision skills? When the idea came up at the next Learning Disabilities Working Committee meeting, it was cautiously received. A strong research base was needed before vision therapy could be recommended. When the Stirling McDowell grant program information came up at a staff meeting, the Kindergarten teacher and I decided to try for the grant in order to properly study vision therapy in the school setting. I consulted with a colleague at the University of Saskatchewan as to how the methodology should be set up. We applied for the grant and received approval for the four year study.

The research literature review took much longer to complete than planned. In many ways, I am glad we started it before the Stirling McDowell project. The articles were difficult to find and the reactions of professionals often baffling. However, we learned much about how to make our study more valid, and which type of vision therapy to use.

I was overwhelmed when Dr. Patterson chose a wide range of tests to be used in the study. I knew from the start that there were too many tests to be viable in the school setting. However, we had no idea which tests would give us the best information, so in that way it was good to do them all. I practiced with Dr. Patterson how to administer the tests, and then learned how to do the remediation

which I taught to the teacher associates. We worked hard to keep all of our jobs separate. The Kindergarten teacher would only work with the control group. Dr. Patterson would never see the students, but only evaluate based on the results placed in front of her. I would handle all the testing, and trouble shoot problems with the computer program. I never sat in on the remediation times with the students and had no idea how they were doing until the post testing.

Kindergarten students are a joy to test. They are a very guileless, cheerful lot, and eager to please. They were all very determined to do well and make sense of the objects they were trying to manipulate. The differences in their approaches to the tests were also interesting. The VMI is a mostly drawing test, and the students tended to be very chatty while completing it. The TVPS is a "point and shoot" test, where the students point to the correct shape. The silence in the room was often numbing, as each student took almost ten minutes to complete the test. One student however discussed each shape as it came up with details on her opinion of it, as well as what it looked like, and "where is the right one?" I was also impressed with the increased awareness the students displayed and the vocabulary they were using to describe how they were seeing. Treatment students were using the words "blurry", "fuzzy", and "clear" by the end of the remediation, and paying more attention to how they were seeing something. Something unexpected was the low scores by both groups on the VMI in post tests. We had been careful when setting up the study to ensure that post testing did not occur in June, as I had found Kindergarten students and Grade One students seem to score poorly at the end of the school year. In British Columbia, where I taught previously, we completed CATV testing the first two weeks of May for that reason. However, the VMI scores were not as high as expected, nor as high as the students we had worked with in previous years at the same time of year.

The computer program was the most frustrating. I could see that the students hadn't improved as each one went through the post test. There had been many phone calls to the head office in Arizona, with private codes being use to get more disk space and open activities. The final hurdle concerned printing the results of the remediation group. These results were all in graphs for each student and each activity. No matter how we tried, even at Atrium Optometric Group with their version of the program, we could not print off the results, and had to send the disks to Arizona for the head office to print and send back to us. Also, the computer program did not seem to readily transfer to an in class activity and often practiced skills not only in isolation, but at a level far above Kindergarten students. I tried the program myself, logged on as a twelve year old. I still couldn't pass all of the tests. I tried with two other staff members and they couldn't pass all the tests either. Dr. Patterson, upon reviewing the computer post-test scores, indicated the students had improved skills from pre testing.

Trial II has been easy in comparison to Trial I. The tests were faster and easier to use. The students seemed to enjoy the Stereopsis more than the computer program. I felt more engaged with the remediation process and seeing the results myself each day. The remediation took only one half hour out of my day, and I used I.A. interns to assist with the workbook and I Spy activities. Statistics are interesting but there is a sense of excitement with the Trial II group. We are giving them the best shot possible at acquiring the reading process. The students targeted are receiving speech/language, fine motor and vision therapy. The Animated Literacy program uses phonemic awareness with visuals, drawings and motor cues. Even though there is a wide range of abilities, we are seeing the

students coming into Grade One this year as a cohesive whole. They are focused and eager to participate in the reading process.

If you were to ask me if vision therapy was worth the effort, I would have to say yes. It makes sense to my special education mind that eye tracking and teaming is a factor in the reading process. Vision therapy is not the cure, but it can be a piece to the puzzle in reading remediation. If we can make one aspect in the student's life easier – that is they can follow from left to right across a line of letters and see them clearly – then that is one more battle won in the war. What remains to be decided in the focus group and second trial is what tests are we going to use, what policy are we going to follow in assessments, and which remediation tasks are going to be promoted? I would like to see a return to more paper/pencil remediation strategies that we saw in the first year working with Atrium, as these activities relate more to in class tasks. I think it's true that good research spawns further research, so we will continue with our project and see what happens.

OPTOMETRIST

At the end of the trials, Dr. Patterson of Atrium Optometric provided the following reflections:

I personally don't think eye exercises correct nearsightedness, farsightedness, astigmatism or loss of accommodation with aging. Concerning ophthalmologist research and dyslexia, the definition used here is not in my circles. I define it as a brain disorder that is outside of my expertise. On learning to read, the goal of vision therapy is to make these skills automatic. A student may be able to do all the skills but with effort and concentration – and then can't concentrate on the content of the materials.

Accommodative facility is easier to facilitate in older groups. The American Optometric Association News joint study which advocates the use of orthoptics for six months, evaluating whether reading ability has improved, and then trying other interventions – this depends on how far behind the child is. These therapies are targeted at giving the child the skills to be able to read comfortably. Sometimes there still is a catch-up period, with no progression. Vision therapy is one piece of the puzzle. Olitsky's opinion that optometrists have a financial interest in proving vision therapy is possibly true in the U.S. but definitely not in Saskatchewan. I try to keep things simple. I address primarily visually related skills both efficiency and perceptual that can and do affect reading ability. Those things can be trained in an attempt to help the child's progress and meet their potential. The issue of learning is bigger and more complex. I think you need to really look critically at what is being opposed. I would be in agreement that we're not treating learning disabilities or dyslexia. It needs to be broken down into smaller groups. Again, I believe we are just a piece of the puzzle. Why would we consider vision therapy to the exclusion of all else. People are not made up that way. Everything is integrated and must therefore, use a multidisciplinary approach. Cooperation rather than opposition would be nice.

ARE THE COSTS IN TRAINING, STAFFING, AND TIME WORTH IMPLEMENTING VISION THERAPY IN THE SCHOOL?

The cost of materials for both trials was \$1,530 Canadian (rounded). This figure includes all of the charts, flippers, workbooks, *VMI*, *TVPS*, Stereopsis, and computer testing/remediation CDs. It covers the testing package and the remediation materials except for the *I Spy* books, which were on hand at the school library. Training was completed in two, two-hour sessions at Atrium Optometric Group by Dr. Patterson. In the second trial, one paraprofessional and one Special Education teacher were needed, at the same time, for 30 minutes. The researchers believe the material cost was not expensive compared to other remediation programs, such as Speech/Language or Occupational Therapy materials. The staff requirements in the second trial, was more efficient, and not unreasonable compared to other remediation programs in the school. The researchers feel the cost, time in training and staffing, as set up in trial II, were worthwhile in administering vision therapy.

Trial I Treatment Group – Second Year

Table 9 describes the number of tests in which the Trial I treatment group showed improvement at the end of year two. The students were assessed using all of the ten post tests for Trial II and the Woodcock-Johnson III reading subtests (shown in Grade Equivalents or GE). One student had moved away, and three who had repeated Kindergarten are noted in the Table with a “K”. This treatment group did not receive any vision therapy in the second year. Six out of the nine students showed improvement in 70% or better of the tests. The T-Test descriptive statistics indicated that these students improved significantly on the VMI – Integrated tests from the end of Kindergarten to the end of Grade One, without having VT during the year.

Table 9: Trial I Treatment Group: Second Year Results

Student	# Tests Improved Scores from K	# Tests Scores the Same as K	# Tests Scores Down from K
1. (K)	7	3	0
2.	8	1	1
3.	8	2	0
4. (K)	8	0	2
5. (K)	8	1	1
6.	6	4	0
7.	7	3	0
8.	6	2	2
9.	4	2	4

Of the students who repeated Kindergarten, one was designated as developmentally delayed and another as dyspraxic. Two of the Grade One students subsequently received support for Language Arts. One of those receiving this support was designated as a special needs student in Grade Two following doctor diagnosis of brain injury, and the other is now seeing an ophthalmologist regarding optic nerve concerns. Therefore, four of the nine students who received vision therapy

treatment in Trial I have been diagnosed with other problems since the start of the study. The *Woodcock-Johnstone III* subtest scores are indicated in Table 10 in Grade Equivalents. It will be interesting to compare the scores of the students who repeated Kindergarten with the scores of those who participated in Trial II – Second Year results, since they are all in the same classroom this year.

Table 10 Woodcock-Johnstone III Reading Subtest Results: Trial I (Second Year)

Student	Letter-Word	Reading Fluency	Word Attack	Picture Vocab.	Reading Vocab.	Overall Reading
1. (K)	1.2	<K.8	1.0	5.0	2.1	K.9
2.	1.2	<K.8	1.0	2.6	1.8	1.1
3.	1.9	1.6	2.2	K.7	1.9	1.9
4. (K)	K.8	<K.8	1.0	<K.0	<K.7	<K.8
5. (K)	K.6	<K.8	1.0	<K.0	<K.7	<K.8
6.	1.6	<K.8	1.6	1.6	1.5	1.2
7.	2.5	2.6	3.7	1.2	1.6	2.5
8.	2.0	1.7	2.2	2.6	2.2	1.8
9.	3.5	2.3	3.2	5.0	2.3	2.8

Focus Group Discussion Summary

QUESTION #1: IS VISION THERAPY EFFECTIVE IN THE KINDERGARTEN SETTING?

Yes, overall the treatment group in both trials demonstrated statistically significant improvement over the non-treatment group.

Two issues were raised by Dr. Patterson concerning the data from Trial I. She asked: was there consistency in training from optometrist to teacher to paraprofessional? She also pointed out that certain tests were not considered in the statistics provided by the study and yet are important. Her questions led to a discussion of how effectiveness is measured. It was agreed that not all effectiveness can be measured statistically. There are benefits to the process in addition to the statistical results. For instance, in Trial II pre-testing showed a considerable gap between the treatment group and the non-treatment group in letter recognition skills. However, post-testing showed virtually no gap between the two groups. On the vision tests in Trial II, the treatment group performed better than the non-treatment group in all of the post-tests except for the *TVPS*, which is understandable because there was no remediation provided for the *TVPS* skills.

In the first trial school personnel found vision therapy effective but time-consuming and staff-consuming. There were doubts about carrying out vision therapy in a Kindergarten environment. It was pointed out that students might have other deficits, e.g., vestibular issues, that could be overlooked if the primary focus in Kindergarten is on vision therapy. The second trial specifically addressed these problems.

Dr. Patterson also raised the question: Did this study measure exactly the visual efficiency skills that all three of the researchers wanted tested? It was acknowledged that for the most part, this study focused on vision therapy that could be best done by people who were not trained as optometrists. The vision therapy protocol for optometrists involves a two-hour assessment, ten remediation sessions of one hour a day, and practice sessions at home for one hour a day, all provided at a cost to the parents. The goal of this study was to come up with a model of vision therapy that schools could adopt, in which the school administered a preliminary visual efficiency skill screen, referred students to optometrists, and, if feasible, provided basic visual efficiency skills remediation. It was noted that not all the possible visual efficiency tests or remediation could be completed in a school setting due to time constraints in the school day, staffing issues, the time that students were required out of the classroom, and the testing limits of five year old students.

Vision therapy in the Kindergarten setting is best regarded as another tool in the reading skills box. It provides another piece to the puzzle of remediation for improving reading skills just as Speech/Language Therapy and Occupational Therapy do. The present Kindergarten screening process already provides the medium for visual efficiency screening.

QUESTION #2 WHAT POLICY AND PROCEDURES ARE NEEDED FOR VISION THERAPY?

1. At ages three and four, all children should have a mandatory eye exam that includes testing for visual efficiency skills. The cost of the exam should be covered by Saskatchewan Health. It was noted that even the critics of vision therapy found through the literature review admitted that vision therapy causes no harm.
2. Schools need to liaise with pre-schools to educate parents about the importance of getting their children tested for visual efficiency skills at age three. A pamphlet on the issue should be available for each parent in community.
3. Ideally, all students would be screened for visual efficiency skills in preschool, thus meeting recommendations of the nursing study (Cheetham, 1998) that screening be administered in a school setting. Preschools could have package of activities that promote eye tracking and teaming.
4. Public Health should carry out these visual efficiency tests before Kindergarten. Kindergarten screening should continue for the benefit of children who have been missed.
5. The Kindergarten screening process should include monocular/binocular skills and eye tracking and teaming tests, not just 20/20 tests.
6. A remediation package of visual activities for Kindergarten students should be developed by an optometrist.
7. A pamphlet should be available for Kindergarten orientation night that includes information about having an optometrist test children for eye tracking and teaming.
8. Home or school vision therapy programs should be under the direction of an optometrist.
9. An optometrist needs to be part of the program plan meeting for Kindergarten.
10. An optometrist needs to assess any data about vision therapy programs and give recommendations to parents or the school.
11. Higher level testing and remediation need to begin with Grade One students who are experiencing problems in a vision area. The computer test and remediation program may be used with students in Grade Four and up.

FINAL THOUGHTS

The focus group held at the conclusion of the second trial added the following thoughts to the questions raised and discussed at the conclusion of the first trial:

1. The researchers need to raise the profile of vision therapy with parents, teachers and school divisions as a necessary screening tool in the Kindergarten setting.
2. The researchers need to share the results of this study with Saskatchewan Learning and the Department of Health. These departments need to recognize that visual impairment affects more than 20 students out of 200. A redefinition of visual impairment may be needed or the definition may need to be expanded to include visual efficiency skills. In the same way that a student diagnosed with Central Auditory Processing problems can obtain funding for a sound field system, a student with visual efficiency problems could receive funding for vision therapy administered by an optometrist or a paraprofessional in the school setting.
3. The screening tools used in this research study may need to be refined or changed in order to utilize the tests that are the most effective predictors, based on the results of the second trial. Once the screening package has been finalized, it would be possible to train a specialist for each school division in much the same way that the division presently has a Speech/Language technician who screens students and, if necessary, refers them to the Speech/Language Pathologist.
4. The preferred steps for vision therapy would be as follows:
 - a) school administers preliminary screen,
 - b) school refers child to optometrist if screening indicates problems,
 - c) the optometrist completes a detailed assessment of the referred child,
 - d) the parents either arrange for the completion vision therapy for the child with the optometrist, or in collaboration with the school, for the completion of vision therapy during class time, and
 - e) the vision therapy would then be tailored to meet the student's individual needs.

If the parents do not wish to take their child for further vision assessment or therapy, the school could provide the basic package as presented in this study. The focus group concluded that although this last option was not the best, it was better to provide the student with partial remediation than not to provide the student with any treatment at all.

5. It was suggested that visual efficiency screening in the school promotes the province's educational philosophy of SchoolPLUS, since it brings together a number of interagency stakeholders.
6. Dr. Barb Patterson is needed as a continuing resource for schools concerning vision therapy and visual efficiency skills.

Conclusions

The mice in our opening fairy tale discovered the creature in front of them was an elephant once all the evidence was compiled and considered. The researchers also realized the relevance and importance of vision therapy in the school setting once the literature review was carefully weighed and the evidence of the data analyzed.

The literature review clearly showed that both the optometrists and ophthalmologists were disagreeing along lines of whether vision therapy “cured” reading issues – not whether vision therapy was useful. The researchers of this study accept that there exists no one “cure” for reading problems. In fact, educators already know the efficacy of using multi-modal techniques together in order to support all the skills needed to read efficiently. The ears must hear the correct phoneme, the eyes must see the correct grapheme and scan left to the next, the brain must pull the correct phoneme and grapheme together and apply meaning, and finally the mouth must articulate the correct phoneme or word. The Kindergarten screening program already remediates for weaknesses in fine motor, speech/language, and cognitive issues. Skill with the visual tracking and teaming was the only missing multi-modal component to the Kindergarten program.

It is extremely difficult to implement a fully randomized, double-blind, placebo research study in the school setting. An educational environment requires multi-modal, humanistic, and constantly evolving strategies or teaching methodologies in order to provide optimum learning opportunities for our multi-faceted students. Often all of this happens in the course of one lesson, never mind every day, week, month or year. It would be a useless quest, as researchers, to try and control all of the factors that occur in such an environment. Also, educators have a commitment to parents to show progress and effort in improving their children’s learning potential. Telling a parent that their child would not be given certain educational support for six months or a year because he or she might be a control participant or blind placebo participant would guarantee an unsigned consent form.

The researchers of this study chose the Kindergarten environment because we could safely state, that as much as could possibly be controlled in a school setting, the only difference between the treatment and non-treatment groups was the vision therapy. Parents of the control group students, who demonstrated significant drop in visual efficiency scores at the end of the study, were advised to check in with their optometrist over the summer.

The researchers also discovered that the answer to the efficacy of vision therapy would not solely be found in quantitative data. We compiled data from several sources and considered time, staffing, effort required, preparation, materials, and efficient remediation strategies. These are all factors teachers need to know before implementing any new teaching methodology.

Considering all of these factors, the researchers concluded that vision therapy improved the treatment groups’ ability to recognize upper and lower case letters and scan left to right on a line efficiently. The treatment groups started the year significantly behind the control groups in this area, but by the end of the year they were at par or better than the control group. The ability to identify the letters of the alphabet is one of the first skills required for acquiring the reading process. The researchers observed the improvement in classroom activities as well as formal data

collection. Vision therapy proved to be a useful and necessary component in acquiring the reading process. We believe, with proper training and support of staff, vision therapy could be implemented in any school setting.

In the process of completing this study, the researchers also discovered some other key issues in working with other stakeholders in the school setting. For instance, it would be advantageous for Health and Education to work more collaboratively together to benefit the students in the area of vision testing and remediation.

The Nursing Study (Cheetham, 1998) recommended the best time to test children's vision is in the Kindergarten setting. The study concluded the school should be responsible for arranging further vision testing for the students who need it and keeping track of whether parents comply with recommendations regarding vision.

An educator would point out that during the vision screening that now occurs in Kindergarten, the Public Health nurse uses an eye chart that has letters, although Kindergarten students may not recognize all the letters of the alphabet. This fact clouds the results of the test because the students must look at the chart, then find the letter on a card placed in front of them. This multi-step approach, requiring eye/hand coordination and letter recognition, can interfere with the direct acquisition of information about whether or not students can see a letter clearly or their eyes can work together efficiently. Even optometrists and ophthalmologists use pictures when testing vision in children of preschool or Kindergarten age. Dr. Patterson provided the authors with a *Bernell* chart using pictures, instead of letters, for this study. We explained the problem with the chart to the local Public Health representatives, and they suggested that optometrists needed to meet with them before changes could be made. Their reaction was understandable. Has Education ever sought out Health to ask for its input? Has Education ever involved Health providers in its research studies? Have all the stakeholders sat down together, on a regular basis to establish and routinely adjust the screening program?

Considering that dollars available to fund programs are scarce, the key to success for students is cooperation and collaboration across departments from the highest level on down. A policy put in place by senior government ministers can provide the framework for sharing expertise that will streamline and improve practice for all. The British Columbia Ministry of Education document, *Handbook for Integrated Case Management (1993)*, is an example of such a policy.

In addition, through this study Dr. Patterson and the Atrium Optometric group learned as much about how school operates and how children learn as the researchers did about vision therapy. When Dr. Patterson viewed the testing results from both Kindergarten classes in the first trial, she stated that, in her expert opinion, one whole class had failed the tests. She had no idea of the scope and magnitude of the issues being experienced in the school setting. Dr. Patterson suggested a wide variety of tests and activities to be used by the Special Education teacher in the remediation process. If the researchers had complied, the students would have been given an hour of vision therapy each day, which neither the Kindergarten program nor the Special Education teacher could facilitate. The realization of the numbers of students and the time constraints in schools provided the optometrists with a new understanding of the issues experienced in the school system. For the second trial, Dr. Patterson was able to select tests that were easier to administer in place of the first trial screening tests. Although this measure was taken at the expense of the completeness of the study, compromises were necessary. The focus groups suggested that screening and remediation be started in preschool or pre-

Kindergarten programs, with packages provided for either home or in-class use to lower the numbers of visual efficiency issues coming into Kindergarten.

Dr. Patterson has already found a vision therapy program for students grades one to six, especially designed for educators to use in any school setting. The program is called *Eyes on Track: A Missing Link to Successful Learning* (Remick, Stroud, & Bedes, 2000).

Even with an approved visual efficiency program in the school setting, there will be students whose vision problems require the expertise of the optometrist or ophthalmologist. Treatment of this kind is a financial burden for parents since vision therapy costs approximately \$50.00 per session and requires ten sessions. Although there are some government subsidies for families that fall into certain income ranges, it would be beneficial if Saskatchewan Learning made a determination about vision therapy and considered sharing its costs with parents, in cases where the vision problems are severe cases, and with schools, in cases where vision problems are less severe and remediation can be implemented. This policy could be similar to the funding of technical aids to assist students with hearing issues, such as sound field systems central auditory processing disorder.

If all these ideas were combined, students could experience the following scenario. Starting in pre-school or pre-Kindergarten, children would be screened for vision and visual efficiency skills jointly by Health service providers and the school system. Children with visual efficiency problems would be referred to an optometrist for assessment and remediation, paid for through Saskatchewan Health. At this stage, the Occupation Therapist might become involved to rule out vestibular issues. Vision therapy would be provided at pre-school or in the pre-Kindergarten setting by a trained teacher associate whose services were paid for by Saskatchewan Learning. The students would be tested each year and remediation, if required, would be ongoing and modified as needed as the student moved across the grades. The American Optometric Association (Organizational Policy, 1999) has described the vision therapy envisioned in this process as follows:

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 a part of a multidisciplinary approach to learning disabilities. (pg. 1)

Follow-up to this study is planned when the Trial I and II groups reach Grade Three. The treatment groups from both trials will be monitored in Grades One to Three and post-tested each year with the vision tests and the *Woodcock/Johnson -III* reading subtests. In Grade Three all the students will be given the CATV tests and the vision tests.

To be able to read efficiently our eyes must work together as a team, they must focus accurately, and they must track efficiently left to right. The recent *Kindergarten Screening Manual*, with study, (Scissons, et al., 2005) suggests that even with intensive remediation, 30% of students are still not reading at grade level by Grade Three. Keeping in mind that no one program can “fix” or “cure” reading problems, the researchers hypothesized that weak visual efficiency skills may cause some students to fall through the cracks of our screening programs and hinder other remediation strategies. If this vision therapy research shows at the Grade Three level that vision therapy has been useful, the type of visual therapy program described here could provide a missing component to the multi-modal methodology required for assisting all students to be more successful in acquiring letter recognition and the scanning skills needed to acquire the reading process.

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Appendix A: Definitions

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VISION AND LEARNING: AN OPTOMETRIC PERSPECTIVE

Optometric management of vision related learning problems can sometimes be divided into three dimensions.

1. Refractive Status, Eye Health, and Visual Acuity
2. Visual Efficiency Skills
 - a. Accommodation (eye focusing)
 - b. Binocular Vision (eye teaming)
 - c. Ocular Motor (eye tracking)
3. Visual Information Processing Skills

1. REFRACTIVE STATUS

- Myopia
- Hyperopia
- Astigmatism

Relationship between refractive status and learning:

Myopic (nearsighted) children tend to be good readers in school. Their vision is clear when reading and because they complain about not being able to see the board well, their needs are usually quickly addressed. Children with significant Hyperopia (farsightedness) and Astigmatism often go undetected because they have relatively clear vision. Because of the effort needed for them to see clearly however, they often experience eyestrain, blurred vision when reading and inability to attend and concentrate for adequate periods of time (and possibly reduced reading comprehension).

2. VISUAL EFFICIENCY SKILLS

A. ACCOMMODATION (EYE FOCUSING)

Eye focusing is important for schoolwork performance and when reading. This skill allows rapid and accurate shifts with instantaneous clarity from one distance to another, such as from desk to chalkboard. It also permits a person to maintain clear focus at a normal reading distance without fatigue or headaches.

SIGNS OR SYMPTOMS OF EYE FOCUSING PROBLEMS

- Blurred vision when looking from board to book to board
- Holds things very close
- Headaches when reading
- Fatigue at end of day
- Discomfort associated
- Eyes water or rubs eyes

B. BINOCULAR VISION (EYE TEAMING)

In order for an individual to have comfortable vision the two eyes must work together in a very precise and coordinated fashion. If this does not occur, it may result in double vision, loss of place when reading, eyestrain or headaches and inability to sustain attention at a visual task for any prolonged period of time.

There are several types of eye teaming problems that can occur. In one common form one eye may actually turn in or out intermittently. This type of problem is rather easy for an observer to notice. A more common form of eye-teaming problem occurs when the eyes have a “tendency” to turn and the ability to compensate for this tendency is inadequate.

SIGNS AND SYMPTOMS OF EYE TEAMING PROBLEMS

- Discomfort associated with reading
- Intermittent double vision
- Closes or covers one eye
- Letters or words appear to move
- Loss of place

Relationship of binocular vision problems to learning:

The efforts associated with trying to overcome eye teaming problems can lead to eyestrain, blurry vision, discomfort and possibly an inability to concentrate when reading.

C. OCULAR MOTOR (EYE TRACKING)

Movement of the eyes across a page of print involves saccades and fixations. Saccadic eye movements are rapid shifts of fixation from one part of the visual field to another. When reading there is a series of rightward saccades called forward fixations and when the end of the line is reached, a large leftward saccade or return sweep moves the eyes to the start of the next line. On each fixation or pause, the central retina (fovea) processes the information. The length of time that the eye pauses during a fixation is called the “*duration of fixation*” and the amount of reading material that is processed during a fixation pause is the *span of recognition*. As reading skill improves, eye movement patterns change – the number and duration of fixations decrease, saccades become longer, and the number of regressions decreases.

Some disabled readers tend to exhibit a greater number of fixations of increased duration, shorter average saccadic length and a higher proportion of regressions for their age and reading level than normal readers do. Some disabled readers have a saccadic dysfunction particularly with the execution of return sweep saccades. In addition some disabled readers are defective in their ability to maintain and shift visual attention, and would therefore have trouble with smooth pursuits allowing continuous clear vision of moving objects within a stable visual environment. Smooth pursuits may indirectly measure the ability of how a child can maintain and shift visual attention, a skill important when reading.

SIGNS AND SYMPTOMS OF EYE TRACKING PROBLEMS

- Excessive head movement when reading
- Frequent loss of place
- Skips lines when reading
- Uses finger to maintain place

Relationship of Ocular Motor disorders to reading:

Ocular motor disorders can interfere with almost any school activity requiring vision. Performance will be affected because the child will be unable to consistently make accurate eye movements to look from one point in space to another.

3. VISUAL INFORMATION PROCESSING SKILLS

• VISUAL SPATIAL SKILLS

Visual spatial skills refer to the child's understanding of directional concepts that organize the environment. Visual spatial skills develop from an awareness within the individual's body, of concepts such as left and right, up and down, and front and back. Visual spatial skills are important for the development of good motor coordination, balance and directional sense. Sub-skills that are evaluated include bilateral integration, laterality and directionality. Bilateral integration is the ability to be aware of, and use both sides of the body separately and simultaneously. Laterality is an important developmental skill that involves the establishment of internal coordinates from which visual-spatial organizational skills can develop. Directionality is the ability to project this set of internal coordinate into space.

SIGNS AND SYMPTOMS OF VISUAL SPATIAL DYSFUNCTION

- Poor athletic performance
- Difficulty with rhythmic activities
- Lack of coordination and balance
- Difficulty sitting or standing still
- Clumsy, falls and bumps into things often
- Tendency to work with one side of the body and not use the other side to stabilize or assist
- Difficulty learning left and right
- Reverses letters and numbers when writing or copying
- Reads or writes right to left
- Has trouble writing and remembering letters and numbers
- Has poor posture, leans against objects for support, works with head on desk

• VISUAL ANALYSIS SKILLS

Visual analysis skills contribute to the individual's ability to analyze and discriminate visually presented information. We subdivide this area into five categories including visual discrimination, visual figure ground, visual closure and visual memory and visualization. Visual discrimination is the ability of the child to be aware of the different features of forms including shape, position, size and color. Visual closure is the ability to recognize a symbol or object when the entire object is not visible. Figure-ground is the ability to recognize distinct shapes from their background, such as objects in a picture or letters on a blackboard. Visual discrimination, figure ground and closure problems may result in confusing words with similar beginnings or endings and even entire words. Visual memory is another important subcategory of visual analysis skills. Obtaining maximum information in the shortest possible time provides for optimal performance. The ability to retain this information over an adequate period of time is essential for reading comprehension and spelling. Dysfunction in visual memory may cause prolonged time in copying assignments, difficulty recognizing the same word on the next page, and difficulty retaining what is seen or read.

SIGNS AND SYMPTOMS OF VISUAL ANALYSIS DYSFUNCTION

- Has trouble learning the alphabet, recognizing words and learning basic math
- Confuses likenesses and minor differences
- Cannot recognize letters or simple forms
- Poor recall of visually presented tasks
- Makes errors in copying from chalkboard or from book to notebook
- Reverses letters, numbers or words
- Poor ability to remember what was read
- Mistakes words of similar beginnings
- Can't distinguish the main idea from insignificant detail
- Over generalizes when classifying objects
- Has trouble remembering letters or numbers or writing
- School performance not up to expected potential

• VISUAL MOTOR INTEGRATION SKILLS

Visual motor skills are related to an individual's ability to integrate visual information with fine motor movement. Another term for visual motor integration is hand-eye coordination. These skills are necessary for daily functional tasks, from playing ball to dressing to handwriting. Two sub categories are assessed within visual motor integration skills. They are visual motor integration and fine motor skills. Good hand-eye coordination is essential for the accurate production of written language symbols. To accurately reproduce a visual stimulus a person must be able to see that the patterns is made up of a certain number of parts and that these parts are connected in a specific manner. To reproduce the pattern the child must call upon analytical skills, integrate this information with other systems, and generate a motor response.

SIGNS AND SYMPTOMS OF VISUAL MOTOR DYSFUNCTION

- Sloppy drawing or writing skills
- Poor spacing and inability to stay on lines in written work
- Erases excessively
- Difficulty completing assignments in time allotted
- Can answer questions orally but has difficulty writing down answers
- Has difficulty copying from blackboard
- Dislikes fine motor activities such as writing, cutting and coloring
- Holds writing, painting, eating tools in awkward way
- Poor eye-hand coordination (buttons, building toys, zippers etc.)

Appendix B: Descriptive Statistics

ANOVA – PERCENTAGES

Picture/Drawing Statistics – Trial II

Treatment Group: Drawing /12 (ECERS scale)

Student	Sept.	June	Improvement + or -	In Fine Motor Group
1.	7	10	+3	Yes
2.	5	11	+3	Yes
3.	8	12	+4	
4.	9	12	+3	
5.	7	8	+1	Yes
6.	6	10	+4	Yes
7.	7	10	+3	
8.	9	10	+1	
9.	7	9	+2	
10.	6	7	+1	Yes
11.	5	9	+4	Yes

**6 students out of eleven (54%) in both Fine Motor and Vision Therapy. 4 students were just in vision therapy (36%) – 18% with large improvement in drawing parts of body. All treatment students showed improvement in this skill.
*** In printing names: all eleven treatment students were assessed as poor in September and all but four assessed as excellent printing of name in June (45% improved).

Control Group: Drawing /12 (ECERS scale)

Student	Sept.	June	Improvement + or -	In Fine Motor Group
1.	6	12	+6	
2.	12	12	0	
3.	10	12	+2	
4.	9	11	+2	
5.	5	12	+7	Yes
6.	8	11	+3	
7.	11	11	0	
8.	7	8	+1	
9.	8	11	+3	Yes
10.	7	10	+3	
11.	7	10	+3	
12.	9	12	+1	
13.	4	10	+ 6	Yes
14.	7	10	+3	Yes
15.	6	5	-1	Yes
16.	9	6	-3	Yes
17.	9	12	+3	

** 6 students out of 17 (35%) in Fine Motor group therapy.

*** 13 students demonstrated improvement, 2 zero growth, and 2 negative growth.

**** 9 out of 17 poor printing skills in September, and 2 out of 17 in June.

ANOVA
Between TR & Control

		Sum of Squares	df	Mean Square	F	Sig.
Premono	Between Groups	1.753	1	1.753	2.373	.136
	Within Groups	19.211	26	.739		
	Total	20.964	27			
Postmono	Between Groups	1.207	1	1.207	2.879	.102
	Within Groups	10.900	26	.419		
	Total	12.107	27			
Precover	Between Groups	5.079	1	5.079	.246	.624
	Within Groups	537.778	26	20.684		
	Total	542.857	27			
Postcover	Between Groups	57.857	1	57.857	3.669	.066
	Within Groups	410.000	26	15.769		
	Total	467.857	27			
PreNrPt	Between Groups	60.457	1	60.457	3.695	.066
	Within Groups	425.400	26	16.362		
	Total	485.857	27			
PostNrPt	Between Groups	14.464	1	14.464	1.313	.262
	Within Groups	286.500	26	11.019		
	Total	300.964	27			
PreAccom	Between Groups	.021	1	.021	.039	.846
	Within Groups	13.902	26	.535		
	Total	13.922	27			
PostAccom	Between Groups	1.403	1	1.403	2.373	.136
	Within Groups	15.378	26	.591		
	Total	16.782	27			
PreBernell	Between Groups	1097.600	1	1097.600	.862	.362
	Within Groups	33103.400	26	1273.208		
	Total	34201.000	27			
PostBernell	Between Groups	159.289	1	159.289	9.891	.004
	Within Groups	418.711	26	16.104		
	Total	578.000	27			
PrePiaget	Between Groups	12.007	1	12.007	3.182	.086
	Within Groups	98.100	26	3.773		
	Total	110.107	27			
PostPiaget	Between Groups	.972	1	.972	.178	.677
	Within Groups	142.278	26	5.472		
	Total	143.250	27			

PreInt	Between Groups	1531.207	1	1531.207	5.326	.029
	Within Groups	7474.900	26	287.496		
	Total	9006.107	27			
PostInt	Between Groups	255.150	1	255.150	1.992	.170
	Within Groups	3330.100	26	128.081		
	Total	3585.250	27			
PreVis	Between Groups	1004.464	1	1004.464	5.092	.033
	Within Groups	5128.500	26	197.250		
	Total	6132.964	27			
PostVis	Between Groups	913.753	1	913.753	3.704	.065
	Within Groups	6413.211	26	246.662		
	Total	7326.964	27			
PreMotor	Between Groups	1093.870	1	1093.870	1.922	.177
	Within Groups	14799.844	26	569.225		
	Total	15893.714	27			
PostMotor	Between Groups	338.420	1	338.420	1.278	.269
	Within Groups	6886.544	26	264.867		
	Total	7224.964	27			
PrePQ	Between Groups	2980.829	1	2980.829	21.195	.000
	Within Groups	3656.600	26	140.638		
	Total	6637.429	27			
PostPQ	Between Groups	905.257	1	905.257	4.131	.052
	Within Groups	5697.600	26	219.138		
	Total	6602.857	27			

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Premono	Between Groups	6.000	1	6.000	5.000	.049
	Within Groups	12.000	10	1.200		
	Total	18.000	11			
Postmono	Between Groups	2.042	1	2.042	1.877	.201
	Within Groups	10.875	10	1.088		
	Total	12.917	11			
Precover	Between Groups	4.167	1	4.167	.256	.624
	Within Groups	162.500	10	16.250		
	Total	166.667	11			
Postcover	Between Groups	.167	1	.167	.005	.947
	Within Groups	358.500	10	35.850		
	Total	358.667	11			
PreNrPt	Between Groups	15.042	1	15.042	1.040	.332
	Within Groups	144.625	10	14.463		
	Total	159.667	11			
PostNrPt	Between Groups	.667	1	.667	.195	.668
	Within Groups	34.250	10	3.425		
	Total	34.917	11			
PreAccom	Between Groups	24.000	1	24.000	1.761	.214
	Within Groups	136.250	10	13.625		
	Total	160.250	11			
PostAccom	Between Groups	37.500	1	37.500	2.304	.160
	Within Groups	162.750	10	16.275		
	Total	200.250	11			
PreBernell	Between Groups	35.042	1	35.042	14.677	.003
	Within Groups	23.875	10	2.388		
	Total	58.917	11			
PostBernell	Between Groups	.042	1	.042	.004	.949
	Within Groups	97.625	10	9.763		
	Total	97.667	11			
PrePiaget	Between Groups	13.500	1	13.500	2.967	.116
	Within Groups	45.500	10	4.550		
	Total	59.000	11			
PostPiaget	Between Groups	1.500	1	1.500	.196	.667
	Within Groups	76.500	10	7.650		
	Total	78.000	11			
PreInt VMI	Between Groups	70.042	1	70.042	.946	.354
	Within Groups	740.625	10	74.063		
	Total	810.667	11			

PostInt VMI	Between Groups	.167	1	.167	.002	.969
	Within Groups	1054.500	10	105.450		
	Total	1054.667	11			
PreVis VMI	Between Groups	2204.167	1	2204.167	12.268	.006
	Within Groups	1796.750	10	179.675		
	Total	4000.917	11			
PostVis VMI	Between Groups	140.167	1	140.167	.614	.451
	Within Groups	2282.750	10	228.275		
	Total	2422.917	11			
PreMotor VMI	Between Groups	60.167	1	60.167	.471	.508
	Within Groups	1276.750	10	127.675		
	Total	1336.917	11			
PostMotor VMI	Between Groups	88.167	1	88.167	.638	.443
	Within Groups	1382.500	10	138.250		
	Total	1470.667	11			
PrePQ	Between Groups	13537.500	1	13537.500	17.133	.002
	Within Groups	7901.500	10	790.150		
	Total	21439.000	11			
PostPQ	Between Groups	21540.042	1	21540.042	25.781	.000
	Within Groups	8354.875	10	835.488		
	Total	29894.917	11			

One Way

K-2 – Trial #2 – Between Groups

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Premono	Between Groups	5.730	1	5.730	8.654	.011
	Within Groups	9.270	14	.662		
	Total	15.000				
Postmono	Between Groups	.001	1	.001	.002	.967
	Within Groups	7.937	14	.567		
	Total	7.938	15			
Precover	Between Groups	.000	1	.000	.	.
	Within Groups	.000	14	.000		
	Total	.000	15			
Postcover	Between Groups	1.286	1	1.286	.048	.829
	Within Groups	373.714	14	26.694		
	Total	375.000	15			
PreNrPt	Between Groups	35.063	1	35.063	3.031	.104
	Within Groups	161.937	14	11.567		
	Total	197.000	15			
PostNrPt	Between Groups	.016	1	.016	.004	.952
	Within Groups	58.984	14	4.213		
	Total	59.000	15			
PreAccom	Between Groups	3.571	1	3.571	.513	.486
	Within Groups	97.429	14	6.959		
	Total	101.000	15			
PostAccom	Between Groups	6.036	1	6.036	4.286	.057
	Within Groups	19.714	14	1.408		
	Total	25.750	15			
PreBernell	Between Groups	150.893	1	150.893	7.630	.015
	Within Groups	276.857	14	19.776		
	Total	427.750	15			
PostBernell	Between Groups	1.286	1	1.286	.362	.557
	Within Groups	49.714	14	3.551		
	Total	51.000	15			
PrePiaget	Between Groups	4.321	1	4.321	.781	.392
	Within Groups	77.429	14	5.531		
	Total	81.750	15			
PostPiaget	Between Groups	4.191	1	4.191	.669	.427
	Within Groups	87.746	14	6.268		
	Total	91.938	15			

PreInt VMI	Between Groups	920.009	1	920.009	7.715	.015
	Within Groups	1669.429	14	119.245		
	Total	2589.438	15			
PostInt VMI	Between Groups	1280.254	1	1280.254	14.319	.002
	Within Groups	1251.746	14	89.410		
	Total	2532.000	15			
PreVis VMI	Between Groups	52809.143	1	52809.143	1.350	.265
	Within Groups	547724.86	14	39123.204		
	Total	600534.00	15			
PostVis VMI	Between Groups	522.893	1	522.893	2.667	.125
	Within Groups	2744.857	14	196.061		
	Total	3267.750	15			
PreMotor VMI	Between Groups	255.009	1	255.009	1.488	.243
	Within Groups	2399.429	14	171.388		
	Total	2654.438	15			
PostMotor VMI	Between Groups	1.509	1	1.509	.010	.921
	Within Groups	2047.429	14	146.245		
	Total	2048.938	15			
PrePQ	Between Groups	13391.147	1	13391.147	11.777	.004
	Within Groups	15918.603	14	1137.043		
	Total	29309.750	15			
PostPQ	Between Groups	15722.580	1	15722.580	10.065	.007
	Within Groups	21868.857	14	1562.061		
	Total	37591.438	15			

Appendix C: Remediation Data

REMEDIATION DATA TABLE AND SAMPLES OF REMEDIATION STRATEGIES

Table 4: Remediation Scores Treatment Group

*meeting = 0 errors
untimed
Independent = 0 errors
timed 1 min.

StudentSkills	Pre Skill Level	Post Skill Level
#1 a.) Pencil Push-ups	0/10	10/10
b.) Saccadic (one min.)	9 errors	0 errors
c.) Vis. Tracking	Need Supp.	8/9
d.) Lora's Card	Need Supp	Independent
e.) Ann Arbour (55)	Need Supp	No errors
f.) Arrows (44)	Need Supp	2 errors, some support
#2 a.) Pencil Push-ups	Need Supp	10/10
b.) Saccadic (one min.)	11 errors	7 errors
c.) Vis. Tracking	9 errors	2/7
d.) Lora's Card	Need Supp	Independent
e.) Ann Arbour (55)	Need Supp	22 shapes – 2 errors
f.) Arrows (44)	Need Supp	6 errors
#3 a.) Pencil Push-ups	3/10	10/10
b.) Saccadic (one min.)	4 errors	2 errors – 45 sec.
c.) Vis. Tracking	Need Supp	Meeting
d.) Lora's Card	Meeting	Meeting
e.) Ann Arbour (55)	Need Supp	36 shapes – timed
f.) Arrows (44)	1 error	2 errors - timed
#4 a.) Pencil Push-ups	7/10	9/10
b.) Saccadic (one min.)	8 errors	2 errors
c.) Vis. Tracking	Need Supp	4/9
d.) Lora's Card	Need Supp	Meeting
e.) Ann Arbour (55)	Need Supp	29 shapes
f.) Arrows (44)	Need Supp	6 errors
#5 a.) Pencil Push-ups	8/10	10/10
b.) Saccadic (one min.)	50 errors	0 errors
c.) Vis. Tracking	Need Supp	7/10
d.) Lora's Card	Need Supp	Meeting
e.) Ann Arbour (55)	Need Supp	55 shapes – timed
f.) Arrows (44)	Need Supp	0 errors timed 45 sec.

#6 a.) Pencil Push-ups	8/10 & bounce	10/10 no bounce
b.) Saccadic (one min.)	5 errors	3 errors
c.) Vis. Tracking	Need Supp	5/7
d.) Lora's Card	Need Supp	Meeting
e.) Ann Arbour (55)	Need Supp	18 shapes – 3 errors
f.) Arrows (44)	Need Supp	0 errors - timed
#7 a.) Pencil Push-ups	5/10	10/10
b.) Saccadic (one min.)	3 errors	0 errors
c.) Vis. Tracking	Need Supp	Meeting
d.) Lora's Card	Need Supp	Meeting
e.) Ann Arbour (55)	Need Supp	38 shapes no errors
f.) Arrows (44)	Need Supp	1 error – 50 sec.
#8 a.) Pencil Push-ups	0/10	10/10
b.) Saccadic (one min.)	2 errors	0 errors – 55 sec.
c.) Vis. Tracking	Need Supp	Meeting
d.) Lora's Card	Need Supp	Progressing
e.) Ann Arbour (55)	Need Supp	28 shapes – 4 errors
f.) Arrows (44)	Need Supp	3 errors
#9 a.) Pencil Push-ups	0/10	10/10
b.) Saccadic (one min.)	2 errors	0 errors
c.) Vis. Tracking	Need Supp	3/9
d.) Lora's Card	Need Supp	Meeting
e.) Ann Arbour (55)	Need Supp	25 shapes – 3 errors
f.) Arrows (44)	Need Supp	3 errors
#10 a.) Pencil Push-ups	0/10	10/10
b.) Saccadic (one min.)	0 errors	0 errors
c.) Vis. Tracking	Need Supp	Progressing
d.) Lora's Card	Need Supp	Meeting
e.) Ann Arbour (55)	Progressing	53 shapes- 1 min
f.) Arrows (44)	Progressing	0 errors
#11 a.) Pencil Push-ups	0/10	4/10
b.) Saccadic (one min.)	5 errors	0 errors
c.) Vis. Tracking	Need Supp	Progressing
d.) Lora's Card	Need Supp	Progressing
e.) Ann Arbour (55)	Need Supp	32 shapes – 2 errors timed
f.) Arrows (44)	Unable	2 errors with support

**TRIAL #1 – TREATMENT
Year 2**

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Year 1 Mono	3.2222	9	1.30171	.43390
	Year 2 Mono	3.3333	9	.86603	.28868
Pair 2	Year 1 Cover	20.0000	9	.00000	.00000
	Year 2 Cover	18.8889	9	3.33333	1.11111
Pair 3	Year 1 Nr. Pt.	6.3333	9	4.24264	1.41421
	Year 2 Nr. Pt.	9.4444	9	1.33333	.44444
Pair 4	Year 1 Accom.	3.5889	9	.90650	.30217
	Year 2 Accom.	5.8333	9	.35355	.11785
Pair 5	Year 1 Bernell	12.0000	9	5.09902	1.69967
	Year 2 Bernell	19.2222	9	1.39443	.46481
Pair 6	Year 1 Plaget	3.4444	9	2.35112	.78371
	Year 2 Plaget	5.3333	9	2.00000	.66667
Pair 7	Year 1 Int. VMI	72.3333	9	16.17096	5.39032
	Year 2 Int. VMI	75.1111	9	11.87902	3.95967
Pair 8	Year 1 Vis. VMI	87.2222	9	16.67916	5.55972
	Year 2 Vis. VMI	106.4444	9	24.12525	8.04175
Pair 9	Year 1 Motor VMI	96.7778	9	19.33118	6.44373
	Year 2 Motor VMI	95.3333	9	10.53565	3.51188
Pair 10	Year 1 PQ	92.2222	9	15.96698	5.32233
	Year 2 PQ	94.1111	9	15.16941	5.05647

Pair Samples Correlations

	N	Correlation	Sig.
Pair 1 Year 1 Mono & Year 2 Mono	9	-.185	.634
Pair 2 Year 1 Cover & Year 2 Cover	9	.	.
Pair 3 Year 1 Nr. Pt. & Year 2 Nr. Pt.	9	-.184	.635
Pair 4 Year 1 Accom. & Year 2 Accom.	9	.091	.816
Pair 5 Year 1 Bernell & Year 2 Bernell	9	.475	.197
Pair 6 Year 1 Plaget & Year 2 Plaget	9	-.408	.276
Pair 7 Year 1 Int. VMI & Year 2 Int. VMI	9	.955	.000
Pair 8 Year 1 Vis. VMI & Year 2 Vis. VMI	9	.388	.302
Pair 9 Yr 1 Motor VMI & Yr 2 Motor VMI	9	.782	.013
Pair 10 Year 1 PQ & Year 2 PQ	9	.848	.004

Paired Samples Test

	Paired Differences				
	Mean	Std. Deviation	Std..Error Mean	95% Confidence Interval of the Difference	
				Lower	Upper
Pair 1 Year 1 Mono - Year 2 Mono	-.11111	1.69148	.56383	-1.41130	1.18908
Pair 2 Year 1 Cover - Year 2 Cover	1.11111	3.33333	1.11111	-1.45112	3.67334
Pair 3 Year 1 Nr. Pt. - Year 2 Nr. Pt.	-3.11111	4.67559	1.55853	-6.70509	.48286
Pair 4 Year 1 Accom. - Year 2 Accom.	-2.24444	.94255	.31418	-2.96895	-1.51994
Pair 5 Year 1 Bernell - Year 2 Bernell	-7.22222	4.60374	1.53458	-10.76097	-3.68347
Pair 6 Year 1 Plaget - Year 2 Plaget	-1.88889	3.65529	1.21843	-4.69859	.92081
Pair 7 Year 1 Int. VMI - Year 2 Int. VMI	-2.77778	5.97448	1.99149	-7.37017	1.81462
Pair 8 Year 1 Vis. VMI - Year 2 Vis. VMI	-19.22222	23.40821	7.80274	-37.21537	-1.22908
Pair 9 Yr 1 Motor VMI - Yr 2 Motor VMI	1.44444	12.89487	4.29829	-8.46743	11.35632
Pair 10 Year 1 PQ - Year 2 PQ	-1.88889	8.60878	2.86959	-8.50618	4.72841

Paired Samples Test

	t	df	Sig. (2-tailed)
Pair 1 Year 1 Mono & Year 2 Mono	-.197	8	.849
Pair 2 Year 1 Cover & Year 2 Cover	1.000	8	.347
Pair 3 Year 1 Nr. Pt. & Year 2 Nr. Pt.	-1.996	8	.081
Pair 4 Year 1 Accom. & Year 2 Accom.	-7.144	8	.000
Pair 5 Year 1 Bernell & Year 2 Bernell	-4.706	8	.002
Pair 6 Year 1 Plaget & Year 2 Plaget	-1.550	8	.160
Pair 7 Year 1 Int. VMI & Year 2 Int. VMI	-1.395	8	.201
Pair 8 Year 1 Vis. VMI & Year 2 Vis. VMI	-2.464	8	.039
Pair 9 Yr 1 Motor VMI & Yr 2 Motor VMI	.336	8	.745
Pair 10 Year 1 PQ & Year 2 PQ	-.658	8	.529

Students	Group	Pretest	%/26 pre	Post test	%/26 post	Ave% Improv	Comparison
A	1	4	15.38462	26	100		
B	1	5	19.23077	26	100		
C	1	7	26.92308	26	100		
D	1	9	34.61538	26	100		
E	1	9	34.61538	26	100		
F	1	11	42.30769	26	100		
G	1	12	46.15385	24	92.30679		
H	1	16	61.53846	26	100		
I	1	21	80.76923	26	100		
J	1	22	84.61538	26	100		
K	1	23	88.46154	26	100		
L	1	25	96.15385	26	100		
M	1	26	100	26	100		
N	1	26	100	26	100		
O	1	26	100	26	100		
P	1	26	100	26	100		
		16.75	64.42308	25.875	99.51923	0.544776119	
Q	2	2	7.692308	25	96.15385	-0.92	
R	2	2	7.692308	26	100		
S	2	5	19.23077	26	100		
T	2	6	23.07692	26	100		
U	2	10	76.92308	26	100		
V	2	13	50	25	96.15385		
W	2	18	69.23077	26	100		
X	2	18	69.23077	25	96.15385		
Y	2	21	80.76923	26	100		
Z	2	24	92.30769	26	100		
AA	2	26	100	26	100		
BB	2			25	96.15385		
		13.18182	54.1958	25.66667	98.71795	0.821505517	28% + Treat

Students	Group	Pretest	%/26 pre	Post test	%/26 post	Ave% Improv	Comparison
A	1	5	19.23077	26	100		
B	1	9	34.61538	26	100		
C	1	11	42.30769	26	100		
D	1	11	42.30769	26	100		
E	1	10	10/.26	26	100		
F	1	15	57.69231	26	100		
G	1	17	65.38462	26	100		
H	1	18	69.23077	26	100		
I	1	25	96.15385	26	100		
J	1	26	100	26	100		
K	1	25	96.15385	26	100		
L	1	26	100	26	100		
M	1	23	88.46154	26	100		
N	1	26	100	26	100		
O	1	26	100	26	100		
P	1	26	100	26	100		
		18.6875	74.10256	26	100	-0.25897436	
Q	2	4	15.38462	24	92.30769	-0.83333333	
R	2	3	11.53846	26	100		
S	2	7	26.92308	26	100		
T	2	10	38.46154	25	96.15385		
U	2	15	57.69231	26	100		
V	2	15	57.69231	25	96.15385		
W	2	22	84.61538	26	100		
X	2	25	96.15385	26	100		
Y	2	25	96.15385	26	100		
Z	2	26	100	26	100		
AA	2	26	100	26	100		
BB	2			24	92.30769		
		16.18182	62.23776	25.5	98.07692	-0.36541889	10.6% + Treat

**2317 Arlington Avenue
Saskatoon SK Canada S7J 2H8
Phone: 306-373-1660
Toll Free: 1-800-667-7762
Fax: 306-374-1122
E-mail: mcdowell@stf.sk.ca**

www.mcdowellfoundation.ca