Summary of Research on the Efficacy of Vision Therapy for Specific Visual Dysfunctions

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Vision therapy, like any area in a health profession, is practiced differently by various clinicians. I will restrict this discussion to the most commonly practiced and largest portion of the area of vision therapy: treatment of accommodative and vergence anomalies, including strabismus. These categories include the majority of patients treated by optometrists providing vision therapy service. In addition, all schools of optometry include diagnosis and treatment of anomalies of accommodation and vergence in their curricula.

Negative feedback control theory analysis of the accommodative and vergence systems provides the basis of today's optometric vision therapy. These models have a strong physiological and anatomical basis, and have been described in numerous articles[1-4] and textbooks.[5-7] Computer simulations using control theory demonstrates the predictability of both the accommodative and vergence systems.[1,2,5] Defects in any component of the system may result in asthenopia, diplopia, and/or strabismus.[8] The most common cause of asthenopia is related to inadequate slow vergence.[4,9] Vision therapy differs from orthoptic models in that control theory analysis acknowledges the dynamic interaction of accommodation and vergence, and its respective feedback mechanisms.

Eye Teaming (Vergence) Problems

Numerous studies have evaluated the effectiveness of vision therapy in eliminating symptoms and abnormal objective findings associated with binocular anomalies. One study used random dot stereograms (RDSs) in a carefully controlled double blind, cross over experimental design to determine if vergence training improved vergence ability.[10] The results of the experiment definitively demonstrate that those subjects who received vergence treatment improved their vergence amplitudes while the control group did not. In addition, improvement on one vergence task generalized to other related vergence tasks such as vectographs, Risley prism, and stereoscopes. These findings have been replicated by other studies using different instrumentation.[11-15] These studies, also, clearly demonstrate that vergence therapy improves vergence ability and that the effects persist over time.

The largest group of patients treated with vision therapy are patients manifesting symptomatic convergence insufficiency. These patients account for up to 15% of the population depending upon the definition and criteria used.[16] Numerous optometric and ophthalmological studies have shown that vision therapy is the treatment of choice for CI.[17-28] Orthoptics or vision therapy is cost effective and has a high success rate. Even

ophthalmological textbooks including the standards such as von Noorden's *Binocular Vision and Ocular Motility: Theory and Management of Strabismus*[29] and Leigh and Zee's *The Neurology of Eye Movements*,[30] dogmatically state the most clinically accepted treatment for convergence insufficiency is orthoptics/vision therapy. Pooled data from 18 studies accounting for 2149 patients is impressive, with 73% reported as cured, 15% reported as significantly improved, and only 5% reported as failed.[16,31] Pantano[32] demonstrated that orthoptic treatment lasts for at least two years following the termination of treatment, when a complete cure is achieved. Similar findings were reported by Grisham, et al.[11] Age is not a deterrent to the successful treatment of binocular anomalies. Wick[33] treated 191 patients who ranged from 45-89 years of age. Immediately after therapy, 93% were reported as cured. Cohen and Soden[34] confirmed Wick's results. They treated 28 CI patients over 60 years of age. They reported an immediate cure rate of 96%. The cure rate was 83% 9-12 months later.

All of the above are large sample, retrospective studies. Their sheer numbers provide compelling evidence of the effectiveness of vision therapy. Case studies, when properly documented, can provide important clinical information about the nature of the treatment. An excellent example of such a case was published in *Neuro-Ophthalmology* describing the findings and treatment of a patient with Guillain-Baire syndrome. This single subject study documents the effectiveness of vision therapy in treating a patient with organic disease.[35]

Cooper, et al.,[36] published in a peer reviewed journal a controlled, prospective, double blind, A-B reversal study that evaluated experimental vergence treatment vs. placebo treatment for a group of patients diagnosed with a pure convergence insufficiency. Prior to treatment, all the patients had clinical vergence amplitudes measured and completed a numerically scaled asthenopia questionnaire to quantify their degree of asthenopia. The experimental group had specific, automated vergence therapy using RDSs to improve convergence amplitudes. The automated design eliminated the possibility of experimental bias. Correct responses to the position of a RDS resulted in an increase in the vergence demand and a concurrent delivery of a reinforcement while incorrect responses resulted in a decrease in vergence demand and no reinforcement. Thus, the vergence demand and therapy was controlled by the patient's responses using an operant conditioning paradigm. The experimental group showed a dramatic improvement in vergence amplitude, a change in a forced fixation disparity curve and a decrease in asthenopic symptoms on the scaled questionnaire. The control group was treated with the same stimuli in an identical therapy paradigm except that there was no alteration in vergence demand during trials. The control group did not show an improvement in either vergence amplitudes or a decrease in symptoms. When the control group, crossed over to become the experimental group, similar findings were found (i.e., an increase in vergence amplitudes with a concurrent reduction in symptoms). This study also clearly meets the definition of well-controlled, multi subject study.

This same study performed by Cooper, et al.,[36] demonstrates that vision therapy eliminates headaches due to accommodative vergence problems. The study found that the experimental group reported that their headaches disappeared with vergence treatment

while the control group did not report a decrease in symptoms related to a headache. The patients in this study had ocular headaches, which were not vascular, surrounded by an aura, eliminated by aspirin, but were associated with increased near work.

Reading Problems

Atzmon, et al.,[37] addressed the effectiveness of orthoptics/vision therapy in the area of reading disabilities in an article, which appeared in Binocular Vision and Eye Muscle Surgery Quarterly, an ophthalmological journal. This double blind prospective study compared the effectiveness of orthoptics to other treatment modalities in the remediation of reading disorders. These investigators matched three groups of children with reading disabilities. One group received orthoptic treatment to improve fusional amplitudes to at least 60D (prism diopters). Group two received conventional reading tutoring. Group three received no treatment and served as the control. Each child had 40 20-minute sessions of therapy. Prior to therapy 100% had poor fusional convergence by the authors' criteria, 60% had a receded nearpoint of convergence, and many had asthenopic symptoms. After treatment asthenopic symptoms were eliminated in the orthoptic group. Reading had improved significantly in both the orthoptic/vision therapy group and reading group, but not in the control group. Atzmon, et al.,[37] concluded that orthoptics/ vision therapy was as effective as reading tutoring but had an additional benefit of eliminating asthenopia. This study also meets the criteria of multi-subject, controlled study.

Intermittent Exotropia

Pooled success rates of different treatment regimens for the divergence excess type of intermittent exotropia have been reported as follows: 59% for orthoptics/ vision therapy, 43% for surgery, and 30% for passive therapy (minus lenses, patching, and/or prisms).[38] These data suggest that vision therapy/orthoptics is more effective than surgery in patients with smaller angle intermittent exotropia and should be considered part of the treatment regimen for patients who receive surgery.[39] Sanfilippo and Clahane[40] reported on the success of orthoptic treatment with 31 intermittent exotropia patients. They reported that 64.5% were cured, 9.7% were classified as improved, and 9% were classified as fair. In a subsequent study, they reported after five years that 52% remained cured while 32% were in the improved group.[41] Similar findings have been reported by other studies.[42-47] Another study reported that the highest success rate occurred when office therapy was supplemented with home vision therapy.[48]

Focusing (Accommodative) Problems

Several studies have reported that accommodation can be modified with therapy.[49-53] Studies have also shown that voluntary accommodation can be taught[52] and that accommodation developed by biofeedback could transfer from one task to another.[53] Accommodative therapy has been shown to be effective in eliminating subnormal accommodation.[54,55] One study reported that 87% of their patients with accommodative

anomalies eliminated their asthenopia and normalized their accommodative findings with approximately 26 sessions of therapy.[55] Therapy to improve accommodative amplitudes resulted in a concurrent improvement of positive and negative fusional amplitudes, as well as stereopsis.[56] It was concluded that orthoptics/ vision therapy is the method of choice in eliminating asthenopic symptoms associated with accommodative anomalies.[57] In those patients who could not participate in orthoptics/vision therapy, plus lenses were successful in decreasing symptomatology. This study was published in a peer reviewed ophthalmological journal (Doc. Ophthalmol).[57]

Another double-blind prospective study to determine the effects of monocular accommodative amplitude therapy on asthenopia showed that the patients in the experimental group had a dramatic improvement in their amplitude of accommodation, a decrease in their dynamic accommodative response time, and a significant reduction in symptoms on a rated, scaled asthenopia questionnaire. There was no change in the control group. When the control group crossed over and underwent identical therapy as the initial experimental group, a similar reduction in symptoms and normalization of accommodative function was found.[58]

The above studies demonstrate that accommodation may be altered via accommodative therapy with a resultant change in accommodative amplitude, accommodative facility, and a reduction in symptoms. They demonstrate changes in symptomatology and clinically measured amplitudes. Therapy may also result in changes in the magnitude, velocity, and the gain of the accommodative response.[59] Accommodative therapy not only eliminates symptoms but shows objective changes in the velocity of the accommodative response and a concurrent decrease in recorded time constants.[60] Therapy provides improvement in time characteristics of the accommodative response including the latency and velocity.[60,61]

Matching Criteria for Strabismus Cure

The criteria of success in many ophthalmological retrospective studies on strabismus surgery are in serious scientific question. For example, most of the studies on esotropia and exotropia define a cure as cosmetic alignment (within 5 prism diopters) without any mention of performance or functioning. A cure should be defined as an outcome whereby the patient is:

- perfectly straight 95% of the time
- has diplopia upon rare deviation
- has normal fusional amplitude
- is asymptomatic
- demonstrates normal stereopsis (40 sec or better on line stimuli and the appreciation of a large disparity random dot stereogram.)

In summary, the majority of studies evaluating the effectiveness of strabismus surgery have not met the criteria of being prospective and double blind.

Summary

When considering vision therapy (orthoptics) as the treatment for any of the visual dysfunctions discussed in this article, optometric and ophthalmological research supports the efficacy of vision therapy. A large body of research is available to those seeking research-based proof.

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