Vision Therapy as a Viable Management Option for Reading Disabilities

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VISION THERAPY AS A VIABLE MANAGEMENT OPTION FOR READING DISABILITIES

VISION IS EYES AND READING IS BRAIN

BY C. V. VERHOFF

ABSTRACT: Various studies have been conducted which have investigated the relationship between reading disability and ocular functions. There have been many conflicting viewpoints resulting from these studies. Some researchers report vision as a significant factor in the disability while other researchers place more emphasis on non-ocular, neurological or social factors. Similarly, there is much variation in opinion as to the degree that vision therapy can remedy reading disabilities. Different vision therapy techniques focus on specific ocular functions. However, this is not a guarantee that vision therapy will cause an improvement in reading efficiency. By compiling information from these reports, we plan to describe the role of vision training and its effectiveness upon this population of reading disabled individuals.

WHAT'S INVOLVED IN NORMAL READING

- Henderson JM, Pollatsek A, Rayner K. Covert visual attention and extrafoveal information use during object identification. *Percept Psychophys* 1989; 45:196-208

Efficient readers first have their attention fixated at the fovea so that they can extract the information from that area. Then they fixate on parafoveal areas to the right of the fixation point. This shifting of attention is independent of eye movements.

- Kulp MT, Schmidt PP. Effect of Oculomotor and Other Visual skills on Reading Performance: A Literature Review. *Optometry and Vision Science.* 1996; 73:283-292

Two major areas are correlated with reading: oculomotor skills and visual processing.

To address oculomotor skills:

Javal noted that reading does not consist of a continuous sweep across the page, but a series of small movements (saccades) with intervening fixations. 90% of the time is spent in fixations. The rest of the time is spent making small, rapid jumps to the right across each line, and larger saccades (return sweep) to the beginning of the next line.

The length of a fixation depends on the letters seen in the first 50 ms. If the information is complex, the duration of the fixation is unaffected. However, less parafoveal information will be acquired. During fixation time, foveal information (up to 5-8 characters) is processed and peripheral information (such as word length) is used to direct successive eye movements.

Saccade length is influenced by perceptual span e.g., if you read right to left (as in Hebrew), the span is asymmetric to the left whereas if you read left to right (as in English), the span is asymmetric to the right. For English readers, the eye seeks 12-15 characters to the right to get an indication of word length, 8 characters to the right as in indication of word shape but only 4 characters to the left. Eye movement is also greater in the direction of habitual reading e.g., Americans make more mistakes when asked to read vertically than do Japanese (who read horizontally and vertically).

Because of the small size of the fovea, saccadic movements need to be very accurate. There is a "convenient viewing position" where words are recognized most rapidly. If the initial fixation is at this "preferred viewing position" at the center of the upcoming word, then you only need to refixate 10% of the time. However if you are 2 letters away, you'll refixate 23% of the time and if 3 letters away, you'll refixate 38% of the time. This increase in number of refixations as you move away from this optimal point is due to the fact that visual acuity decreases as you move away from the central foveal area.

Vision is suppressed during a saccade and 50 ms before and after the saccade. Of course, vision is clear during the fixation. So the end result is packets of information gathered from each fixation.

This is where visual processing plays its part: the "visual packets"are integrated spatially and temporally across saccades by the brain to form a continuous visual perception. The system that "sews" them together is known as the transient pathway. This channel, stimulated by saccades, suppresses the sustained image from the previous fixation. In this way, information from fixations can be kept distinct and processed sequentially in an organized fashion.

NORMAL DEVELOPMENT OF READING SKILLS

Kowler E, Martins AJ. Eye movements of preschool children. *Science* 1982;215:997-9

- found that preschoolers have larger saccades, longer latencies and less stable fixations than adults. By the time they reach elementary school, there is some improvement of oculomotor skills. Beginning readers have shorter saccade lengths, longer fixations, and more regressions (backward/leftward saccades) than do skilled readers. Overall though, reading rate doubles between 1st and 6th grade. Beginning readers also have a slightly smaller perceptual span, but this has not been found to be a reason for the variation in reading rate.

Regressions are common in skilled readers (5-20%) and function to correct misreading, and verification. Frequency of regressions increase with an increase in text difficulty. They correct for oculomotor inaccuracies. If regressions are more than 20% though, reading efficiency decreases. This may be manifested as omission of lines/words or frequent loss of place (fingerpointing or excessive head movement). Head movement is a sign of poor comprehension regardless of text difficulty.

PAPERS IDENTIFYING THE VISION PROCESSES INVOLVED IN READING

1. Kulp MJ, Schmidt PP. Visual Predictors of Reading Performance in Kindergarten and First Grade Children. *Optometry and Vision Science*. 1996;73:255-260

- found that "visual performance was significantly related to reading performance" after an investigation of 90 kindergartners and 91 1st graders
- accommodative facility was a larger factor in 7 year olds and 1st graders than in kindergartners. The reason for this relationship is that as children get older, the print size of their reading material gets smaller. This smaller print requires more rapid and repeated changes in accommodation.
- failure of the Modified Clinical Technique (MCT) was significantly associated with decreased reading skill in 5 year olds
- decreased Randot stereoacuity (less than 100 sec arc if that is the only decreased function, or less than 50 sec arc if the child also failed the MCT) was also a predictor of reading performance
- visual perceptual skills (as measured by the Test of Visual Analysis Skills Short Form and Gardner Reversals Frequency Test) were also good indicators of reading performance in the age groups tested

2. Eden GF, Stein JF, Wood HM, Wood FB. Differences in eye movements and reading problems in dyslexic and normal children. *Vision Res* 1994; 34:1345-58

- conducted a study of 93 5th grade children and reported that

- 29% of disabled readers as compared to 15% of normal readers reported blur while reading (decreased convergence)

- 64% of disabled readers as compared to 20% of normal readers reported loss of place when reading (decreased convergence, decreased divergence ranges and saccadic difficulty)

- over 24% of the reading disabled had poor fixation control

- found more visual confusion during reading as a result of the transient system.
- noted that additional eye movements must occur to try and bring about the activity of the transient system.

3. Garzia RP, Nicholson SB. Visual function and reading disability: an optometric viewpoint. *Journal of the American Optometric Association.* 1990;61:88-97

- listed the following as associated with reading dysfunction

(a) hyperopia (farsightedness)

(b) anisometropia (different prescription between right and left eyes)

(c) decreased nearpoint visual acuity, especially binocularly

(d) ocular motility efficiency

(e) accommodative and vergence function

accommodative infacility

decreased fusional vergence

convergence insufficiency

vergence stress

(f) binocular vision anomalies

exophoria at near

fixation disparity

aniseikonia

- Stein J, Fowler S. Occlusion treatment. *Optician* 1986; 11:16-22
  report better reading performance in children with divergence difficulties if one eye is occluded

(g) transient system deficit

When there's a deficit, this lack of masking results in decreased efficiency, organization and integration during reading.

(h) Disabled readers who have a dysfunction in attention manipulation (difficulty shifting attention from the fovea to the parafoveal area as required) show an increase in the duration of fixations as well as a decrease in saccade lengths

(i) visual perceptual-motor development

may be caused by (a), (especially if left uncorrected) as determined by

- Rosner J, Rosner J. Comparison of visual characteristics in children with and without learning difficulties. *Am J Optom Physiol Opt* 1987;536-41

reported in a study of 712 children ages 6-12 years that only 18% of hyperopes (>1.25D) showed appropriate visual perceptual skills in contrast to 74% of the emmetropic and myopic children.

- Rosner J, Rosner J. Some observations of the relationship between the visual perceptual skills development of young hyperopes and age of first lens correction. *Clin Exp Optom* 1986;69:166-8

  reported in a study of 48 hyperopic (>2.25D) children ages 6-12 years that fewer visual perceptual-motor delays were found if they were corrected before their 4th birthday

4. Brannan JR, Williams MC. Allocation of visual attention in good and poor readers. *Percept Psychophys* 1987; 41:23-8

- found that disabled readers cannot allocate visual attention adequately across visual space; they do not have accuracy superiority to the right of fixation

STUDIES THAT DEMONSTRATE VISION THERAPY AS BENEFICIAL TO READING DISABILITY

1. Haddad HM, Isaacs NS, Onghena K, et al. The use of orthoptics in dyslexia. *J Learn Disabil* 1984; 17:142-4

- reported increased attention during reading after fusional vergence therapy in a group of children referred for reading disability.

2. Atzmon D. Positive effect of improving relative fusional vergences on reading and learning disabilities. *Binoc Vis* 1985;1:39-43

- noted improvements in reading following antisuppression and vergence vision therapy in a sample of learning disabled children.

3. Hoffman LG. The effect of accommodative deficiencies on the developmental level of perceptual skills. *Am J Optom Physiol Opt* 1982; 59:254-62

- found that monocular, biocular and binocular accommodative rock vision therapy resulted in a 60% improvement in visual perceptual discrimination, visual-motor integration and visual attention skills in five 8 year old children manifesting both accommodative and visual perceptual – motor skills deficiencies.

4. Solan HA. Deficient eye movement patterns in under-achieving high school students: three case histories. *Journal of Learning Disabilities.* 1985;18:66-70

- noted a significant gain in reading comprehension in these high school students(after vision therapy)

  (1) patient with convergence insufficiency, poor binocular fusion and poor facility of accommodation

  (2) patient with exophoria at near point, deficits at convergence and divergence and sluggish accommodation at reading distance

  (3) patient with difficulties at both convergence and divergence, sluggish facility of accommodation and a significant deficit at ocular-motor skills.

5. Wold RM, Pierce JM, Keddington J. Effectiveness of optometric vision therapy. *J Am Optom Assoc.* 1978;49:1047-1059

- advocated vision therapy designed to improve binocular vision and oculomotor control to improve reading ability in learning problem students.

6. Kulp MT, Schmidt PP. Effect of Oculomotor and Other Visual Skills on Reading Performance: A Literature Review. *Optometry and Vision Science.* 1996;73:283-292

- stated that "vision therapy can improve saccadic control, left to right sequencing, and rhythmic motor planning, as well as eliminate excessive head movement".

7. Solan HA. Eye movement problems in achieving readers: an update. *Am J Optom Physiol Opt* 1985;62:812-9

- found both subjective and objective improvement (by 42-117%) in eye movements of 9 readers with at least average reading comprehension (after orthoptic therapy).
- found that inefficient eye movements are more common in slow, laborious readers than in those who did not understand the material:

-If you give easier text to a poor reader, there is a decrease in the number of fixations and regressions with a resultant increase in reading rate.

-However, the eye movements of a good reader are the same regardless of the reading level of the text.

8. Kulp MT, Schmidt PP. Visual Predictors of Reading Performance in Kindergarten and First Grade Children. *Optometry and Vision Science* 1996;73:255-260

- stated that "published studies have shown that vision therapy results in improvements of focusing ability, ocular motor skills, and fusion range and quality".
- stated that " accommodative facility therapy decreases asthenopia".

stated that vision therapy improves reading and attention in reading disabled children.

9. Heath EJ, Cook P, O'Dell N. Eye exercises and reading efficiency. *J Acad Ther* 1976;11:435

- stated that saccades can be trained to a large degree.

10. Getz DJ. Learning Enhancement Through Vision Training. *Academic Therapy.* 1980;15:457-466

1.Homolateral creeping
2. Herman
3. Marsden ball
4. Simon Says
5. Penlight Versions
6. Cross-pattern creeping
7 Pre-writing designs
8. Fixations
9. Chalkboard templates
10. Balance board or block
11.Chalkboard circles
12. Geoboard
13. Balance board on a two-by-four
14. Chalkboard bimanual lines
15. Parquetry blocks
16. Chalkboard left-to-right patterns
17. Jigsaw puzzles
18. Walking rail
19. Box of cube blocks
20.Perceptual development motoractivity cards
21. Tracking work book
22. Slant desk
23. Jump board
24.Perceptual-developmental skill builder (light and buzzer)
25. Toss back with tooties
26. Angels-in-the-Snow
27. Visual-fields card
28. Tachistoscope with circles
29. Tachistoscope with forms
30. Chalkboard animal fixations
31. Road map
32. Beads and patterns
33. Kirshner arrows
34. Tumbling E and number charts
35. Flannel boards with fish
36. Templates on paper
37. Brock string
38. Perceptual developmental drawing cards
39. Wide View
40. Small geoboards
41. Designs for large parquetry blocks
42. Flannel boards with geometric forms
43. Accommodative rock
44. Alphabet pencils
45. Tachistoscope with tic-tac-toe grid
46. Tachistoscope with arrows
47. Parquetry chips
48. Flipped forms
49. Tachistoscope with digits
50. Motor control stick with Marsden ball
51. Rotated forms
52. Outline patterns for parquetry block

- performed the above vision therapy procedures on 2nd grade students for a total of 40 hours (1/2 hour per day, 5 days per week for 4 months) and noted better reading comprehension and word recognition skills than the control group. The results reinforced the concept that reading is a hierarchy: The most impact was seen at the basic level of reading skills (decoding) upon which higher level reading skills are based. They suggested that a longer period is needed to improve more refined levels such as spelling.

11. Solan HA, Feldman J, Tujak L. Developing Visual and Reading Efficiency in Older Adults. *Optometry and Vision Science.* 1995;72:139-145

- found " a statistically significant and clinically meaningful improvement in all aspects of reading efficiency, including reduced number of fixations and regressions per 100 words, increased average span of recognition, and improved reading rate without loss of comprehension" in a group of 20 adults aged 62-75 years old. They had no oculomotor anomalies. The training "sessions lasted 1 hour and included Guided Reading, tachistoscope, React and PAVE training (Perceptual Accuracy Visual Efficiency).

12. Hoffman LG, Rouse MW. Vision therapy revisited: a restatement. *J Am Optom Assoc* 1987;536-41

Solan HA, Ciner EB. Visual perception and learning: issues and answers. *J Am Optom Assoc* 1989; 60:457-62

- "report positive effects of remediation of visual perceptual-motor skills on subsequent academic performance of children".

13. Garzia RP, Nicholson SB. Visual function and reading disability: an optometric viewpoint. *Journal of the American Optometric Association*. 1990;61:88-97

Because the deficiency of the transient system occurs early in the visual information processing sequence, some people do not believe that it will be responsive to treatment. They stated that proper management would be compensatory in nature, which means that with increased experience and skill, the readers will develop alternate reading strategies to overcome the visual deficit. It still is not absolutely clear though what the improvements after vision therapy are due to: changes in sustained-transient function or in these compensatory strategies.

First you must consider how vision therapy works. It utilizes a variety of target parameters:

- target size and separation
- spatial frequency
- orientation
- contrast
- movement
- color
- central/peripheral location
- clarity

This requires the patient to make figure-ground decisions and respond to frequent adjustments in spatial and temporal stimulus properties. That means that sometimes they must distinguish small, detailed patterns that are moving or situated in a particular way against a background. In order to do this, they must use both pathways for visual processing: the sustained one that is sensitive to detail and the transient one that is sensitive to motion. Therefore, by placing demands on the (transient system) skills that the disabled readers are deficient in, vision therapy can enhance the deficient response.

14. AOA VisionFax System Information-on-Demand Document #0040 Vision, Learning and Dyslexia

"Optometric intervention for people with learning-related vision problems consists of lenses, prisms, and vision therapy. Vision therapy does not directly treat learning disabilities or dyslexia. Vision therapy is a treatment to improve visual efficiency and visual processing, thereby allowing the person to be more responsive to educational instruction. It is part of a multidisciplinary approach to learning disabilities."

STUDIES THAT DEMONSTRATE VISION AS SOMEWHAT RESPONSIBLE FOR READING DISABILITY

1. Poynter HL, Schor C, Haynes HM, Hirsch J. Oculomotor Functions in Reading Disability. *American Journal of Optometry and Physiological Optics*. 1982;59:116-127

- found that the relationship was only significant if oculomotor functions are considered collectively, rather than independently.
- Although oculomotor functions are not the primary, principal causes of reading disability, they still may be significant factors.
- The most important functions (which are of marginal significance) responsible for this relationship depend upon the grade level of the student:

  the frequency of forward fixations for 4^{th} graders

  the frequency of regressive fixations for 6^{th} graders

  the lag of accommodation for both groups (4^{th} and 6^{th} graders)
- Age does not affect the magnitude of the relationship, only which function accounted for the relationship.
- Language is a factor only if the reading material is above the grade level of the individual. In this case, it was found that there was an increase in the number of saccades and an increase in the duration of fixations. In this study, however, they eliminated language as a factor by having the subjects read numbers.

2. Poynter HL, Schor C, Haynes HM, Hirsch J. Oculomotor Functions in Reading Disability. *American Journal of Optometry and Physiological Optics.* 1982; 59:116-127

- found a significant, moderate relation between oculomotor functions (combined) and reading ability. They estimated that at least 20% of reading disability is related to oculomotor function. Therefore, there's still 80% that vision practitioners cannot fully correct.

STUDIES THAT DID NOT FIND ANY RELATIONSHIP BETWEEN VISUAL FUNCTION AND READING

Vision is "eyes" and reading is "brain"

1. Kurzweil SR. Developmental Reading Disorder: Predictors of Outcome in Adolescents Who Received Early Diagnosis and Treatment. *J Dev Behav Pediatr* 13:399-404, 1992

- conducted a study of 40 children who were diagnosed and began reading therapy at 7-years-old. Upon follow-up at 14-years-old, they found that 40% of the children were reading appropriately and that IQ was significantly related to improvement and recovery. Therefore, they suggested that if cognitive therapy is offered together with specific reading therapy, these lower IQ students may be more successful. The level of the parents' education was also found to be a significant factor in the children's success. Furthermore, they stated that "although having a speech disorder or hyperactivity did not significantly affect the outcome, children with multiple additional specific developmental disorders may be at greater risk for persisting dyslexia than are those with just one of the additional disabilities. The type and severity of the additional learning disability (ies) also may be relevant".

2. Letourneau JE, Lapierre N, Lamont A. The relationship between convergence insufficiency and school achievement. *American Journal of Optometry and Physiological Optics*. 1979;56:18-22

- "found no relationship between the convergence sufficiency of 735 school children and their school achievement"

3. Brown B, Haegerstrom-PortnoryG, Yingling CD, Herron J, Galin D, Marcus M. Tracking eye movements are normal in dyslexia children. *American Journal of Optometry and Physiological Optics*. 1983;60:376-383.

- "found no differences in the visual and oculomotor abilities of normal achievers and poor readers"

4. Goldberg HK, Arnott W. Ocular motility in learning disabilities. *Journal of Learning Disabilities*. 1970;3:160-162.

- "found that dyslexics had erratic eye movements only when reading material above frustration level. Therefore, abnormal eye movements were secondary to, not the cause of, poor reading".

5. Keogh BK, Pelland M. Vision training revisited. *Journal of Learning Disabilities*. 1985;18:228-236.

- "declared that it was uncertain whether vision therapy or even vision functions were associated with reading achievement".

6. Hall PS, Wick BC. The Relationship Between Ocular Functions and Reading Achievement. *Journal of Pediatric Ophthalmology and Strabismus*. 1991;28:17-19

- assessed 111 students (total number screened were 125; those with significant refractive errors, strabismus or low IQ were eliminated) who were in grades 1-6. Evaluated 11 ocular functions

(1) Visual acuity

(2) King-Devick Test (simulates the movements required for efficient reading)

-time taken to complete the test

-number of errors*

(3) Accommodative facility (the ability to change focus at various distances/through different lenses)*

(4) Amplitude of accommodation (how much you can focus)*

(5) Accuracy of accommodation (how accurately you focus towards the target)

(6) Heterophoria (posture of eyes)

(7) Horizontal fixation disparity

(8) Vertical fixation disparity

(9) Near point of convergence (how close things come towards your nose before they double)*

(10) Stereopsis (depth perception) as measured by Titmus

(11) Stereopsis as measured by Randot*

They found no relationship between ocular functions and reading achievement, even when considering special statistical techniques to detect small relationships between the * items and reading achievement.They attributed reading ability to

(a) highly trained teachers/ remedial instructors

(b) language ability

(c) peer pressure

(d) parental encouragement

(e) home tutoring

(f) innate intelligence

7. Helveston EM, Weber JC, Miller K, et al. Visual functions and academic performance. *Am J Ophthalmol.* 1980;99:346-355

- "found the ratio of students with vision problems was similarly distributed among poor readers, average readers and above average readers".

8. American Academy of Ophthalmology, "Eye Care Facts & Myths" brochure 1984. p4

"Eye trouble is the cause of learning disabilities. True or False.

False Reading, mathematics and other learning problems among children are often referred to as learning disabilities. There is no scientific evidence that eye trouble causes learning disabilities, or that eye exercises cure learning problems.

Children with learning difficulties often need help from teachers and people with special training. Before such treatment begins, it is important for the child to have a complete medical eye examination, to see if he or she has a vision problem that may affect reading."

9. Getman G. A Commentary on Vision Training. *Journal of Learning Disabilities*. 1985; 18:505-511

In reading this article, it seems that most ophthalmologists (and other specialties) are not advocates of vision therapy because they think that vision therapy is still essentially the same as orthoptic therapy. Their concept of vision therapy is "eye exercises". They don't realize that it

has gone beyond the classical "eye as a camera" model. The difference now is that the eye care practitioner should be concerned how the patient's brain is interpreting and processing the information. Having straight eyes with 20/20 vision does not mean that vision therapy cannot be of any help.

CONCLUSION

It is evident from this review that since vision is not the only contributor to reading disabilities, the role of the optometrist is limited. According to "Vision, Learning and Dyslexia," a joint policy statement from the American Optometric Association (AOA) and the American Academy of Optometry (AAO), the "comprehensive optometric evaluation should be part of a multidisciplinary approach in which all appropriate areas of function are evaluated and managed". Parents, students and educators should be aware of this so that they may seek the guidance of all the appropriate specialists. This policy statement has been "formally endorsed by the College of Optometrists in Vision Development (COVD), the American Foundation for Vision Awareness (AFVA) and the Optometric Extension Program (OEP) Foundation. Therefore, it fully represents the positions of the various schools of thought throughout the optometric community.

Furthermore, the timing that optometric intervention is sought is important. If vision is assessed early and shown to be the root of the problem, treating the vision disorder at that time can make the student more responsive to later therapy for higher order processes (e.g., neurological and brain functions).

It is imperative that this be understood by those responsible for the education of our children. Early and appropriate treatment (even if it does not completely rectify the problem) can only increase the student's self-esteem and quality of life.

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