THE EFFECT OF VISION THERAPY ON READING RATE: A PILOT STUDY

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Abstract

Three subjects, two age 8 and one age 10, with identified visual system disorders were selected as subjects to evaluate the effects of vision therapy on reading efficiency as measured by reading rate. Reading rate measures were taken prior to initiation, at the conclusion, and 90 days post-visual therapy. The results were that all subjects had accelerated reading rate gains during the period of vision therapy and that the reading rates for two of the three subjects continued to increase in the post-therapy (maintenance) period. All three subjects experienced positive gains over the period (180 days) of the study.

Key Words

vision therapy, visual perception, visual discrimination, visual system dysfunctions, prism-induced visual system dysfunctions, standardized achievement test, criterion-based assessments,

Researchers have investigated the efficacy of vision therapy for visual perception, visual discrimination, vision as related to IQ and achievement,[1] visual perceptual motor training,[2] and vision therapy as related to the reduction of reading stress.[3] In addition, investigators have studied the effects of vision therapy on changes in the vision performance of subjects.[4,5] The results of these studies have been interpreted to conclude that the visual system can be positively changed through vision therapy. However, researchers studying the effects of vision therapy on academic performance have had less definitive conclusions.

Few studies have been published that relate to the topic of reading efficiency and visual system function. Haddad[6] surveyed 73 learning-disabled readers, of which 37 were found to have poor fusion amplitudes. Haddad treated the 37 subjects, using orthoptic procedures, and the results were increased reading performance in direct proportion to the amount of fusion dysfunction that was present for each subject at the onset of the investigation. Reading rate and comprehension increased when vision therapy was used with a 15-year-old subject who was diagnosed with visual system dysfunctions.[7] Siederman[8] identified 36 reading-disabled students with visual dysfunctions and divided them into two groups. One group was provided with vision therapy and the control group with a combination of physical education, art, or music. Both groups received usual and similar reading instruction. The vision therapy group made significantly better gains than the control group.

Positive effects of vision therapy were reported by Solan and Seiderman,[1] who found significant increases for vision function from pre-therapy to post-therapy in all visual areas measured. Lewis[2] reported a single case study of a girl with a measured 130 IQ who was failing classes and was found to have vision dysfunctions. After three months of vision therapy, she enjoyed reading and was receiving A's and B's in her school classes. Ludlam and Ludlam[9] studied the effects of prism-induced visual system dysfunctions on the reading performance of normal adults. They reported that the subjects experienced declines in both reading rate and comprehension.

Studies in which the investigators controlled for both visual system dysfunction and reading disability more often found significant positive changes in reading function than studies that used non-specific learning disability group membership as a sole criterion.[7,8] Research questions regarding vision therapy have not consistently addressed its effect on the subject's ability to learn to read, read efficiently, or read for increased duration.

The specific questions for this investigation were:

1. Does vision therapy increase reading efficiency, as measured by rate of reading, in subjects identified as having a visual system dysfunction?
2. Does an increase in efficiency of reading maintain over time?

METHOD

A qualitative research design was utilized for this investigation. The investi-

gators believed the qualitative or case study design to be appropriate for determining changes in performance of individual students. Group or quantitative research designs obscure an individual subject's change by comparing effects of treatment for groups of subjects through statistical analyses. Case study designs provide useful anecdotes or examples of one or a few subjects and report changes in behaviors over time and treatment.[10] Actual changes in behaviors are reported and statistical analyses are generally not applied. Thus, readers of the research may interpret the value of the data and treatment for the individual cases reported in the study and make applications to their patients' treatment needs.

The case subjects for this study were three children, two age 8 and one age 10. Each subject completed a comprehensive visual examination by Dr. Wylie. All three subjects had normal ocular and general health. None of the subjects were taking systemic medications. The subjects were diagnosed as having visual system dysfunctions and were scheduled for vision therapy when they were solicited to join the investigation.

Each subject was administered a reading rate inventory at the initiation of vision therapy, at the conclusion of vision therapy, and three months post-vision therapy by a graduate assistant of Dr. Sigler. The graduate assistant was knowledgeable of the purpose for the study and had volunteered to interview the parents and children.

The reading rate inventory was a list of words taken from grade level word lists. Each child had demonstrated the ability to read at the difficulty level of the words on the list. A master set of words were developed specifically for each child and a random subset of words were made from the master lists and were typewritten, using 18-point type, on 8 1/2 x 11 inch paper, and were formulated in horizontal rows in order to simulate a written text. The words were presented in random order (nonsense) to minimize the influence of content knowledge. For each administration of the rate inventory, the child was provided with a new set of randomly selected words from the master set and the child was asked to read the words quickly and accurately during a one-minute timing. The subjects were aware of the timing procedure. The word-per-minute (wpm) "score" was calculated by counting only the correct responses within the one-minute period for each administration of the inventory.

The word list approach was used instead of more common standardized achievement tests in order to avoid problems with reliability inherent in standardized tests and to be able to measure changes in reading rate behavior that are not generally measured by standardized achievement tests. The validity of the criterion-based assessments, such as the word list, are inherent in that they measure the exact behavior desired and do not rely on inferences made from scores from standardized measures.[11] For this study, change of reading rate was directly measured by the criterion-based assessment and inferences about rate change were not required. Reliability is controlled by using the same pre-evaluated master list for the development of all rate assessment lists.

The vision therapy was conducted in the office of Dr. Wylie by him and his therapy assistant with follow-up techniques completed by the family in the child's home. Initially, patients were scheduled at two-week intervals, with three-week intervals near the termination of therapy. Each therapy session was 30 to 45 minutes in duration. The vision therapy continued for approximately three months for each subject and the exact number of visits to the optometric office was controlled by client need and varied across clients and will be discussed below.

Subjects were monitored during the course of the study by Dr. Sigler and his graduate assistant. Each subject was seen in person for the rate evaluations and were contacted by telephone between evaluations. Each subject was given a $5.00 gift certificate for McDonalds at the conclusion of each rate evaluation. During telephone and personal visits with subjects, inquiries were made to insure that subjects had not received reading training other than what normally occurs during the school year. None of the subjects received reading assistance after school or during the summer months of the study.

CASES

Subject 1: TC

TC was 10 years of age at the time of the optometric examination and had experienced difficulty with reading since first entering school. TC was in a fifth grade placement at the time of inclusion in the study, but had been retained in the first grade due to poor academic progress. TC had been provided with assistance in the Learning Assistance Program (LAP) wi' the primary goals being to improve basi. reading skills and reading comprehension. TC's progress at school remained slow and it was reported that the LAP intervention was not substantially improving reading ability.

TC's reading behaviors were initially reported as fatigue after reading only one paragraph and frequently skipping words. TC was reported to cover one eye and to change the reading distance of material frequently. TC's explanation for these behaviors was that the print would "run together" or there would be "two of everything."

TC's pertinent optometric findings are displayed in Table 1.

Table 1
Optometric Evaluation
TC

Optometric Findings	
Distance acuity (in each eye)	20/15
Nearpoint acuity (in each eye)	20/20
Nearpoint of convergence (NPC)	6/8 in.
Ocular motility	Smooth /accurate
Refraction (each eye)	OD, Plano OS, Plano
Nearpoint Findings	
Phoria:	2 exo to 1 eso
Vergence amplitude:	With Plano
Base-out	14/10
Base-in	14/8
Accommodation	
Relative negative	+1.25
Relative positive	-0.75

It is apparent that TC had significant visual system difficulties at the onset of the therapy. At the conclusion of the vision therapy, the vision system evaluation had changed to reflect more normal patterns and abilities.

The diagnosis for TC was vergence insufficiency and accommodative dysfunction. TC was loaned a +1.00 sphere OU for sustained nearpoint work. These were provided to reduce the relative esophoria at near. TC was then given a number of vision therapy procedures to use in a home-based therapy program. These procedures included Accommodative Rock, Prism Rock, and other vergence training. Over 10 weeks TC was seen for five visits to evaluate progress and to modify therapy. Evaluations involved phoror ter measurements of vergence an. accommodative findings.

The reading rate measures for TC are displayed in Table 2. On the initial reading rate inventory, TC read 73 words per minute (wpm), minus two errors, for a net reading rate of 71 wpm. At the conclusion of vision therapy, a second rate assessment was administered and TC read 85 words, minus two errors, for a net reading rate of 83 wpm. At the conclusion of the 90-day post- vision therapy period, the reading rate was 100 wpm, less two words read incorrectly, for a net reading rate of 98 wpm.

Table 2
Reading Rates
TC

	Total Words /Min	Errors	Net Words /Min
Initial	73	2	71
End of Treatment	85	2	83
90 Days Post-Treatment	100	2	98

Without reading instruction beyond what had been typical for TC, the reading rate advanced from 73 wpm to 98 wpm for an increase of 35%. The gains in reading rate were consistent across the vision therapy and maintenance periods of the study.

Subject 2: LV

LV was 8 years of age at the time of the optometric examination and was attending the second grade. LV had experienced difficulty with reading since first attending school and there had been a history of reading difficulty in the family. A diagnosis of dyslexia was made by the school system and LV was placed in special education for reading remediation. Before being determined eligible for special education, LV had received reading assistance through LAP.

LV's reading behaviors included reversals of letters and words, skipping words and lines, word substitutions, and a close working distance while reading. Maintaining the learning pace of second grade classmates was becoming increasingly difficult and LV was beginning to express self-doubts concerning general academic abilities. Additionally, there were some visual task avoidance behaviors reported by the teacher.

The request for optometric evaluation was made by LV's parents. The results of LV's pertinent optometric findings are displayed in Table 3.

Table 3
Optometric Evaluation
LV

Optometric Findings	
Distance acuity (in each eye)	20/15
Nearpoint acuity (each eye)	20/20
Nearpoint of convergence (NPC)with diplopia	24 in.
Ocular motility	Smooth /accurate
Refraction (each eye)	OD +.50 SPH OS +.50 SPH
Nearpoint Findings	
Phoria	9 exo
Vergence amplitude	
Base-out	4/-4
Base-in	18/14
Accommodation	
Relative negative	+1.75
Relative positive	-0.75

In addition to the data in Table 3, the cover test showed intermittent alternating exotropia at nearpoint only. The cover test at distance showed no tropia.

The diagnosis for LV was intermittent alternating exotropia at nearpoint.

Therapy was a combination of in-office and in-home procedures. Procedures were modified based on LV's progress and extended over an eight-week period, which included seven office visits. Procedures included Accommodative Rock, Prism Rock with suppression control, and other stereoscopic and vectographic procedures to improve fusional convergence.

The results of the rate evaluations at each time period for LV are displayed in Table 4. The initial rate of 45 wpm was particularly slow when compared with peer rates.

Table 4
Reading Rates
LV

	Total Words /Min	Errors	Net Words /Min
Initial	45	14	31
End of Treatment	97	33	64
90 Days Post-Treatment	73	23	50

The rate improvements for LV were substantial with a +19 (61%) wpm gain from the initial evaluation to the end of the 90-day post-vision therapy period. There was a regression from the end of the therapy period to the 90-day post-vision therapy evaluation. No explanation is offered for the regression. In spite of the regression, the overall changes in rate are superior to the average rate growth during the previous school tenure. The reading rate gap between LV and class peers was reduced.

As was the case with TC, LV's post-vision therapy period was during the summer and no reading intervention was attempted during that time. During the school year only the reading instruction that was provided prior to inclusion in this project was continued. Gains in both the reading efficiency and maintenance questions of this research were upheld in the case of LV, although there was some regression during the summer period. Regression during the summer is a normally occurring phenomenon among children. For most children, the recovery from the summer regression occurs quickly once they re-enter the school environment. No follow-up was attempted to determine if the reading rate would return to the previous level once LV began school and formal instruction in the fall.

Subject 3: BK

BK was in the second grade and was 8 years of age during the initial evaluations for the study. There was a history of reading problems since kindergarten, which included the inability to visually decode words into parts. BK's general developmental history was normal.

BK was not in special education. The school BK attended had small class sizes and it was the opinion of school personnel that the needed specialized instruction was adequate within the regular instructional setting.

BK's parents requested the optometric evaluation. They reported concerns with BK's nearpoint vision and ability to maintain place while reading. It was observed that BK tracked visual stimuli by head movement rather than eye movement. BK's pertinent optometric findings are summarizeds in Table 5.

Table 5
Optometric Evaluation
BK

Optometric Findings	
Distance acuity (in each eye)	20/15
Nearpoint acuity (in each eye)	20/20
Nearpoint of convergence (NPC)	2/2
Ocular motility	Smooth/ accurate
Refraction (each eye)	OD, Plano OS, Plano
Nearpoint findings	
Phoria with Plano	4 eso
Base-out	x/18/14
Base-in	x/12/6
Accommodation	
Relative negative	+1.75
Relative positive	-0.75

The diagnoses for BK were accommodative dysfunction and esophoria. A pair of glasses, +0.75 OU, were loaned to BK during the initial therapy to reduce the esophoria.

Therapy procedures for BK were similar to TC's and included accommodative techniques, Prism Rock and other vergence training. BK had six progress visits over a three-month time period. At the conclusion of therapy, BK's fused crossed cylinder (#14B) finding was OU +1.25 and these were prescribed as a reading prescription.

As with both of the other subjects, vision therapy had a substantial impact on the quantitative measures of BK's vision functioning.

Reading rate evaluation data was collected for BK at each of the three time periods. The rate data is displayed in Table 6.

Table 6
Reading Rates
BK

	Total Words /Min	Errors	Net Words /Min
Initial	64	25	39
End of Treatment	70	20	50
90 Days Post-Treatment	74	20	54

Consistent with the other subjects, BK showed substantial changes in the rate of reading. Increased reading rate, from 39 to 54 wpm, for a 38% increase was recorded over the period of investigation. Additionally, BK was able to reduce errors in reading by 20% during the period of study. No reading instruction other than what was normally delivered in school was provided for BK during the period of the study.

The vision therapy was successful for BK and the research questions of increased efficiency and maintenance was confirmed positively. BK increased reading efficiency and the gains maintained over time.

DISCUSSION

Each of the three cases gained reading efficiency over the duration of the study. All subjects made gains during the therapy phase and two of the three subjects made additional gains during the maintenance period of the study, which was devoid of reading instruction. Displayed in Table 7 are the summary results for the three subjects.

Table 7
Summary of Case Data

	Age	Rdg. Rates	Net Change	% Net Change
Subject 1, TC	10	71/83/98	+27 wpm	+38%
Subject 2, LV	8	31/64/50	+19	+61%
Subject 3, BK	8	39/50/54	+15	+38%

During the interval between the first and second rate timings (during the vision therapy period), the reading rates for TC, LV, and BK increased by 17%, 106%, and 28%, respectively. Net gains in reading rates across the total time of the study were 38%, 61%, and 38%, respectively. Two of the three subjects continued rate gains during the maintenance phase (summer vacation), while one of the three subjects declined during this period but maintained a net increase in wpm rate for the total period of the study. All three subjects' rates increased more rapidly than they had historically.

At the onset of the study each subject had reading rate deficiencies in comparison with their age and grade peers. Second grade students read at an average of 71 wpm, while fourth grade students read at 100 wpm (total reading rate minus errors). At the conclusion of the study, TC was at expectancy with fourth grade peers, while LV and BK remained less efficient than their second grade peers, although the differences were substantially less than were observed at the onset of the study. During the approximate six months of the study, the subjects increased their reading efficiency at an annualized rate of two to four times what they had been able to gain per year in previous school years. They had been averaging 10 to 14 wpm gains per school year and in the period of the study they gained and annualized 30 to 54 wpm.

The results of this investigation contribute to the data supporting vision therapy for visual system deficient readers and are consistent with the results of Haddad,[6] who found that when vision system-deficient learners were provided with vision therapy, concurrent gains were made in reading. Hendrix[7] observed reading rate increases for a 15-year-old subject during vision therapy under similar circumstances of this study. Similarly, support for the findings of this study are found in the work of Ludlam and Ludlam,[9] who demonstrated they could induce slow reading rate and comprehension errors in normal reading adults by using undetectable prism lenses provided for their subjects.

CONCLUSIONS

For the three case subjects in this investigation, the research questions were upheld. First, the efficiency of reading, as measured by rate, increased more rapidly than the subjects' historical rates during the period of vision therapy. Second, reading rate gains were maintained during the post-vision therapy period and, in two of the three cases, further rate gains were observed during the post-vision therapy period.

Additional research would serve to further clarify the effects of vision therapy. For example, could predictions of reading change be made by comparing the type of reading disorder to the specific visual system dysfunction? What are the effects of duration, frequency, and setting for vision therapy on the changes in reading ability? Answers to these questions would increase the knowledge base for systematic investigation of the relationship between visual system disorders and reading dysfunctions.

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Date accepted for publication:
October 15, 1993