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The effectiveness of visual training on reading and academic achievement: A review of the literature

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Abstract
A representative sampling of the literature is reviewed in this paper to determine the effectiveness of visual training on improving reading and academic achievement. Background information on the relationship between vision and reading, the techniques used in these training programs, and the common flaws of research design are discussed. Poor subject selection, controls, and research design make it difficult to directly compare many of the studies; however, results were positively skewed toward the benefits of this type of training program. In conclusion the authors present their ideal research design which avoids the research flaws encountered in their review.

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THE EFFECTIVENESS OF VISUAL TRAINING ON READING AND ACADEMIC ACHIEVEMENT: A REVIEW OF THE LITERATURE

presented to

Dr. William Ludlam

for partial credit for a degree in Optometry

by

Susan Gordon &
William Lenon

/78/
ABSTRACT

A representative sampling of the literature is reviewed in this paper to determine the effectiveness of visual training on improving reading and academic achievement. Background information on the relationship between vision and reading, the techniques used in these training programs, and the common flaws of research design are discussed. Poor subject selection, controls, and research design make it difficult to directly compare many of the studies; however, results were positively skewed toward the benefits of this type of training program. In conclusion the authors present their ideal research design which avoids the research flaws encountered in their review.
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INTRODUCTION

In today's society, academic achievement is very closely linked with success. Failure to achieve academically may severely limit career opportunities. Academic achievement, beyond a minimum level requires the use of information gathered through reading. The importance of reading to academic achievement has generated great interest in the factors affecting reading. The causes and remediation of reading problems have probably been studied more than any other area of education.(12) Unfortunately, controversy still surrounds reading remediation. Confusion arises because reading is a very complex task, and because difficulties in reading may be caused by several factors that overlap and often confound one another.

Various remedial approaches have been developed. One of the major remedial approaches places emphasis on the basic sensory process underlying reading-vision. The subject of vision's relationship to reading and achievement has been predominant in the literature for the past forty years. Leading authorities from the fields of education, psychology, optometry and ophthalmology have all expressed opinions on the role of vision as a prerequisite for reading. The use of visual training as a means of improving reading and achievement has become a major issue and is an emotional one for those concerned with the problems of the underachiever. Extravagant claims and exaggerated criticisms abound, and yet, no definitive statement on the effectiveness of visual training has ever been reached.

The purpose of this paper is to summarize the research relating the effectiveness of vision training programs on improving academic
achievement, and to analyze the reasons why so much confusion still exists in this area. The paper will first discuss some of the background information dealing with the complex relationship between vision, reading and achievement. The basic types of visual training will be defined: binocular-function, visual-perceptual and visual-perceptual-motor training. The second section will examine the flaws and pitfalls commonly encountered in this type of research, and point out why so much of the research that has been done is unreliable and contradictory. In the third section a representative sampling of the research will be reviewed, and then followed by a discussion and summary of their results. Based on an analysis of these studies, the authors have designed what they consider to be a feasible study avoiding most of the flaws so commonly encountered in this type of research.
Reading is a fundamental tool for gathering the information needed for academic achievement. Unfortunately, despite its importance, reading is still not completely understood. Before the relationship between vision and reading can be discussed, it must first be specified what level of reading is meant. The term reading is used to encompass an enormous range of skills. The skills involved in learning to read are vastly different from those used in reading for information. One must also consider the different aspects of reading, such as speed, accuracy and comprehension, since each of these aspects also require different skills.

Levels of Reading

When a young child is first learning to read he must decode a visual symbol and match it with the appropriate vocal sound. This task requires the beginning reader to pay special attention to the details of letter and word construction, and to integrate these through memory and logic with the correct pronunciation. This requires visual-perceptual skills of form recognition, directionality and visual memory. The beginning reader must concentrate on the small shape differences between letters without confusing these with typographic changes found with various printing styles. The beginning reader is given large print that is widely spaced. He deals with short words isolated on the page or with large spaces between the lines. The child is not required to engage in the task for long periods of time. This means that the task of learning to read does not require the fine eye movement control or sustained visual functioning needed for advanced levels of reading.
The advanced reader is not as interested in decoding individual words as he is in abstracting the ideas conveyed in phrases and sentences. At this level the print is usually smaller and more closely spaced, requiring fine eye movements in order to maintain one's place and to take in uniform packets of information. When reading for information, the advanced reader is required to concentrate for long periods of time. This requires the ability to keep one's eyes focused and properly aligned with minimum effort for sustained periods.

Aspects of Reading

When examining studies relating visual requirements to reading it is important to consider not only the level of reading, but also the aspect of reading being measured. When the reading ability of either the advanced or beginning reader is being determined, there are several different aspects of reading that may be tested, each of which require different skills. Pierce (35) has enumerated the four principal aspects of reading, any or all of which may be included in a standard reading test:

1) Reading Rate: the number of words recognized per unit of time
2) Reading Accuracy: measured by counting the number of omissions, substitutions or additions made during oral reading
3) Level of Difficulty: complexity and length of words recognized
4) Comprehension: ability to answer questions after reading a standardized paragraph

Each of these aspects requires different reading and visual skills. The skills needed to recognize words in a list are much
different from those needed to comprehend a paragraph. A child may do well on a test of reading accuracy but do poorly on a timed reading test. Thus the visual skills required of a "good" reader vary greatly with the task. This is a point that many researchers have failed to keep in mind. No wonder the studies comparing the relationship between reading and vision often seem to reach conflicting conclusions. (35) It is important to consider the level as well as the aspect of reading being measured before its relationship to vision can be examined.

Aspects of Vision

A second major area of difficulty in trying to determine the relationship between reading, achievement and vision is in understanding what is meant by "Vision." Surprisingly, there is disagreement over the basic definition of vision. Vision is sometimes restricted to include only the physiological aspect of seeing clearly and at other times it is used in a broader sense to include the perception and interpretation of what is seen. At least three major ways of defining vision are in common use today.(26) Ambiguity between studies may seem to arise if careful consideration is not given to the definition of vision being used by the author.

The first definition, used predominantly by ophthalmologists and physicians, equates vision with sight and refractive error. To them, vision is the purely physical, mechanical act of seeing a clear image long enough to read small letters at twenty feet.(13) The incidence of refractive error found among poor readers varies slightly between the different studies, depending on the screening techniques used, the age of the students examined and whether or not the subjects
were wearing appropriate prescriptions. The conclusion reached by nearly all of the investigators using this definition has shown there to be very little relationship between reading ability and sight. (1, 13, 15, 35)

Many optometrists use a definition of vision that includes not only clear sight, but also binocular functioning ability and ocular motility. They consider the vergence movements and the focusing ability an important part of vision. They also look at the stability and flexibility of the interaction of these two systems, and at the ability to carefully control eye movements. These abilities are tested at the near reading distance as well as at twenty feet. Many more studies have found a correlation between binocular functioning ability and reading than was found between sight and reading. (1, 13) Again, there is some variation between the different studies, depending on the screening technique used and the age of the subjects. (35)

A third definition used by some optometrists, educators and psychologists includes visual perception as well as sight. When they talk about vision they mean the ability of the mind to receive and sort out visual images as well as ascribe meaning to them. Many studies have shown a correlation between poor visual-perceptual skills and difficulty in learning to read. (13, 41, 45) However, the reverse correlation does not hold true. In other words, good perceptual skills do not guarantee ease in learning to read. Some authors have noted that beyond a certain age the correlation between reading and visual perceptual skills declines. (35) This is quite understandable if one considers the different skills required at different levels of reading.
From this brief look at the different areas of vision, it becomes evident that the definition of vision employed greatly influences one's conclusion about the relationship between vision and reading. The next step will be to examine the training programs that have been developed to improve vision and reading skills.

Types of Visual Training

Many different techniques have been developed to modify and improve visual skills. All visual training programs are based on the assumption that vision is learned and can thus be enhanced by appropriate training techniques. It is hoped that by improving the visual skills that underlie reading one will in turn improve academic achievement. Vision training programs can be grouped into the categories of binocular function training, visual-perceptual training and visual-perceptual-motor training.

Binocular Function Training

Binocular function visual training includes techniques designed to improve eye movements, focusing and vergence skills. Many eye tracking and saccadic jump techniques have been developed to improve the facility of smooth eye movements and develop quick and accurate shifts in eye position. Other techniques use lens and prism therapy to develop quick shifts in accommodative and vergence posturing and to increase the flexibility between these two systems. Some techniques require sustained accommodative and vergence ability and work at increasing the range of comfortable use of these systems.

Visual-Perceptual Training

Visual-perceptual training generally consists of training techniques designed to improve form perception, visual-motor coordination
and figure-ground discrimination. The techniques used in this type of training approach are based on the work on Marianne Frostig, and follow her developmental program. This program consists of desk activities contained within 359 work-sheets of increasing difficulty. Five basic areas are covered within the program. The first deals with visual-motor coordination and involves the drawing of lines, curves and angles between dots. The figure-ground section involves perception of geometric figures hidden within increasingly complex backgrounds. Perceptual constancy requires recognition of shapes presented in various orientations, sizes and shadings from others of slightly different shape. Position in space techniques require recognition of rotated or reversed figures. The fifth set of activities deal with spacial relations and involve the reproduction of forms and patterns using dots as a guide. The Frostig training manual also includes some activities in body image and gross-motor control for children that show a need in this area.

**Visual-Perceptual-Motor Training**

This third type of training approach also includes many visual-perceptual techniques, but does not follow Frostig's developmental program and includes more work in gross and fine motor control. The techniques in the area are devised to first assure control of the gross-motor muscles, then fine-motor control and then visual perception. This type of training approach draws many of its techniques from the works of Kepart and Getman. Training usually begins through the tactile senses and by locomotion through space. Gross-motor techniques include balance-board walking, hopping sequences, chalk-board activities and creeping-crawling patterns. The training then progresses to the fine-motor and ocular-motor techniques of eye-hand.
activities, monocular pursuits and Marsden ball rotations. In this approach, visual-perception techniques begin by using pegboard and block patterns before advancing to worksheets. Training in directionality and visual memory are also included in these programs.
FLAWS IN EXPERIMENTAL DESIGN

Many studies have attempted to show the relationship of vision therapy on reading and academic achievement. Unfortunately, the majority of the studies generally contain a number of flaws in experimental design. These flaws, along with the difficulties encountered in undertaking experiments of this type, will be discussed in order to better understand the studies reviewed in this paper.

Testing of Subjects Prior to Selection

The studies reviewed by these authors varied significantly with respect to the testing and data collecting done prior to the selection of the control and experimental groups. Table I lists some of the possible areas of pretesting that could be done.

Some studies used intelligence tests, reading tests, visual-perceptual tests and so on in order to limit subject selection from a normal range of intelligence quotients having decreased perceptual and reading ability. Other studies did essentially no preselection of subjects. Most studies lacked a visual function or visual-perceptual analysis and diagnosis. Without pretesting in these areas it is impossible to separate out those subjects having reading and achievement difficulty due to a visual or perceptual deficit from those doing poorly for other reasons.

Most studies were also lacking a case history which would give evidence of vision related symptomatology and behavioral signs of visual difficulty. If the subject showed no symptoms, such as blurriness of vision, rubbing of the eyes or excessive blinking, and yet had a diagnosed functional visual problem, this may indicate that
he or she has already adapted to the problem by suppressing one eye and will have no reading difficulty. If the subject avoids the visual task entirely and therefore has no symptomatology, this avoidance may be diagnostic of a visual problem. Vision related symptomatology should therefore be included as an important pre-test prior to selection of subjects for a binocular visual training program.

Another aspect of testing is the type of test being used to evaluate reading, achievement or vision. The studies reviewed in this paper utilized a wide variety of tests for reading, achievement and vision. Because of this, care must be used in evaluating results and making comparisons between the different studies. Table I facilitates the comparison of different tests used among the studies reviewed.

The importance of thorough and appropriate testing prior to an experiment in order to screen for those individuals most likely to benefit from intervention cannot be overemphasized.

Control Groups

Although studies may cite substantial improvements on normed tests, without a control group there is no way of determining if it was the training that produced the improvement or some unknown and uncontrolled variable. Some of the studies used no control groups. (17, 28, 49, 51) Of those studies utilizing control groups there was considerable variation in what they controlled for. Some merely matched for age, while others considered any number of the following: intelligence, reading level, readiness level, visual function, visual-perceptual ability, auditory perceptual skill, achievement level, educational curriculum, Hawthorne effect and maturation.

Two of the best controlled studies with respect to these variables were those undertaken by Seideman and McCormick.
The goal in matching the groups for most of these variables if fairly obvious, yet many of the studies neglect the majority of them. Some studies do not even control for sex. (22, 47) As Halliwell and Gamsby found, this may be a major complicating factor.

A major difficulty in the undertaking of these type of studies is controlling for the Hawthorne effect. The control group must receive equal and appropriate attention from the investigators, which is often difficult to accomplish in a clinical setting. Several of the studies were able to adequately control for the Hawthorne effect. Two studies (22, 30) even used dual control groups but found no difference between the absolute control and the one controlling for the Hawthorne effect. This indicates that the Hawthorne effect may not influence this type of therapy as many of the critics have suggested.

Another criticism is that most studies do not match for visual function or perceptual ability. This is important to assure experimental and control groups have equal abilities before commencing treatment.

Another difficulty is the lack of matching of control and experimental groups for intelligence. One child may be doing the best that he can and not be able to increase his achievement level due to his limited intellectual capacity, while another student may be underachieving with respect to his intellectual capabilities and, once the visual or perceptual barrier is removed, may be able to improve dramatically.

The need for control of educational background, cultural or family differences will not be discussed since the difficulties in controlling variables in these types of experiments should have become quite obvious to the reader.
Training Procedures

The vision therapy used among the different studies can vary widely with respect to content and emphasis, yet still carry the title "vision therapy". As mentioned earlier in this paper, "vision therapy" may include binocular vision therapy, visual perceptual therapy, visual-perceptual-motor therapy or any combination of these. Binocular vision therapy is always done under the supervision of an optometrist. The other types of therapy may be done under optometric supervision, but are often done by psychologists or educators and don't utilize lenses, prisms and specialized instrumentation of optometry. Optometric vision therapy represents an approach to perceptual training which incorporates, and often expands many of the techniques used in more traditional training procedures. In order to properly evaluate the success and compare different studies, it is necessary to know the content of a given training program.

With whatever type of vision therapy that is undertaken, a major difficulty is that the researchers often indiscriminantly give the same therapy to each individual without regard to his or her deficit areas.(18, 19, 28, 29, 30, 33, 39) This is commensurate with giving all people with an outwardly manifest red eye the same medication without properly diagnosing the condition to determine which medication would be most effective.

A number of the studies are especially vague with respect to training techniques employed.(14, 38) The number of treatment sessions, the amount of time per session and whether or nor home training is given are also extremely variable among the different
studies. This complicates the task of making comparisons of the research. It would also seem much more logical to have some type of therapy goal set in advance and when that goal is reached, therapy would be discontinued rather than artificially set a time limit. This regards the individual differences of the subjects and their deficit areas.

Some of the studies use vision therapy in conjunction with reading therapy or in place of reading therapy.\(^{(4, 5)}\) Where properly controlled this may provide valuable information as to the effectiveness of vision therapy as compared to reading therapy. Unfortunately, proper controls are seldom implemented.

Another area almost entirely neglected in the studies is the use of some type of rating scale for subject motivation, the adherence to the home therapy schedual when prescribed and regular attendance of subjects at the therapy sessions. These would all be particularly valuable in evaluating the efficacy of individual therapy programs.

**Analysis of Results**

Most of the studies used statistical analysis of their results. Analysis should be done on a pre-training and post-training test score of each individual in both the experimental and control group to determine if statistical improvement was shown by either. Analysis should also be done on any difference noted between these two groups to determine its significance. Only the studies by Swanson and Coleman lacked statistical analysis.
Binocular Function Programs

"Is Reading Disability a Fusional-Eye Movement Disability?", by Nathan Friedman (first Study)

Friedman reported on the effects of fusional eye movement training on reading improvement in two separate studies. The first study included only eight ninth graders with an average reading level of 4.5. These subjects were chosen on the basis of their interest, their high motivation and their ability to apply themselves to a vision training program. The students were given daily 45 minute sessions on Friedman's fixation training device for nine weeks. Friedman reported a median improvement from an original level of 4.5 to a post-test median grade level of 8.5. No statistical analysis was performed. However, Pierce's analysis of the data reported indicated that the mean improvement was from 5.0 to 8.38, significant at the .001 level. This is 13 times greater than one would expect from regular classroom reading programs. Friedman, however, doesn't report the test utilized or whether he himself administered the reading test or whether the teachers did. He also failed to specify whether the subjects had a fixational or a fusional convergence problem to begin with and whether or not these abilities improved. No control group was included. The study does suggest, though, that Friedman's training device had a remarkable impact on the reading efficiency of the small group of ninth graders and that their original four year lag in reading might be due to ocular fixation difficulties. It is unfortunate that more details of the study and patient pool were not provided in his paper.
Nathan Friedman (second study)

Friedman did a second study utilizing an experimental group of 40 poor readers and a matching group of 30 poor readers. All were eighth and ninth graders. The control group received routine remedial reading instruction and the experimental group received fusional eye movement training. The vision training group received four 45 minute training sessions per week for thirteen weeks. It was not specified if this was in addition to regular reading time or if it was time taken from the reading class time. The control group had only regular class instruction. Reading measurements were taken before and after the 13 week period. However, the test used or who administered it was not specified. Friedman reported a median improvement of 2.2 years for the training group and 1.2 years for the control group. No statistical analysis was performed, but Pierce's analysis indicated that the mean improvement was 1.4 years for the controls and 1.8 years for the training group. The gains were statistically significant in comparing the experimental and control groups.

The author does not state how the control and experimental groups were matched, whether they had fusional eye movement problems, whether fusional eye movement skills improved differently for the two groups and what reading test were administered and by whom. Although the gains for the experimental group are impressive, one must question why the control group's gains were so high. The control group improved by more than four times what one would expect from regular classroom instruction. There are too many unanswered questions in the experimental design and procedure of this study.
"The Influence of Orthoptic Training on Reading Ability," Peters, Henry B.

This study uses college freshman from an "Introduction to Teaching" course as subjects. The students were given standardized psychological and reading ability tests, and then were divided into six experimental groups matched by the results of these tests. Each group received a different amount of Binocular Functioning training and/or pedagogical training. The binocular training consisted of training on the Binocular Synchronizer, Stereoscope and squint Korrector; pedagogical training included instruction in reading comprehension. Progress was evaluated by comparing reading test scores, eye movement photographs and optometric examination findings taken before and after training.

Results showed that binocular training alone created increases in reading ability equal to or greater than the improvement made by the group which received pedagogical training alone. They also found an improvement in visual functioning in the binocular training group but not in the pedagogical group. Binocular training was found to accompany the greatest increase in reading in students whose initial reading ability was lower than their I.Q. would predict. Binocular training also accompanied a greater improvement among those students whose initial optometric findings showed functional restrictions.

This is a very well executed study involving a large amount of carefully collected data. However, a glaring fault of the study is that even though Peters performed a optometric evaluation on each of the students, no attempt was made to screen for those students who
actually had a binocular disfunction, or even be sure that the
students with binocular difficulty were randomly distributed
among the six groups. Nor was any attempt made to individualize
the training. Peters admits that those students who showed binocu-
lar difficulty gained the most from the binocular training. These
authors feel that Peters results would have been even more dramatic
if a visual screening had been done before the patients were
selected.

"The Relationship Between Visual Training and Reading and Academic
Improvement," Howard C. Olson, Charles C. Mitchell and William C. Westberg

This study used college sophomores in agriculture and education
as a source for their sample pool. Participation was on a voluntary
basis and nearly all of the 65 students were having academic diffi-
culty in that they were near or below a "C" average. The optometric
examination disclosed no significant uncorrected refractive errors
or any indication of eye pathology.

The Otis Test of Mental Ability, the Iowa Silent Reading Test,
the Bernreuter Personality Inventory and a complete visual exam, in-
cluding an OEP 21 points, was done on each of the subjects. The exper-
imental design used three experimental groups plus a control. Group "A"
received three 45 minute vision training sessions per week for eight
weeks. Group "B" received similar vision therapy plus counselling.
Group "C" received only counselling and Group "D" was an absolute
control group receiving no treatment. There was a statistically
significant improvement in reading rate on the Iowa Silent Reading
Test for both groups "A" and "B", but not for "C" or "D". No sig-
nificant gains were made on the OTMA or in the G.P.A. by any of the
Although a complete visual functioning analysis was done using the OEP 21 point exam, no mention was made as to whether or not the participants had any vision functional problems. Also, no mention was made as to the extent to which the related vision functional factors improved. The study was further contaminated by the use of a reading pacer utilized during the last six sessions for ten minutes each.

The study doesn't permit determination of whether the students had vision functioning problems, the type and magnitude of changes in visual function and whether the sixty minutes that the subjects used the reading pacer was responsible for reading improvement, or if it was the improvement in binocular abilities due to training.

Although well conceived and carried out, the study makes it difficult to draw any conclusions about vision functioning problems, vision therapy and reading improvement. One may conclude that a vision training program combined with a little speed reading results in a significant improvement in reading rate.

"Optometric Vision Therapy-Results of a Demonstration Project with a Learning Disabled Population," Seiderman, A. S.

Forty-three children from a private school for learning disabled children, ages 9 to 10 years, were screened for this study. All children were given a thorough battery of visual-perceptual tests (Table I). The children were then given a complete optometric vision examination during which any vision function deficit was diagnosed. Thirty-six of the original forty-three children were found to have visual function or visual-perceptual difficulties, and so became the sample pool. These children were then given a second battery of
tests: the WISC, the Stanford Achievement Test and an informal reading and word recognition inventory. They were then divided into eighteen pairs and matched for age, sex, I.Q., severity of vision function and visual-perception difficulty, and degree of reading deficit. Both the control and experimental groups continued to receive their regular reading program. The experimental group received individually programmed visual training thirty minutes per day, four days per week. The control group received physical education, art or science class during this period in order to control for the Hawthorne effect. This represents the most completely controlled study reviewed by these authors.

The vision therapy was individually tailored to stress each child's deficit area and began at his/her specific developmental level. Perceptual training was based on a developmental hierarchy beginning with gross-motor control, then working into from perception, fine-motor control and visual perception. The last level of training developed the ability of the child to process visual information and to use it to formulate concepts. Binocular vision therapy was administered and continued until the child met Morgan's criteria necessary for comfortable, sustained effort at the reading distance. Training was done in groups of three and continued for nine months over one and a half academic years.

The results of this study showed statistically significant gains in several areas of visual perception by the experimental group as compared to control group. Statistically significant improvement in reading and achievement were also found.

These authors feel that this is one of the best designed and
carried out studies in this area. Seiderman has used proper pre­
therapy testing to determine the visual-perceptual and visual
functional level of the subjects to be sure that they actually have
a visual difficulty. He has matched his control and experimental
using almost all of the factors that these authors feel are im­
portant in this type of study. He has used standardized and well
recognized tests to do this. Another important quality of this
study is the fact that the training was individually programmed,
done in small groups and aimed at each child's deficit area. Train­
ing was continued until they were cured rather than for some ar­
bitrary period of time.

The authors do not feel that it is coincidental that one of
the best designed studies shows some of the most statistically
significant gains through vision therapy.

"Optometric Vision Therapy-How Successful is it in the Treatment of
Learning Disorders?," Swanson

This study looks at the results obtained with 100 consecutive
cases of visual training patients referred for learning disorders in
a private clinic. The age of the patients ranged from 2-60, with the
majority being 7-9 years old. All of the patients were given a com­
plete optometric vision examination and a diagnosis of visual function
difficulty was made. Reading and achievement tests (Table I) were
administered before training began. No attempt was made to match these
patients with a control. The average length of therapy was 63 ses­
sions. Each patient came in for one hour three times a week. This
adds up to approximately five months of training.
Swanson reports that 93% of the patients were successful, using the criteria of an increase in achievement ability. Apparently, though, no statistical analysis was done, which makes these claims difficult to substantiate. Post-therapy achievement test were administered to 82% of the patients. For those patients without post-testing success was based on patient, parent or teacher reports of academic improvement.

The nature of this study makes it difficult to analyze the results. Without proper controls it is impossible to determine whether improvement was due to maturation, classroom instruction or vision therapy. This study also lacks an adequate description of pre-therapy testing and actual training techniques. Although not statistically analyzed, 93% is a very high rate of improvement. The authors feel this high success rate may be due to the fact that Swanson individually programmed the therapy toward each patient's deficit area and that training was continued until the deficit area was remediated. The fact that this therapy was performed in a private office might also have affected the results.

"Effectiveness of Optometric Therapy," Robert M. Wold, John R. Pierce, and Joan Keddington

In this study, one hundred consecutive visual training patient records were evaluated to determine the effectiveness of the training on the improvement of patient's visual abilities. An evaluation was also made of the pre and post-training achievement scores available for 34 of the patients. Ages of the patients ranged from six to twenty-one. All of the patients exhibited some learning dysfunction from subtle to severe.
The patients were given a complete visual evaluation and diagnosis before training was begun. The pre-training visual performance was rated on a 100 point visual performance scale outlined by Sherman.

Therapy was given in a small group setting for one hour three times per week. The number of sessions varied from 22 to 53. Therapy was primarily of the binocular function and oculomotor control variety. Complete post-training visual evaluations were performed and the results rated on the 100 point scale. All areas of visual ability were found to improve at the .001 level of significance.

Pre and post-training word recognition scores on the WRAT were available for 34 of the patients. The mean age of this group was 9.8. Changes in these scores as a function of three months of visual training showed improvement three times greater than the expected change based on regular school attendance.

This was a thorough study. Unfortunately, the first part was based on a large number of subjects but only 34 were evaluated for pre and post-training achievement ability. The major fault, however, is the lack of controls, especially needed in controlling for the Hawthorne effect. The positive aspect of this study is the complete pre training visual testing and diagnosis which allowed training to be directed to each child's weak areas. This allowed training to continue as long as needed rather than end at some arbitrary time. This study lends strong support to the premise that binocular vision training, properly applied, does improve visual skills. It's effect on the improvement of achievement, however, is not unequivocal at this point.
**Visual-Perceptual Programs**

"Comparison of Perceptual Training and Remedial Instruction for Poor Beginning Readers," Ira Belmont, Hannah Flegenheimer, and Herbert Birch

Two groups of children with equivalent degrees of risk for reading failure were provided, respectively, with supplementary perceptual training or with special instruction in reading using remedial reading techniques. Each group started out with 16 children who received regular classroom instruction in addition to supplementation.

The children were selected from 176 children who had been in kindergarten and were beginning first grade in the same school. All 32 had functioned very poorly on the New York City Pre-reading assessment test and were rated as having exhibited poorest overall kindergarten performance. This criteria had previously been found to predict poor reading attainment in the first grade at a high level of confidence.

The children were divided into 16 pairs and matched for age, sex and reading readiness. The authors stated that none of the children had uncorrected visual or hearing defects, that all were of normal intelligence and nothing unusual was noted in the behavior of any of the children. The type of intelligence test used was not indicated nor was the means for determining visual or auditory defects.

The perceptual and perceptual-motor training procedures were based on programs and materials developed by Kephart and Frostig. The author named many of the techniques in the paper.

Although there was no absolute control group, both groups achieved a nine month reading level improvement in approximately six and a half months. This was tested on four different reading
tests. Since both groups were high risks, they most likely would not have progressed even six and a half months. Therefore, it is likely that both supplemental reading and supplemental perceptual-motor therapy were quite effective.

The major criticisms of this project are that no perceptual-motor testing was done prior to training and the lack of an absolute control group. Since the subjects were tested on four different reading tests the lack of an absolute control is partially compensated for.

"Effectiveness of Visual Perceptual Training on Reading Skills of Non-Readers, an Experimental Study," Elaine Bieger

This study used 108 second or third grade non-readers who were attending the Reading and Diagnostic Center in New York City as a sample pool. The children were screened with the Frostig Developmental Test of Visual Perception, the Durrell Test of Visual Discrimination of Words, the Durrell Identification of Lower Case Letters and the Keystone Telebinocular Test. Students who showed poor visual-perceptual skills but adequate visual acuity became subjects for the study, and were randomly divided into two groups. The Spache word list and oral reading test were given to establish pre-training reading level. It was determined that both groups began with equivalent reading and visual perceptual tests.

The control group received two one hour remedial reading sessions per week. The experimental group received the Frostig training program for $1\frac{1}{2}$ hour and remedial reading for $1\frac{1}{2}$ hour twice a week. Training lasted for 7 months.
The Frostig DTVP, Durrell TVDW, Durrell ILCL and Spache reading tests were re-administered at the end of the training period. Of the perceptual tests, only the experimental group showed significant increases on the Frostig DTVP, both groups showed improvement on the Durrell ILCL, but neither group showed any change on the Durrell TVPW. On the Spache Reading Test, both groups showed statistically significant improvements over pre-training scores. The control group showed two months more improvement than the experimentals. However, this difference was not statistically significant.

These results show that the Frostig Visual Perceptual Training Program was just as effective as remedial reading instruction in improving reading ability. Bieger concluded that perceptual training had no significant influence on reading training or achievement; however, when one considers that the controls received twice as much reading instruction as the experimental group, one begins to question this conclusion. It would be interesting to see what improvement the experimental group could achieve with equal reading instruction and the Frostig program as supplemental training.

This study used a well selected subject pool by only including subjects with perceptual deficits. They also used well recognized pre and post-training testing materials and proper statistical analysis. However, a better controlled experimental design might have been to give both groups equal reading instruction. The present study did show the Frostig to be just as effective as remedial reading instruction.
"Effectiveness of Visual Training of Letters and Words on Reading Skills of Non-Readers," Elaine Bieger

This second study by Bieger follows much the same format as her first study, the main difference being the training materials used. Her first study examined the effectiveness of the Frostig visual-perceptual training program which trains discrimination of shapes, forms and lines. This second study utilizes a similar worksheet type program that trained discrimination of actual words and letters.

One hundred and nine students were screened with the Frostig Developmental Test of Visual Perception, Durrell Test for Visual Discrimination of Words and the Keystone Telebinocular Test. Only the 43 students 1½ years below level in reading and showing perceptual deficits but having normal intelligence and visual acuity became subjects. The experimental group received 20 minutes of visual training in word discrimination and visual memory with forty minutes of remedial reading instruction twice a week. The control group received one hour of remedial reading training twice a week.

The results obtained were similar to those of the first study. Both the experimental and the control groups showed significant improvements on all of the perceptual tests. Both groups also showed significant improvements between pre and post-training reading scores with no significant difference between the two groups. This study again indicates that visual perceptual training is just as effective as remedial reading instruction. It also indicates that perceptual training using actual words and letters was no more effective than the traditional Frostig techniques using shapes and forms.
"Effect of Visual Perceptual Training on Reading Achievement," Pearl Buckland, Bruce Balow

Four schools, each having at least four first grade classrooms, were selected from a suburban school district with 21 elementary schools. In each of the 16 classrooms, first grade pupils who were in the lower half of their classroom in reading as defined by teacher judgement and who scored "C" or below on the Metropolitan Readiness Test comprised the sample pool. Pupils were randomly selected from the sample pool and assigned by sex to control and experimental groups. There were 88 experimental subjects and 78 controls.

The Mariane Frostig Developmental Test of Visual Perception was administered to all subjects before and after treatment. The experimental group treatment materials consisted of a workbook derived from the Frostig Program for the Development of Visual Perception. The control group listened to and discussed with the teacher stories each child heard through a headset. Therefore, the control group received equal time and attention from the teacher. This was done 15 minutes per day for two months.

Statistical analysis showed the two groups to have progressed equally in their reading skills. The authors went one step further in their analysis and reported that pupils having high pre-training perceptual scores had high perceptual outcome scores, while pupils with low pre-training scores had low outcome scores on the perception variable. This information has the same impact as actually treating perceptual deficit areas. The study was well designed and implemented so as to determine the effects of different variables.
"A Longitudinal Study of Visual Perceptual Training and Reading Improvement," Neal R. Gamsky and Faye Williams Lloyd

In this study twenty kindergarten classes from six midwestern school districts were designed as experimental and control groups. Both groups were randomly selected from morning and afternoon sessions of the same teacher in order to control teacher and time variables. All groups received the Frostig Developmental Test of Visual Perception as a pre and post-test, and the Metropolitan Reading Readiness Test was administered at the end of the Kindergarten year. All children in the experimental group received the visual-perceptual training program for 15 minutes each day for four and a half months. At the end of the following year all students were given the Stanford Achievement Test.

Results indicated statistically significant improvement on the Frostig Visual Perceptual Test by the experimental group on several of the subtests. There were also significant differences between the sexes in three of these subtests. The experimental group did significantly better on the Metropolitan Reading Readiness Test and the Stanford Achievement after treatment.

The Frostig Test of Visual-Perception was deemed to be useful in predicting which children would have difficulty in learning to read since non-treatment youngsters ranked consistently low on the majority of subtests, while the experimental youngsters ranked consistently higher on most subtests.

Although this study supports the use of a Frostig visual-perceptual development program for all preschoolers since the efficacy is well demonstrated in this paper, these authors' criticism is directed
to the lack of more thorough matching of the experimental and control groups. This is the same criticism made of several other articles and is felt to be extremely important due to the variety of results obtained in studies of this sort. The importance of controlling for sex is alluded to by the significant difference in test results cited in this paper. This single variable has been found to be of major significance in other studies, which makes one wonder how many of the other variables not generally controlled would be found to be significant in a well controlled and well analyzed study.

"The Improvement of Reading Ability Through a Developmental Program in Visual Perception," James N. Lewis

An analysis of SRA Reading Achievement Test scores given in the spring of 1967 in an elementary school in Midland, Texas revealed eight second grade males reading at the first grade level. These eight youngsters were given an individual intelligence (WISC) and the Frostig Developmental Test of Visual Perception. Five students, diagnosed as having reading disability, were selected as subjects for the study.

In order to evaluate the program of therapy, the SRA was given in October. The results plus the age equivalents and perceptual quotients from the Frostig Test served as pre-test criteria.

The Frostig Developmental Program in Visual Perception was used as the therapeutic tool and was administered during a ten week program, consisting of three hourly sessions each week for a total of thirth hours of therapy. The therapist, a special education teacher, was employed to administer the program after school.

At the conclusion of the therapeutic program, the children were
re-tested on the SRA and Frostig tests. The means for the group were compared by utilization of Fisher's "t" technique.

An analysis of the results indicated improvement in each area of visual perception. However, due to the limited number of subjects, the mean gains after therapy were not statistically significant except in eye-motor coordination. Before therapy, the children as a group were reading at the 48th percentile. After training with the Frostig program, the children rose to better than the 80th percentile in reading ability. The mean difference between the percentile ratings before and after therapy was large enough to be statistically significant at the .01 level of confidence.

This is too small of a study to make any major conclusions, and since there was not an established control group, the results of this study are of questionable value. In this paper as well as some of the others reviewed in this paper, it becomes increasingly more evident that boys with reading disabilities tend to respond better to visual-perceptual-motor training than girls do. This may be a more important variable than many of the investigators have thus far admitted.

"An Investigation of Perceptual Training and Reading Achievement in First Grade," Carl L. Rosen

In this study Rosen used 703 beginning first grade children. All of the subjects were given the Lorge-Thorndike Intelligence Test, the Metropolitan Reading Readiness Test and the Frostig Developmental Test of Visual Perception. The children were randomly assigned into two groups; twelve experimental classrooms and thirteen control classrooms. Statistical evaluation showed no differences between these two groups with regard to sex, age, IQ, reading readiness or
The experimental classrooms received a shortened Frostig workbook program for 30 minutes daily along with their regular reading instruction for 29 days. The control classrooms received additional reading instruction during this 30 minute period as well as their regular reading instruction. At the end of the therapy, the Frostig DTVP was re-administered and the New Developmental Reading Test was given at the end of the school year.

Post-testing with the Frostig DTVP showed the experimental group scoring statistically higher than the controls. Analysis of the reading test showed no significant difference between the two groups on mean reading scores. However, the control group did significantly better on one of the reading comprehension subtests.

Rosen noted that when looking at a group of 50 boys from the experimental group having the lowest pre-training perceptual scores that all the boys showed consistently higher reading scores than a comparable group of boys from the control group. This was merely a trend, but it does point out one of the major faults of this study; perceptual training was given indiscriminately to all of the students regardless of whether or not they scored low on the Frostig pretest. Besides this major criticism, the experiment was carried out very well. The investigator used reasonably thorough controls, matching and appropriate pre and post-test training testing.
"The West Warwick Visual Perception Study - Part I & II," Howard M. Coleman

Coleman conducted two studies. The first was during the 1968-69 school year and the second was during the 1969-70 school year. These will both be reviewed in this section due to their similarity in methodology.

The experimental group had the following criteria for admission:
1. Minimum visual perceptual scores (using a test designed by Coleman in an earlier study and reported to predict academic achievement).
2. Failure to pass the first grade, 3. Apparently normal intellect as measured by the WISC, 4. No evidence of overt neurological or emotional dysfunctions. 5. Parental consent, approval and support. The author points out the it is highly possible that some self-selection process occurred in both the experimental and control groups since children meeting the necessary criteria had to have some parental support.

It is not entirely clear from the paper how the author selected his control group. He mentions once in the paper, however, that it was only the experimental group that was repeating the first grade. Both groups had visual-perceptual-motor problems and did poorly on the Metropolitan Readiness Test and had normal intelligence as measured by the WISC.

A multidisciplinary educational team was formed to work with the experimental group. The classroom teacher was the nucleus and focal point of that team. The training of the students was multi-sensory,
utilizing visual, auditory, kinesthetic and tactile skills. Coleman notes, "Behavior problems were rampant. The children would shun any task that would in any way seem to involve learning." After several months a change was gradually seen. Remarks from parents came concerning the "eagerness" with which the children who formerly were late for school were now first at the bus stop and waiting in the schoolyard with eager anticipation.

The previous reading instruction utilized was the Houghton-Mifflin Series, which is basically a look-say method with some degree of phonetic analysis. The program for the experimental group utilized the Orton and Gillingham approach for remedial training for children with specific disabilities in reading and spelling. It is basically a clinical, one-to-one approach to children with severe learning disabilities, but was modified to a small group and class presentation. The language therapist, with the support of the teacher, spent one hour per day with the children in the experimental group.

Training techniques are described in the paper. Gross motor activity was emphasized along with visual tracking and eye-hand coordination type skills. The experimental group received one hour of this training per day.

The author cites the many improvements made in the WISC scores of the experimental group compared to the control. It is not known whether the improvements are statistically significant or not since the author did no statistical analysis. He also cites gains by the experimental group on the Stanford Achievement Test, but did not pre-test the control group in that area.

He notes that every child in the experimental group learned to
read, write and spell well, which is all verified by their WISC scores. The problem is that there was not an adequate control group, improvements made were not subjected to a statistical analysis and, most importantly, one cannot differentiate improvement due to a radically different reading approach or a visual-perceptual-motor program. The possibility of a rather strong Hawthorne effect and the self-selection of control and experimental subjects must not be overlooked either.

Coleman's second study was done the following academic year, 1969-70. The samples differed from the children in the first study in the manner and criteria used for selection. All first grade children were evaluated in September and the sample was made up of entering first graders who had not failed. For inclusion in the study children had to have a low score on Coleman's visual-perceptual-motor battery and be contacted through their parents for possible inclusion in the experimental group. The author again points out that since parental permission was required for admission to the experimental group, some degree of self-selection probably took place. The experimental group was made up of those whose parents accepted, while the control group was what was left over. The study ended up with 14 control and 14 experimental subjects. Everything else between the two studies was reasonably similar. The pre and post-testing was as follows:

<table>
<thead>
<tr>
<th>Pre-test</th>
<th>Post-test</th>
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<tbody>
<tr>
<td>WISC</td>
<td>WISC</td>
</tr>
<tr>
<td>Coleman's VPM Battery</td>
<td>Coleman's VPM Battery</td>
</tr>
<tr>
<td>Motor abilities</td>
<td>Motor ability</td>
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<tr>
<td>Metropolitan Readiness Test</td>
<td>Stanford Achievement Test</td>
</tr>
</tbody>
</table>

Through statistical analysis, intelligence was shown to stay
constant for the two groups. The post-study means of the visual-perceptual-motor skills were better for both groups, but the experimental group was not significantly better than the control. The post study results on the motor abilities test show a significant difference between the experimentals and controls. There are also substantial differences on the SAT. The experimental group scored five months ahead of the control group and four months above the national mean. This difference is significant at the .01 level, the author states. The question that immediately comes to mind is that since this test was not previously administered to the subjects, how can their true improvement be evaluated.

There is some question as to whether the effectiveness of this study could be viewed as a Hawthorne effect. The question of the difference in reading techniques also arises. Although both of these studies appear to have been quite effective, it is not nearly so clear if it was the new reading therapy or the visual-perceptual-motor training that produced the improvement. Since the experimental and control groups improved their VPM skills about the same amount, this suggests that the new remedial reading technique may be responsible for the improvement in achievement. This study, with its confused style of writing and number of uncontrolled variables make it difficult to draw any major conclusions.
"The Effects of Special Perceptual-Motor and Perceptual-Visual Training in Kindergarten on Reading Readiness and on Second Grade Reading Performance," Louis H. Falik

This study was designed to determine if providing a group of kindergarten children with a specially designed curriculum based on principles of perceptual-motor development would have any effect on their readiness for reading at the end of the kindergarten year. Students scoring in the lower two-thirds on the Anton-Brenner Developmental Gestalt Test of School Readiness made up the subject pool. Subjects were then matched for sex and performance on the Brenner Gestalt Test. Training was briefly discussed and was designed primarily after the work of Kephart.

The authors do not state how much time per day is spent on perceptual development training. The overall duration of the program appears to have been one academic year. Upon completion of the year, all subjects were given the Brenner Gestalt Test again, the Metropolitan Readiness Test and a specially devised test of basic perceptual-motor development by Schorr. A year and a half later the investigator returned and administered the reading section of the Metropolitan Achievement Test. None of the results of these tests showed significant differences between the control and experimental groups.

There are so many uncontrolled variables in this study that it makes it difficult to evaluate. Only one test, admittedly given in a large scale, rapid screening process during the child's first visit to school and scored by graduate students, is the entire bases for the selection of subjects. The amount of time spent on the
perceptual-motor therapy daily is not given, nor is the activity of the control group given during the same time. The control and experimental groups had different teachers and evidently followed different curriculums which further contaminate the study. No reasonable conclusions may be drawn from this study with respect to perceptual-motor training effectiveness.

"The Effects of Supplemental Perceptual Training Program on a Reading Achievement," Joseph W. Halliwell and Harold A. Solan

All of the entering first grade students in a large suburban school district in New Jersey were administered a battery of tests. A preliminary study conducted during the previous year had indicated that the Metropolitan Readiness Test was the single best predictor of success in the first grade reading out of about forty predictor variables.

One hundred and forty first grade pupils who were considered most likely to encounter difficulty in reading were selected as the source from which the final sample of subjects would come. Each student in the sample was matched as closely as possible on the basis of reading scores and sex, with two other students. The 105 students (35 matched trios) who were most closely matched were then randomly selected to one of three groups: experimental I, experimental II and control.

The experimental I group was composed of 35 students who were distributed throughout the school system and were to participate in the regular reading program conducted by first grade teachers. In addition to this, they were to be recipients of perception and
perceptual-motor training for 45 minutes twice per week for five and a half months in groups of 3 or 4. Techniques and methods are described in the paper.

Experimental II group was also composed of 35 students distributed throughout the school system and were to participate in the regular reading program conducted by the first grade teachers. In addition, they were to be recipients of special reading instruction for 45 minutes, twice per week for five and a half months in groups of three or four. The type of instructional emphasis is described in the paper.

The control group was composed of 35 students who were distributed throughout the school system and were to participate in the regular reading program conducted by the various first grade teachers. They did not receive additional small group assistance in reading or perception.

The criteria of effectiveness was the reading comprehension subtest of the Metropolitan Achievement Test. The Friedman Two-Way Analysis of Variance Test was used to determine the statistical significance of the reading scores of each of the matched sets. This revealed that among the girls the findings were not significant, but among boys the contrary was true. The only significant differences favored the experimental I boys and the experimental I total group over the controls. The same pattern existed with respect to the experimental II group and the control groups. The results, therefore, indicate that first grade boys who perform poorly on the reading section of the Metropolitan Achievement Test would benefit from supplemental vision perception training of the type utilized in this study.
and that they would benefit more from perceptual training than they would from supplemental reading training.

This study is notable for its methodological care. Although it doesn't control for a number of variables, it appears to have been able to achieve a reasonable success in less time by choosing a fairly good predictive test to weed out those who will respond best to perceptual-motor therapy. As this study also demonstrates, the variable of sex appears to be extremely important.

"Visual-Motor Training, Readiness and Intelligence of Kindergarten Children," R.P. Keim

Subjects were selected from the kindergarten classes of Emmaus, Pennsylvania schools on the basis of chronological age of 5.0 to 6.0, I.Q.'s from 80 to 130 on the Peabody Picture Vocabulary Test, no previous kindergarten experience and absense of diagnosed physiological or neurological impairments. Following the imposition of the selection criteria, the Bender Visual-Motor Gestalt Test was administered to the remaining kindergarten children to identify those with poor visual-motor skills.

The seventy-four who demonstrated visual-motor difficulties were then divided equally into an experimental and a control group. A second control group was selected randomly from among the children who evidenced no visual-motor difficulties. The three groups were equated on the basis of intelligence, as measured by the Peabody Test, and readiness for kindergarten, as measured by the Pre-Kindergarten Survey.

All subjects were tested at the end of the experimental period, the length of which was not designated in the paper but is assumed to
be one academic year. The Metropolitan Readiness Test, the Peabody Test, the Stanford-Binet Intelligence Scale and the Bender-Gestalt Test were administered.

The results showed no significant differences among the three groups. Forty percent of the subjects in the experimental group and 57 percent of the control group with initial visual-motor difficulties continued to have poor visual-motor skills. It is not known how much time was spent on the training since the authors didn't discuss it.

The test used to determine which students had visual-perceptual problems was the Bender Test, a test used to evaluate brain injury, mental retardation, emotional difficulties, neurological impairment, physiological maturation, school readiness, reading and learning problems and intelligence, in addition to determining visual-motor difficulties. From this study and some of the others reviewed, one must question the predictive value of this test. If it does have validity in diagnosing the above mentioned conditions, perhaps a more limited test would be more valuable.

The question of whether training classes were large or small must be asked along with other specific questions about the program not answered in the paper. Few specific details are given by the author with regard to methodology. Not enough information is made available to the reader to make a definitive statement of the program followed. However, the design is one of the better ones reviewed in this paper.
"Improvement in Reading Through Perceptual-Motor Training," Clarence, McCormick, Janice Nelson Schnobrich, S. Willard Footlick and Betty Poetker

In this study 42 underachieving first grade children were matched for age, sex, intelligence, class instruction and reading level. The children were randomly divided into three groups. The experimental group received two 45 minute training sessions per week which included perceptual-motor activities and began by first establishing gross motor control and then proceeded to the development of fine motor control and eye-hand coordination. The second group served as a control for the Hawthorne effect. They received standard physical education training during the same time period. The third group was as absolute control group receiving no training or special attention of any kind.

After seven weeks all subjects were re-tested for reading achievement on the Lee-Clark Reading Test. Only the experimental group showed a statistical gain in reading achievement.

The experimenters matched their subjects for a variety of factors but ignored the pre and post-testing of perceptual-motor skills, which is the area where all the training was done. It is therefore impossible to determine if the improvement in reading was accompanied by an improvement in perceptual-motor abilities, if perceptual-motor abilities were randomly distributed or if perceptual-motor deficiencies were shown by any of the subjects before training.

This study utilized predominantly gross and fine motor training in contrast to the majority of the studies reviewed. It was included because of its good design and close correlation with the optometric philosophy on gross and fine motor control, development and
training.

This study utilized a dual control group. Lack of improvement by either control group indicated the Hawthorne effect may not be as influential in these studies as imagined.


A group of wighty fourth grade pupils were given a visual test to identify poor eye synchronization. In this test the children read silently in front of a closed circuit TV on which their interpupillary distance was monitored. The PD measurements that varied more than 2mm during the reading task were considered as failing. Fifty-three of the eighty were found to have poor eye synchronization. These children were divided into a control and experimental group. A second control group was formed from those with satisfactory eye synchronization. The Metropolitan Reading Test and Otis Test of Mental Ability were administered to all three groups.

The experimental group was given a program of "visual behavior modification" for ten minutes each morning for ten weeks. This included gross motor, eye focusing, touch, sound, balance and directionality training. Visual tests were re-administered at the end of the school year. Sixty percent of the experimental group showed improvement in eye synchronization. Control groups I and II showed zero and eleven percent improvement respectively. The reading tests were re-administered in October of the following academic year. The experimental group showed statistical improvement on their post-training reading scores, yet, neither control group showed statistically significant changes.
This was a well executed study aimed at improving visual ability. Although the experimenters controlled for age, maturation, pre-training visual ability, intelligence and classroom instruction, no attempt was made to control for the Hawthorne effect. The experimental group received much more individual attention and parental and teacher support than the controls in this study. One must also question the correlation between the author's eye synchronization test and other more traditional visual analysis techniques. It would also have been helpful to see more complete description of the training procedures and an explanation of why post-training reading scores were taken the following year. On the whole, this was a well run experiment that showed a statistical correlation between improved eye synchronization and improved reading ability.

"A Pilot Study in the Diagnosis and Remediation of Special Learning Disabilities in Preschool Children," Dorothy Shipe, Solveiga Miezitis

In this study eight children were selected from a large sample who displayed a perceptually handicapped learning disability. Selection criteria was the following:

1. Chronological age between 4 and 6
2. Full scale IQ greater than 70 on the WPPSI
3. Evidence of specific learning defects as defined by a marked scatter on the subtest scores of WPPSI
4. Hyperactivity and distractive behavior
5. Freedom from primary emotional distress

All of the children were pre and post-tested with the following tests: WPPSI, ITPA, DIVP and PPV. (see Table II for abbreviations used)
The children were randomly divided into two programs which met for one hour daily, four days per week for twelve weeks. Each program used a different approach; one emphasized language and cognitive development and stressed the formation of complete sentences and grasp of concepts, while the other focused on visual-motor functioning, including work on gross and fine motor skills, visual discrimination and eye-hand coordination.

At the end of the 12 week training period all of the children were re-tested. No attempt was made to statistically analyze the results. It is therefore impossible to determine if any changes noted were significant. However, two of the children, one from each therapy group, showed a more than two year improvement on the tests. Some of the other students showed improvement in some subtest areas, but it is impossible to determine if these are significant.

Due to the small number of subjects and the lack of statistical analysis, it is difficult to draw any conclusions about the effectiveness of either of the therapy approaches used in this study. The investigators also failed to aim their training at the specific deficit areas of the individual children. This study has been cited as an example where visual-motor training has little effect on academic improvement(26), however, careful evaluation of the study shows that no reasonable conclusions may be drawn either in favor or against this type of training.

"Perceptual Readiness and Beginning Reading," Simpson, D. M.

In this paper Simpson investigated the predictive value of the
Metropolitan Readiness Test of later reading ability. He then began a perceptual training program to determine its effectiveness in improving reading ability.

In the first part of this study 312 first grade pupils were given the Metropolitan Readiness Test and their scores compared to later scores on the Metropolitan Reading Test. Simpson found that the perceptual subtests (matching, copying and space) correlated significantly higher with actual reading ability than did the traditionally designated "reading readiness" sub-tests (sentence meaning and information).

In the second phase of this study, Simpson administered a program of perceptual, gross motor and oculomotor training to a group of 24 experimental students. Twenty-four pupils matched in terms of pre-readiness skills served as a control group and received no special instruction. At the end of the training period it was found that the experimental group scored significantly higher on the Metropolitan Reading Test than the controls, indicating that this type of mixed training program can be effective.

This was a well run experiment. However, it did not control for the Hawthorne effect and its training program contained such a wide range of procedures that it is difficult to determine how many of them were actually necessary.

"Perceptual-Motor Generalizations and Remedial Reading," Wharry, Rhoda E.

In this study thirty boys referred to the Purdue remedial reading clinic were used as subjects. All of the subjects showed intelligence scores of at least 90 on the WISC, but were two grade levels behind in reading on the Durrell Analysis of Reading Difficulties, as well
as having perceptual-motor deficits. The subjects were randomly divided into two groups, both receiving remedial reading instruction. The experimental group also received perceptual-motor training involving eye-hand coordination, rhythmic movement and locomotion, balance, form perception and visual memory. After training, the subjects were given the Slingerland Screening test for Children with Specific Language Disability, the Metropolitan Achievement test, the Durrell Reading test and the Purdue Perceptual-Motor Survey.

The results show that the experimental group made significantly greater improvements relative to the controls in: oral reading rate, silent reading rate, word recognition, spelling, listening comprehension and language mechanics. This was a well designed and controlled study. All subjects were shown to have perceptual-motor defects before training began, and the training was well designed and individually programmed. It is interesting that only boys were used. From the evidence of Halliwell and Rosen, it appears that boys respond better to this type of therapy. Thus sex may have had an influence in the excellent gains seen in this study.
CONCLUSION

In this literature review it has been these authors' goal to choose a representative sample of studies from each of the three major approaches to visual training. Due to the wide variety of experimental designs it is difficult to directly compare the results of the studies. However, by dividing the studies according to the type of therapy employed several trends begin to appear. In general, those studies investigating the effectiveness of binocular visual training show the greatest improvement in achievement. The majority of the studies investigating the effectiveness of visual-perceptual-motor training also show improvement. Studies utilizing the Frostig visual-perceptual program generally tended to show no greater improvement in achievement than their control groups.

Seven studies reviewed fall into the binocular visual training category. Of these studies, two combined it with visual-perceptual-motor training. Two studies were of the case review type, where a consecutive number of cases were taken from a private optometric practice and their success assessed with regard to academic achievement. This is a convenient type of study clinically and has several advantages and disadvantages. The major disadvantage is the lack of a control group, especially important in dealing with the Hawthorne effect. However, it should be noted that the two studies which used dual control groups, one absolute and one controlling for the Hawthorne effect, showed the Hawthorne effect not to play a significant role in the success of training. Along the same vein, the subjects in these two experiments presented themselves voluntarily for a visual examination and payed for the training, thus showing a high degree
of interest and motivation which one would expect to have some influence on training success. The advantage of this type of study is that complete visual testing may be done prior to training, which allows training to be directed to the individual’s deficit area and also allows it to be continued until the deficit is remediated.

The average age of subjects in the binocular visual training programs was higher than that of the subjects in the other studies. This is in line with the belief that binocular abilities influence reading efficiency rather than learning to read. Only one-half of these studies included pre-testing to determine if binocular difficulties existed. One study even did binocular pre-testing but failed to mention the results of the pre-testing compared with therapy success. In light of this, it is remarkable to note that even those studies which gave blanket visual training to all the individuals still showed significant improvement in achievement.

The studies utilizing the Frostig Visual Perceptual Training Program, in general, showed no greater improvement in reading achievement than standard remedial reading techniques. Several of the studies did, however, show significant improvement on visual-perceptual scores after training. Length of training varied from five weeks to a full year and daily training time ranged from ten minutes to an hour. Over half of the studies applies the Frostig training program to all experimental individuals without first determining if the individuals had any visual-perceptual difficulties. In the two studies by Biager, the Frostig training program was given in place of regular reading instruction. The results of these two studies support the use of the Frostig program as a supplementary program instead
of serving as a replacement for reading instruction. Two studies showed that boys having low visual perceptual scores showed greater improvement in achievement than girls using the Frostig training program. This is an area that should be more thoroughly investigated.

In these authors' opinion, the Frostig test appears to be a fairly reliable test for identifying those children likely to have difficulty in learning to read. The Frostig training program, however, does not appear to be very successful in treating the perceptual disorders of these youngsters even though the youngsters do better on the test after training. This may be due to the training of splinter skills rather than actual improvement in visual-perception. Perhaps, then, a combination of Frostig training along with more accepted visual-perceptual-motor training techniques that have been found to be more successful with this age group would provide a better means of treating these youngsters.

Seven of the ten studies utilizing visual-perceptual-motor therapy demonstrated significant improvement in achievement upon completion of training. Training techniques varied greatly among the studies but most adhered to a basic training hierarchy of gross motor, then fine motor and finally visual perceptual techniques. Although only one study was optometric, most followed this developmental optometric philosophy. Unfortunately, most studies only outlined their training philosophy and failed to give more than a sketchy idea of what specific training techniques were employed. Due to the wide range of training techniques utilized, it is difficult to make direct comparisons between the studies. However, evidence gathered so far does support the use of this type of therapy, especially for those children shown to have a perceptual deficit. As
research continues it is hoped that the effective training techniques will be isolated from the wide variety currently employed.

In summary, although poor research design makes it difficult to interpret many of these research studies it does appear that visual training has some effect in improving academic achievement for some children. Before further statements can be made, more controlled research needs to be done. After reviewing the flaws in the current research and examining the areas that seem most promising, these authors have designed what they consider a well controlled study to help clarify the effectiveness of visual training on improving academic achievement.

The experiment has been designed to utilize a binocular-function training approach; this appears to be the most effective training approach and yet the least research has been done on it. The subjects are of normal intelligence, but display reduced academic achievement and a binocular dysfunction. The null hypothesis will be that binocular-function visual training will have no effect on improving reading ability and academic achievement.
PROPOSED EXPERIMENTAL DESIGN

Selection of Subjects

1. The subjects will be selected from a population of poor readers in the local school district, grades three through five.

2. Subjects will be screened using the Peabody Picture Vocabulary Test (PPVT), the Wide Range Achievement Test (WRAT) and the Durrell Standardized Reading Inventory (DSRI). Under-achievers will be identified by reading and achievement scores thirty percent or more below their grade level and an intelligence quotient of 85 or higher.

3. The subjects meeting the criteria above will be given a visual screening at their school. The screening will include the following tests:

   1. Case history of visual symptomology (Table 3)
   2. Near and far visual acuity
   3. Static retinoscopy
   4. Book retinoscopy
   5. Cover tests
   6. Near point of convergence
   7. Ocular motilities
   8. Accommodative rocks (+ 1.50)
   9. Prism rocks (8 BI/BO)
   10. Stereo fly
   11. Ophthalmoscopy

4. Only subjects showing binocular difficulty and symptomology on this screening will be included in this study. Therefore, those students showing the following visual anomalies will not be included: uncorrected refractive errors greater than +1.50 or less than -.50, ocular pathology, stabismic or amblyopic behavior. These students will be appropriately referred.

5. All subjects failing the vision screening will be given a complete 21 point examination, visual analysis and diagnosis. Any near prescriptions needed will be supplied. These children will require a second 21 point exam to determine if a binocular dysfunction still exists.

6. Following the examination, the subject population will include at least 60 students. These students will be matched for age, sex, reading level, I.Q., degree of binocular dysfunction, achievement level, teaching instruction and then be randomly divided into three groups: an experimental and two controls.
Training Procedure

1. The experimental group will begin a visual training program tailored for them from the training procedures outlined in Table III. All of the training will be done at the school, after school hours. Each subject will receive a one hour session per week and thirty minutes per day of home training. No program will extend beyond twelve weeks.

2. The first control group will begin a language development program aimed at improving language skills and equalizing the time the experimenters spend with the experimental group and this control group. This program will also meet once a week for an hour an involve story relating and discussion.

3. The second control group will receive no special program or attention at this time and will continue in regular classroom instruction.

4. Attendance records will be kept on all subjects and motivation rated on 1-5 scale at each session.

5. At the conclusion of the language and visual training programs, all subjects will be given another 21 point exam and analysis. The Durrell Reading test will also be re-administered at this time. The results of both pre and post-training 21 point exam will be rated on Sherman's one hundred point scale (46) so that any change can be compared.

6. The subjects will be re-tested using the Peabody Picture Vocabulary Test, the WRAT and the Durrell Reading Test six months after the termination of training.

7. The results will be analyzed using a t-test to compare reading, achievement and visual scores of the experimental and control groups. Analysis will also be made of any difference between these groups. A null hypothesis stating that visual training has no effect on reading and achievement scores will be tested at the .05 level.

Using this methodology has several advantages:

- All testing is done with widely accepted, standardized tests.
- Contact time between the experimental and first control group will be equalized to control for the Hawthorne effect.
- Only children showing visual deficits will be trained.
- All techniques will be individually programmed.
- Visual symptomology will be considered before subject selection.
- The control groups allow an evaluation of training effectiveness without being compounded by age, sex, educational environment, intelligence, reading or visual skill or maturation.
- Both short and long term effects will be assessed.
- Statistical analysis will be applied to all results.
### TABLE I

**SUMMARY OF THE STUDIES**

| AUTHORS' NAME | FRE | FRE | DOE | PETE | SEID | SWAN | WOLD | WALE | WIELE | ROSE | COLE | COLE | FALL | HALL | KEIN | RUBA | SHIP | MOCD | SME | NAME |
|---------------|-----|-----|-----|------|------|------|------|------|-------|------|------|------|------|------|------|------|------|------|------|
| TOTAL NUMBERS OF SUBJECTS |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Controls      | 9   | 7   | 49  | 100  | 36   | 20   | 105  | 72   | 8     | 42   | 42   | 20   | 6    | 28   | 28   | 42   | 105  | 72   | 8    |
| Experiments   | 9   | 42  | 42  | 18   | 100  | 100  | 14   | 26   | 200   | 112  | 14   | 12   | 21   | 21   | 70   | 34   | 48   | 4    |
| AGE GROUP LEVEL OF |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| I. TESTING OF SUBJECTS |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Visual Func. Tested | 21  | 21  | 21  | 21   | 21   |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Visual-Sensor. Ability |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Reading Readiness |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Achievement Level |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| II. MATCHING OF CONTROL AND EXPERIMENTAL GROUPS |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Sex |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Age |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| III. VISUAL TRAINING PROGRAM |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Type of Therapy |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Therapy Tech. Described |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| V. Therapy in Conjunction with Reading Therapy |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| V. Therapy in place of Reading Therapy |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Length of Each Session |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Over-all # in Weeks |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Home Therapy Followed |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Patient Cooperation Eval. |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Therapy Done individually |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Therapy Done in Small Group |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |
| Therapy Done in Whole Class |     |     |     |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |

**Notes:**
- **TABLE 1** provides a summary of the studies conducted.
- **Visual Function Tested** includes various tests such as Reading Readiness and Achievement Level.
- **Sex** and **Age** are also recorded for comparison.
- **Type of Therapy** includes different therapies such as Visual-Sensor Ability and Reading Readiness.
- **Length of Each Session** and **Over-all # in Weeks** indicate the duration of the therapy sessions.
- **Home Therapy Followed** and **Patient Cooperation Eval.** show the progress of the therapy.
- **Therapy Done individually** and **Therapy Done in Whole Class** highlight the methods of therapy delivery.
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### TABLE II

Abbreviations found in table I

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<th>Abbreviation</th>
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<tr>
<td>ABGT</td>
<td>Anton Brenner Developmental Gestalt Test of Readiness</td>
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<td>BVMT</td>
<td>Bender Visual Motor Gestalt Test</td>
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<td>BVT</td>
<td>Binocular visual test</td>
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<td>CTMA</td>
<td>Calif. Test of Mental Ability</td>
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<td>CTSR</td>
<td>Chapman-Cook Test of Speed of Reading</td>
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<td>CVPM</td>
<td>Coleman Visual-Perceptual-Motor Battery</td>
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<td>DILS</td>
<td>Durrell Identifying Lower Case Letters</td>
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<td>DTVD</td>
<td>Durrell Test for Visual Discrimination of words</td>
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<td>ESM</td>
<td>Eye Synchronization Monitor of P.D.</td>
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<td>FB</td>
<td>Divided Form Board</td>
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<td>FDTVD</td>
<td>Frostig Developmental Test of Visual Perception</td>
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<td>FPDB</td>
<td>Frostig Program for the Devel. of Visual Perception</td>
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<td>Informal Reading Inventory</td>
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<td>New Developmental Reading Test</td>
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<td>NYCPR</td>
<td>New York City Pre-Reading Assessment Test</td>
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<td>OEP 21-0EP</td>
<td>Examination</td>
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<tr>
<td>OM</td>
<td>Ocular Motility (cover test, rotations, fixations, n.p.c.)</td>
</tr>
<tr>
<td>OSUPT</td>
<td>Ohio State University Psychological Test</td>
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<td>CTMA</td>
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<td>Pressy General Reading Test</td>
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<td>PPVT</td>
<td>Peabody Picture Vocabulary Test</td>
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<td>Rosner-Rechman Perceptual Motor Survey</td>
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<td>SPMD</td>
<td>Shorr's Basic Perceptual Motor Development</td>
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<td>VAT</td>
<td>Visual Acuity Test, near and far</td>
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<td>VPMT</td>
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<td>Visual-Perceptual Training</td>
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<td>WCF</td>
<td>Winterhaven Copy Forms</td>
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<td>WISC</td>
<td>Wechsler Intelligence Scale for Children</td>
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<td>Wechsler Preschool and Primary Scale of Intelligence</td>
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<td>WRAT</td>
<td>Wide Range Achievement Test</td>
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TABLE III
TRAINING PROCEDURES

The entrance of a subject into any of the levels outlined below will be based on his or her current ability.

A. Motilities:

1. Monocular:
   a. Fixations, pursuits and rotations with various targets
2. Binocular:
   a. Fixations, pursuits, rotations and saccades

B. Accommodation:

1. Monocular:
   a. Near/far rocks
   b. +/- rocks with flip lenses at near
   c. Loose lens rocks (minus/plano) at far
2. Binocular:
   a. Near/far rocks
   b. +/- rocks

C. Motor fusion:

1. Nearpoint of convergence:
   a. Red-green glasses and penlight
   b. Three-dot card
   c. Brock string
   d. 20/20 letter on a white bead
   e. Variations using binocular motilities, cover-uncover-recover and near-far jumps with techniques a. through d.
2. Fusion ranges:
   a. Loose prisms
   b. Vectographs
   c. Stereoscopes
   d. Aperture rule
   e. Lifesaver card

D. Flexibility of accommodation and convergence:

1. +/- Prism rocks
2. Stereoscope tromboning
REFERENCES


