

Current Research in Behavioral & Developmental Optometry

The following article summaries were compiled from submissions from the students and residents who received Travel Grants to attend the COVD 40th Annual Meeting.

The College of Optometrists in Vision Development Annual Meeting Travel Grants are offered to encourage and support optometry student and resident participation at COVD's annual meeting. The grants are provided through the Wold SAFE Fund.

COVD members donate to this fund to support student and resident attendance at the meeting. The number and amount of the grants given are based on monies available in the fund each year.

To be eligible to receive a grant, an optometry student or resident must:

- Be a COVD member
- Submit an application and current copy of their CV.
- Summarize an article presented to them by the COVD Academic Services Committee.

Grant recipients are selected based on a review of their CV and article summary.

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AMBLYOPIA

PEDIG. A Randomized Trial of Atropine Regimens for Treatment of Moderate Amblyopia in Children. *Ophthalmology* 2004; 111: 2076-85.

This study examines the effects of either daily or weekend atropine in the treatment of amblyopia.

The requirements for the participants in this study were children under 7 years old, the amblyopic eye having a VA of 20/40-20/80, the sound eye having a visual acuity (VA) of 20/40 or better and a history of strabismus and/or anisometropia. The study consisted of 2 groups, one for the daily treatments and one for weekend treatments.

160/168 participants completed the study. After about 16 weeks, results showed that both daily and weekend groups had similar results of improved VA, on an average of about 2.3 lines. The VA in the amblyopic eye was at least 20/25 or better than/equal to the good eye's VA in 47% of the daily group and 53% of the weekend group. Although both groups achieved similar results, a questionnaire filled out by parents showed that it was easier to administer the atropine treatments daily rather than only on weekends. Another benefit to daily atropine was less light sensitivity than in the weekend only group.

Polat U, Ma-Naim T, Spierer A. Treatment of children with amblyopia by perceptual learning. *Vis Res* 2009, Oct 49(21) 2599-603.

This study involved 5 children ages 6-9 who were previously either noncompliant with patching or whose vision was no longer improving with patching. Children participated in a specially designed "video game" for one hour twice a week for no more than forty sessions. The computerized task, which was designed to seem like a video game, used a technique known as perceptual learning. The perceptual learning game requires patients to look at a computer monitor with the good eye patched; detect a gray-level grating target.

This study showed that perceptual learning improved visual performance on many basic tasks. The average visual acuity improvement in this study was 1.5 lines on the Snellen acuity chart. Binocular functions, such as ocular alignment, stereopsis, and suppression, were also shown to improve in some patients after treatment. Most importantly, no adverse effects were noted in any of the treated patients and every patient showed some improvement.

Spierer A, Raz J, Benezra O et al. Treating amblyopia using liquid crystal glasses: a pilot study. *Invest Ophthalmol Vis Sci*, 2010; 51: 3395-3398.

Researchers looked at a new treatment for amblyopia, or lazy-eye, Parents in this study wore a special pair of glasses. These glasses were fit with a special filter (liquid crystal – "LC") that could be activated electrically using a computer chip and a battery. The filter flickered on and off, making the lens dark or clear, respectively and blocked vision to the good eye for 66%

of the time the glasses were worn. If the participants had a needed an eyeglass prescription, it was included in the (LC) glasses, otherwise, the lenses did not contain a prescription.

24 children, age four to seven, with vision of 20/40 -20/120 in the amblyopic eye, completed the study. All children were asked to wear the glasses at least eight hours a day for nine months. The parents were asked to monitor how well or often the glasses were worn and tolerated, and any other issues or findings they came across. All participants had a comprehensive initial examination, and there were five follow up visits to monitor the visual acuity at distance and near. By the end of the study, 79% of the participants improved at least by at least 3 lines of acuity, or reached 20/30 vision in the amblyopic eye. One noted unexpected finding was a significant increase in stereopsis (depth perception), in 21% of the participants. However, it is unknown if this was due to the increase in visual acuity alone, or to the increased amount of binocular viewing that the glasses allowed.

PEDIG, Holmes, J. M., Kraker, R. T., Beck, et al. A randomized trial of prescribed patching regimens for treatment of severe amblyopia in children. *Ophthalmology*, 2003; 110: 2075-2087.

Amblyopia is a condition where the visual acuity is decreased in one eye. A common treatment for this condition, called patching therapy, is where the better seeing eye has a patch placed over it for a set amount of time a day in order to force the poorer seeing eye to do the visual work. A study was done to determine if consecutive 6 hours a day of patching therapy was comparable to 24 hours.

Who was included in the study?

Children less than 7 years old with a severe degree of amblyopia (VA=20/100 to 20/400) were studied.

What did the patients have to do?

During the prescribed patching time, both groups of patients were asked to do near activities such as reading, word searches, video games, etc, for one hour of that time.

How well was the treatment tolerated?

Compliance to the therapy was somewhat better in the 6 hour group versus the 24 hour group.

How did the treatment improve the amblyopia?

Both groups had statistically similar speed and level of improvement in visual acuity after four months of patching therapy. The 6 hour group showed a 4.8 line improvement in VA while the full time patching group showed a 4.7 line improvement in VA.

What else was found during the study?

There was no difference between the treatment groups in eye alignment or stereopsis. Patients who started with worse visual acuity (20/200-20/400) had a greater improvement in VA after four months of patching therapy than those who started with better visual acuity (20/100-20/160). Patients so are younger also showed a greater improvement in VA than older children (5.5 lines in, 5 year old v. 3.8 lines in children 5 years or older).

Repka MX, Kraker RT, Beck RW, Holmes JM, Cotter SA, Birch EE, et al. A randomized trial of atropine vs patching for treatment of moderate amblyopia: follow-up at age 10 years. Arch Ophthalmol 2008;126(8):1039-44.

A previous study compared the use of daily atropine versus 6 hours of daily patching for patients with moderate amblyopia (visual acuity of 20/40-20/100). The current study was extended to see a long-term outcome at age 10.

The initial study randomized children (aged 3-7) to either patching for 6 hours a day or atropine 1% 1 drop daily. The patients maintained the treatment for 6 months and then were re-examined. The initial study found no difference in visual acuity improvement in either treatment group at the 6 month mark. Between 6 months and 2 years, the investigators used their own discretion in terms of treatment and were asked to examine patients every 6 months. A total of 188 patients agreed to continue with the study at age 10.

The results of this study showed that the mean amblyopic eye acuity, measured in 169 patients at age 10 had an approximate visual acuity of 20/32. 46% of patients had an acuity of 20/25 or better in the amblyopic eye. The study found that the visual acuity outcome was slightly better in patients who were age 3 to 5 at the initiation of therapy compared to patients age 5 to 7. The recurrence rate for amblyopia has been commonly reported as 24% to 27% in the first year after stopping therapy. This particular study will continue until the patients are 15 years old to assess the effects of treatment at that time. The importance of this study is to understand that the visual acuity improvement achieved in amblyopic eyes can be maintained, but residual amblyopia is common. The outcome was similar regardless of whether initial treatment was with atropine or patching.

ATTENTION

Berman R, Colby C. Attention and Active Vision. Vis Res. 2009; 49: 1233-48.

Vision is an active and dynamic process. What we see is influenced by more than just the light signals sent to our eyes from the world around us. Vision consists of visual and motor signals, as well as our attention to an object and our ability to move our eyes. Research has shown that we actually do not see many things in our environment simply because we are not paying attention to them. This process is known as 'selective attention.' Selective attention helps us to gather visual information about what matters to us at the moment. On a neural level, images may be continually updated, or "remapped" based on our attention. Berman and Colby investigated how this remapping is done in the brain.

The parietal cortex integrates sensory information, and is the part of the brain that determines our concept of spatial sense and awareness. Studies have shown that neurons specifically in the lateral intraparietal (LIP) area are active in a standard memory-guided saccade (glance to glance) task. This experiment involves making a saccade from a fixation target to a nearby stimulus that was present and has faded away. The subject is to watch a

fixation target and look in the area of the faded stimulus only after it disappears completely—in other words, remember where the stimulus was. Researchers found that the neurons in LIP begin to fire in anticipation of the stimulus in the memory-guided saccade task.

Researchers have found that both visual and motor signals together are required to remap an internal representation of a stimulus. In other words, shifting attention without making an eye movement will not cause a neuron to fire. These visual and motor signals converge in the parietal cortex. This illustrates that the role of remapping is to “maintain an accurate alignment between the visual world and its internal representation”. The eye movement is also important for ending the neuronal firing. Researchers found that when the stimulus was turned off the neuron kept firing, but when the eyes moved away from the stimulus, the neuron’s firing stopped.

Remapping is seen not only in parietal cortex, but in other visual areas in the brain. Researchers have found that the pathway for eye movements involves the superior colliculus (SC) to the mediodorsal thalamus to the frontal eye field (FEF). Disruption along the pathway can affect remapping. However, disruption across cerebral hemispheres did not affect remapping. Additionally, researchers found that forebrain commissures are important for updating visual information across cerebral hemispheres. However, alternate pathways can develop.

Multiple factors and pathways contribute to visual perception. Aside from input from the eye, our brain constructs an internal representation of what we see based on attention, memory, and our intention to act. Paying attention to only certain things at a particular moment keeps us from seeing what is not relevant to us. When we do actively look somewhere, neurons in the parietal cortex and other areas of the brain continuously update information. This process of ‘remapping’ allows us see a stable and constant perception of the world even though our eyes move.

Finneran DA, Francis AL, Leonard LB. Sustained attention in children with specific language impairment. J Speech Lang Hearing Res. 2009; 52: 915-29

Children with specific language impairment (SLI) show significant language difficulties without hearing loss, mental retardation or neurological damage. This study was completed to assess the attentional skills of children with SLI compared to children without SLI.

Twenty-six children between four and six years of age participated in the study. Prior to participation in the study, all of the children were tested for clinically significant attention deficit hyperactivity disorder (ADHD). None of the children in the study had ADHD. The study required the children to correctly identify circles on a computer screen containing squares and circles. There were a total of 5-5 minute presentations, each on different day. The targets were displayed as a fast stimulus (1 trial – each stimulus separated by 1100 ms) or slow stimulus (4 trials – each stimulus separated by 5600 ms).

Results of this study found that the children with SLI had marked difficulty with sustained attention on visual tasks. The SLI children were not slower on the tasks but they were less accurate. The accuracy did not change between the fast and slow target presentations. Additionally, both groups were more accurate with the slow rate target.

This study found that children with SLI have sub-clinical sustained attention deficits.

BRAIN INJURY

Han MH, Craig SB, Rutner D, et al. Medications prescribed to brain injury patients: a retrospective analysis. *Optometry* 2008;79:252-8.

This retrospective study compared potential visual side effects that can manifest secondary to medications used to manage patients with a traumatic brain injury (TBI) or cerebral vascular accident (CVA), or from the trauma/damage itself. This sample size included 160 patients with a TBI and 60 with a CVA. The primary purpose of this study was to investigate the frequency of medications prescribed to TBI and CVA patients in a clinic/outpatient setting. The secondary purpose was to determine the possible relationship between the visual symptoms/diagnosed ocular conditions and the known ocular side effects of the medications prescribed. The common visual symptoms associated with both TBI and CVA are blurred vision, diplopia, asthenopia (headaches, eyestrain, loss of place while reading), poor depth perception, light sensitivity, accommodative dysfunction, vergence dysfunction, version dysfunction, dry eyes, and ptosis. The study further analyzed the TBI and CVA groups individually.

In the TBI group, the 4 most commonly prescribed medication categories were; anti-anxiety/antidepressants, anticonvulsants, opiate/combination analgesics, and cardiac/anti-hypertensive's. The most common symptoms or diagnoses found in over 50% of patients were blurred vision, light sensitivity, vergence dysfunction and version dysfunction. The study found that 52.1% of patients taking medication and 30% of those not taking medication, had light sensitivity. The study suggested that the blurred vision, diplopia, asthenopia, vergence and accommodative dysfunctions in TBI cases could be secondary to the trauma itself and not from the medications. However patients on anti-anxiety/antidepressants and anticonvulsants were more likely to have problems with depth perception. In the CVA group, the prevalence of light sensitivity wasn't as pronounced. However, blurred vision, asthenopia associated with near activities and versional/vergence dysfunction were noted.

The authors recommend careful evaluation for dry eye in these patients. They recommend; tints/antireflective coatings light sensitive TBI patients. They also note that further research in this area is needed.

Ciuffreda KJ, Kapoor N, Rutner D et al. Occurrence of oculomotor dysfunctions in acquired brain injury: a retrospective analysis. *Optometry* 2007; 78:155-61.

In acquired brain injury (ABI), which consists of both traumatic brain injuries (TBI) and cerebrovascular incidents (CVA), many areas of the brain and their associated functions are adversely affected. One such area is vision. Injury to vision related areas of the brain can result in a range of dysfunctions, including the oculomotor, color vision and visual field systems. Through this retrospective study by Ciuffreda et al, it was found that the majority of individuals with ABI manifested an oculomotor dysfunction.

In this study, 220 individuals with either TBI (160 patients) or CVA (60 patients) were reviewed and 5 major categories of oculomotor dysfunction were investigated: accommodation, versions, vergence, strabismus and cranial nerve (CN) palsies. In this study, 90% of individuals with TBI and 86.7% of individuals with CVA manifested an oculomotor dysfunction, with accommodative (41.1%) and vergence (56.3%) deficits being the most common in the TBI subgroup, whereas strabismus (36.7%) and CN palsy (10%) were most common in the CVA subgroup. The difference is due to the fact that TBI patients tend to have more diffuse brain injury due to the coup-countercoup forces, while CVA patients tend to have more localized brain injury due to the more regional vascular etiology. In both groups version disorders were present in approximately 55% of the sample. From this current retrospective analysis it can be concluded in the TBI and CVA populations an oculomotor dysfunction would be an expected finding on an eye exam.

It is important to identify and understand any abnormal vision conditions and their associated symptoms so that appropriate therapy can be implemented. If an appropriate diagnosis is not made, the patient could continue to suffer with the symptoms leading to difficulties in activities of daily living such as reading, writing, and ambulating through complex environments.

Ciuffreda KJ, Rutner D, Kapoor N. et al. Vision therapy for oculomotor dysfunctions in acquired brain injury: A retrospective analysis. *Optometry* 2008; 79: 18-22.

In patients with acquired brain injuries such as cerebrovascular accident (CVA) or traumatic brain injury (TBI), changes in visual function frequently result. The difficulties most commonly experienced after brain injury are categorized as oculomotor dysfunction – that is, problems with smooth and accurate eye movements, eye teaming, and focusing. The purpose of this article was to retrospectively analyze the effectiveness of optometric vision therapy in patients with oculomotor dysfunction following acquired brain injury.

Forty patients (predominantly adults) were included in the study; 33 had a TBI, and 7 had a CVA. The most common visual symptoms experienced by the brain injury group before vision therapies were difficulty with reading (81%), eye strain (55%), double vision (55%), and headaches (33%). The most common clinical signs in this group were decreased convergence and abnormal reading eye movements. For the CVA patients, the only visual symptom was reading difficulty secondary to oculomotor dysfunction. The most common clinical signs were abnormal reading eye movements and decreased versional eye movements.

Vision therapy varied in length from 10 to 30 sessions and followed a conventional course, including training in eye teaming and focusing. After vision therapy, improvement in both clinical signs and symptoms was seen in each group. In the traumatic brain injury group, almost 91% of patients (30/33) experienced either complete or significant reduction in one or more of their main symptoms, and 90 percent (27 of 30) demonstrated either significant improvement or complete normalization of at least one of their clinical signs. One hundred percent of the stroke patients (all 7) demonstrated either complete resolution or significant reduction of both their primary signs and symptoms.

The results of this study suggest that the visual system is somewhat malleable, even in those patients who have experienced brain injury or trauma. Optometric vision therapy

definitely has a role to play in the rehabilitation process, especially in those patients with visual symptoms.

ESOTROPIA

Ludwig IH, Imberman SP, Thompson HW, Parks MM. Long-term study of accommodative esotropia. JAAPOS 2005;9:522-6.

This article was a retrospective review of 1307 accommodative esotropia patients treated over a fifty year period. Of these patients, 354 patients met the following inclusion criteria: initial diagnosis occurred before age 8, corrected with glasses and/or bifocals, if necessary, follow up for 5 or more years, and ocular alignment of 8 prism diopters (pd) or less of esotropia at both distance and near with glasses. A secondary analysis was also compiled using a criterion of alignment within 4pd or less of esotropia. Deterioration, or progression, was defined by those patients who required eye muscle surgery to maintain good alignment or by those whose eye turn, as measured at distance with glasses, had increased to 12 or more pd of esotropia. Successful cases were those who maintained alignment within 8 or 4 pd or less of esotropia.

The authors of this study found the following:

1. The incidence of deterioration increased with an increase in AC/A grade. The authors defined AC/A ratio as the difference between the distance and near cover test. The grade was defined according to the scale: "within normal range" was less than 10 pd change, "grade 1" was from 10-19 pd change, "grade 2" between 20-29 pd change, and "grade 3" was 30 pd change or greater.
2. With higher AC/A ratios, there was an increase in bifocals prescribed.
3. Inferior oblique over action was correlated with deterioration

EXOTROPIA

Figueira EC, Hing S. Intermittent exotropia: comparison of treatments. Clinical Exp Ophthalmology 2006; 34: 245-51

Intermittent exotropia is the most common form of exotropia in normal children, having a prevalence of 9.4-18.7 in every 1000. There are many ways of treating this condition that are still being heavily debated. Some treatment approaches include: (i) overminus lenses, to stimulate accommodative vergence (ii) feedback training to improve the range of sensory fusion. (iii) Occlusion therapy (antisuppression treatment – covering the stronger eye to stimulate the sensory input of the weaker eye in hopes to avoid suppression) and other antisuppression therapies, and (iv) surgery, by altering the muscular insertion point.

This retrospective study looked at different treatment options in 150 intermittent exotropia patients under 15 years of age. Treatments included: (i) surgery combined with presurgery orthoptics/occlusion therapy, (ii) surgery only, (iii) orthoptics/occlusion therapy only, (iv) observation. Other inclusion criteria included no neurological deficits, magnitude of deviation <15 PD, no significant vertical deviation (>10PD), and normal range of ocular movements.

Success was defined as: a deviation <10 pd, 'good' Lang stereoacuity and 'good' cosmesis. Surgery with preoperative orthoptics/occlusion therapy had the highest success rates of 87.5% at 6 months, 85.7% at 1 year, 83.33% at 2 years, and 84.62% at 5 years. The success rates of the surgery alone group were 40% at 6 months, 42.86% for 1 year, 36.4% for 2 years and 25% for 5 years. In the occlusion therapy alone, the success rate was 6% at 6 months, 8.57% at 1 year, 5.26% at 2 years, and 0% at 5 years. The orthoptics only group had a success rate of 5.26% at 6 months, 5.88% at 1 year, and 7.14% at 2 years at 0% at 5 years. Finally in the observation only group, the success rate was 5% at 6 months, 5.26% at 1 year, 9.09% at 2 years, and 33.33 % at 5 years.

This study found that preoperative orthoptics/occlusion therapy with surgery was more effective in reducing exodeviation compared with surgery only, observation, or occlusion therapy only.

Mahoney BG, Huffaker RK. Common forms of childhood exotropia. Ophthalmology. 2003;110: 2093-6.

This study looked at the occurrence of each type of exotropia among children under 19 years of age. The study involved completion of an eye exam including a thorough medical and ocular history, measurement of the ocular deviation, eye movements testing, cycloplegic refraction and dilated fundus exam. Children with prior strabismus surgery were not included in the study.

The authors categorized exotropia as: Congenital, present by six months of age; intermittent, neurologic-related, and sensory (from binocular or monocular ocular disease).

The most commonly occurring type of exotropia was intermittent, accounting for almost half (47%) of the children examined. The next most common type was exotropia related to central nervous system defects (21.3%) Convergence insufficiency exotropia was found in 11.5% of patients, while sensory exotropia was found in 10%. Only 1.7% of patients had congenital exotropia.

The most common causes of neurologic associated exotropia were found to include cerebral palsy and developmental delay (approximately 20% each) while the most common causes of sensory exotropia were optic nerve hypoplasia (25%) and cataract.

EYE MOVEMENTS

Bucci, MP Bremon-Gignac D, Kapuula Z., Speed and Accuracy of Saccades, Vergence and Combined Eye Movements in Subjects with Strabismus Before and After Eye Surgery. *Vis Res* 2009, 49: 460-69

The purpose of this study was to test saccadic and vergence eye movements in children with strabismus. Eye movements were recorded by a photoelectric device. Children with both esotropia (eye turn in) and exotropia (eye turn out) were tested before and after strabismus surgery. Prior to surgery all subjects showed slow and inaccurate saccade, convergence and divergence movements when compared to standard values. Following the surgery, improvements were recorded in both speed and accuracy of vergence movements. However, saccadic eye movements at distance did not show a change in accuracy pre/post surgery. The conclusion was that correcting the visual disparity enables eyes to make marked improvements in all types of eye movements, but the exact mechanism for the change is not known.

CONVERGENCE INSUFFICIENCY

Scheiman M, Mitchell GL, Cotter S et al. A Randomized Clinical Trial of Vision Therapy Orthoptics versus Pencil Pushups for the treatment of Convergence Insufficiency in Young Adults. *Optometry Vis Sci*; 82:583-95. 2005.

A multicenter pilot study was performed in which 46 young adults, age 19 to 30, with symptomatic Convergence Insufficiency (CI) were treated in one of three ways: pencil pushups, office-based vision therapy, or office-based placebo vision therapy for a 12 week period. The CI Symptom Survey (CISS) is a scale used in this study to measure patients' symptoms before and after treatment.

The purpose of this study was to compare treatments for young adult patients with symptomatic CI. Pencil pushups have traditionally been the most commonly prescribed treatment. In this study, patients assigned to pencil pushups were instructed to do pencil pushups at home, three sets a day, five days a week. Office-based vision therapy involved 60 minute weekly office sessions with a trained therapist and 15 minute home sessions five days a week. The placebo office-based vision therapy group also involved 60 minute office sessions with a trained therapist and 15 minute home sessions five days a week; however, these patients underwent a treatment sequence that was not expected to affect their symptoms or affect their convergence. Patients assigned to the placebo and office-based vision therapy groups were not aware of whether or not they were undergoing actual vision therapy.

The patients in this study were followed at four, eight, and 12 weeks of treatment. A total of six patients dropped out of treatment, but at the final assessment, 15 patients in the pencil pushup group, 12 patients in the office-based therapy group, and 13 patients in the placebo therapy group were analyzed. The outcome measurements included symptoms and

clinical signs (near point of convergence and positive fusional vergence at near). Although there was a reduction of symptoms for all three treatment groups, only patients assigned to the office-based vision therapy group improved to a CISS score that would be considered non-symptomatic. Still, 58% of the office based group was symptomatic after 12 weeks of treatment, as compared to 80% in the pencil pushups group and 69% in the placebo therapy group. The researchers noted that a longer treatment period might yield better results. The measures of near point of convergence and positive fusional vergence at near also showed improvement in all three groups; however, only the office-based vision therapy group achieved an improvement to a level considered clinically normal.

Overall, the investigators in this study found that 50% of the office based vision therapy patients were either cured or improved. In contrast, 0% of the pencil pushups or placebo vision therapy patients were cured, and 15% of the pencil pushups and 13% of the placebo vision therapy patients were improved. The study found that placebo effect cannot explain the positive outcomes of office-based vision therapy, and that vision therapy should be considered for the treatment of CI in young adults.

Granet DB, Gomi CF, Ventura R et al. The Relationship Between Convergence Insufficiency and ADHD. *Strabismus*. 13:163-68.

A study completed at the UCSD Ratner Children's Eye Center in San Diego, CA reviewed the files of 266 patients diagnosed with convergence insufficiency (CI). The study was performed to identify a possible link between patients with convergence insufficiency and attention deficit hyperactivity disorder (ADHD).

Nearly 10% of patients with CI also had ADHD, which is triple the number of ADHD cases found in the general population. Similarly, the authors found almost 16% of patients with ADHD were found to have CI. The authors noted the surveys used to diagnose CI and ADHD contain five of the nine symptoms in common.

The authors question if CI is a comorbid condition in patients with ADHD, if it could worsen symptoms of ADHD, or if, medications taken to improve ADHD symptoms may intensify convergence problems. The authors recommend that patients with ADHD should be tested for convergence insufficiency and patients with CI should be tested for ADHD if symptoms do not improve with treatment.

Scheiman M, Cotter S, Rouse M, et. al. Randomised clinical trial of the effectiveness of base-in prism reading glasses for symptomatic convergence insufficiency in children. *BJ Ophthalmol* 2005; 89, 1318-23

This study compared base-in prism reading glasses to placebo glasses (reading glasses without prism) for the treatment of symptomatic convergence insufficiency. Children ages 9-18 were broken into two groups. One group was given base-in prism glasses and the other was given glasses without prism. Seventy two children were enrolled in the study and 65 children completed it. The amount of prism was determined by Sheard's criterion and ranged from 1-10 prism diopters. A quantitative symptom questionnaire was used as the primary measurement. The secondary measurements included near point of convergence and positive fusional

vergence at near. Children were reevaluated in both these areas after 6 weeks of wearing glasses

Both groups showed an almost equal decrease in average scores on the CI Symptom Survey (52%, in prism group, 47% in placebo group) . Neither group showed clinically significant changes in the secondary measurements. It was concluded that base-in prism reading glasses were not any more effective than reading glasses without prism for the treatment of symptomatic convergence insufficiency.

CITT. Long-term effectiveness of treatments for symptomatic convergence insufficiency in children. *Optom Vis Sci* 2009, 86: 1096-103

The purpose of the Convergence Insufficiency Treatment Trial (CITT) has been to research the different treatments for convergence insufficiency and to analyze the effectiveness of those treatments. A prior CITT study found that 12 weeks of office-based vergence/accommodative therapy with home reinforcement is more effective than alternate therapies (pencil pushups, home based computer vergence therapy and placebo therapy) is more effective than alternate therapies in improving clinical signs associated with symptomatic convergence insufficiency in children 9-17 years old.

This current study looked at long term follow up of the asymptomatic patients in each group at 6 months and 1 year after initial study. Primary outcomes were patient symptoms and secondary outcomes were clinical test findings. Symptoms were measured using a survey sheet, which each patient filled out prior to and after treatment. If the patient's score showed improvement to a certain extent at the end of the 12 weeks, they were considered to be asymptomatic. All patients who were considered asymptomatic at the end of the initial study were given 15 minutes worth of home therapy to perform for the 6 months directly after office treatment was complete. During months 6-12, no homework was given. At the 12 month follow up, 84% of children who had performed office based vision training, 80% of patients who did home based computer therapy, 77% of patients who did placebo therapy, and 67% of patients who did pencil pushups remained asymptomatic.

Additionally, while only 30% of patients in the office based therapy program received additional treatment in the year after the study, 15% of patients in the placebo group, and 20% each in the pencil push up and home based computer therapy did.

Aziz S, Cleary M, Stewart HK, Weir CR. Are orthoptic exercises an effective treatment for convergence and fusion deficiencies. *Strabismus*. 2006; 14: 183-189.

This study evaluates the effectiveness of home vision therapy/orthoptics to treat patients that have difficulty with convergence (using eyes together to look at an object). Patients with this difficulty often report seeing double, blurred vision, or experiencing headaches/eye strain. All participants for this study had at least one of these symptoms and further testing confirmed that these symptoms were related to difficulties with convergence. Some patients enrolled in the study also showed problems with their accommodation (focusing ability). Treatment involved specific techniques that the patients were instructed to complete up to six times per day with each session lasting 5 minutes. Patients also had follow up visits

with an orthoptist to check their progress. On average, patients completed treatment in 8.2 months and 79.5% of patients completed treatment within one year. After treatment, 83.3% of patients showed an improvement in their symptoms. This was confirmed with clinical testing. Initial testing showed that 70% patients had difficulty with near point of convergence, but after treatment 85.5% of those patients improved to normal levels. In addition, 64% patients initially showed difficulty with fusional reserves (prism bar ranges). This study showed that 54.7% of these patients improved to normal levels after treatment.

When comparing patients with exo deviations to patients with eso deviations, the authors noted improvement in near point of convergence, fusional reserves, and symptoms in patients with exo deviations. In patients with eso deviations only 33% showed an improved near point of convergence, many showed a reduction in fusion ranges and 50% still had symptoms. The authors do note that their overall patient numbers were smaller for patients with eso deviations.

This study shows a high success rate for vision therapy/orthoptics treatment of patients that have problems using their eyes together. The article does make note that “compliance, discipline, effort, and patient attitude are important factors” for success.

DYSLEXIA/READING PROBLEMS

Vidyasagar TR, Pammer K. Dyslexia: a deficit in visuo-spatial attention, not in phonological processing. Trends Cognitive Science;2009; 14: 57-63

Studies show that dyslexia affects up to 10 percent of the population. It has always been thought that dyslexia is caused by problems in how words are decoded and sounded out—phonology. There is new research that suggests that dyslexia may potentially be caused by impairments in visual processing. There have been reports of children and adults with brain damage who have problems with reading, but have the ability to properly sound out words. This leads some researchers to believe that phonology cannot be the only link to dyslexia. Researchers believe that the inability to properly sound out words plays a role in reading failure, but may not be the major cause of it. This article questions whether the problem in sounding out words is directly responsible for dyslexia or if some other problem such as visual processing could cause a domino effect leading to trouble in sounding out words.

Studies suggest that a dyslexic reader may experience distorted text, disorder and reverse letters, and have trouble making proper visual pictures of words. When reading, words are not read as a whole, but as letters or small groups in a certain order. Our ability to visually scan—or search—is thought to be due to the magnocellular pathway/dorsal stream in the brain that specializes in movement and depth perception. Problems in this pathway, involving visual attention, have been linked to dyslexia and evidence suggests that a visual processing problem in recognizing the order of letters may be one factor in the development of dyslexia.

Studies have been done to compare dyslexic and non-dyslexic children’s ability to visually scan. One study found that children with dyslexia improved their ability to visually scan

up to a level of non-dyslexic children after a 3 week training program. Unfortunately, there was no measure to determine if the visual improvements would lead to improved reading ability.

The theme of this article is that the main problem in dyslexia might be one that disrupts the visual attention pathway. It is understood that dyslexics can have problems in sounding out words, but new research suggests this inability to sound out words might be partially due to an improper input to the visual system. Because reading requires the use of multiple pathways and systems, it is thought that dyslexia could surface due to problems at various sites in the vision pathways. But, because the brain and its pathways are so complex, it is very difficult to accurately pinpoint where problems start. Some details of dyslexia are known, but much can be learned, and further research is needed to understand just how involved the visual system is with this disorder.

Lyytinen, H, Erskin J, Kagalaj et al. In search of a science based application: A learning tool for reading acquisition. Scand J Psych 2009; 50: 668-75

Reading disorders can have a devastating impact on a child's school performance, a child's confidence and their future careers. Many studies have attempted to understand the basis of reading disorders in hopes of finding a way to intervene and change many children's lives.

The Jyvaskyla Longitudinal study of Dyslexia (JLD) is based on the work of Heikki Lyytinen who showed how children facing severe problems in learning to read may have a family history of dyslexia.

Prior studies on dyslexia proposed two different theories as to how reading skills are developed. One theory is that learning to read is associated with the development of speech and sound, and if people have dyslexia, they have a defect in their ability to differentiate different sounds. The other theory is that there is a problem in the development of the thinking/reasoning centers in the brain.

The goal of the JLD study are first, to understand dyslexia and how it happens, secondly to identify early enough the children at risk, and lastly to develop preventative training tools to overcome or reduce the consequences of dyslexia. However, many of these studies were based on the English language where the same letter or group of letters can represent different sounds. In contrast, the Finnish writing system is transparent which means that there is a very consistent sound/pronouncing system.

The study followed 107 children with family history of dyslexia for 13 years. About half of these children faced some initial difficulties in learning to read. The researchers also found that 2/3 of the dyslexic children in the study had phonological difficulties and half showed poor scores in rapid naming tasks. Eleven of those children who had initial difficulties were helped by reading instruction in grades 1-3 and a large amount obtained benefit from remediation offered during grades 4-6. Therefore by the end of the fifth grade, less than 25% of the original at risk children had persistent reading difficulties.

The JLD findings have led researchers to create a game that teaches phonemic differentiation, which is the ability to sound out words, and parts of words. It is called the Literate game and has been used by more than 50,000 children in Finland. The researchers are expanding their work into Africa with a similar program.

After more than a decade of research, the JLD has found that the more important roadblocks for children at risk for dyslexia are: poor ability to hear and understand speech as an infant and difficulty in writing and verbalizing thoughts as toddler. These problems result in poor letter knowledge and difficulty in acquiring fluent reading skills as children. The creation of intervention for these at risk children before they start school can help avoid heartache for these children and given them a more even starting ground to succeeding in school.

Shin HS, Park SC, Park CM. Relationship between accommodative and vergence dysfunctions and academic achievement for primary school children. *Ophthalmic Physiol Opt.* 2009; 59: 615-24.

This study looked at children aged 9-13 years old who displayed visual symptoms such as headache blurred vision, diplopia (double vision) when doing near work. All were in grades 2, 4, 5 or 6 in a public school in Korea. After administration of the COVD – QLQ (Quality of Life Questionnaire) symptomatic children without amblyopia, strabismus, ocular disease (and some other exclusion criteria) were assessed with an extensive test battery including refraction, distance and near binocular and accommodative tests, stereopsis, and a health assessment.

Of the 114 eligible children 72% had an accommodative and/or vergence dysfunction. 35% had only an accommodative dysfunction, 34% had only a vergence dysfunction and 31% had both an accommodative and vergence dysfunction.

The researchers had academic achievement test scores available for the children. For children in grades 4 to 6, researchers had math, reading, science and social science test scores, while for children in grade 2, the researchers had only reading and math scores.

Children with accommodative dysfunction and a combination of accommodation and vergence dysfunction had lower mean academic scores for reading, math and social science than children in the comparison group with symptoms. Children with vergence dysfunctions had lower mean academic scores than the comparison group for reading only

The authors note that these percentages may be an inaccurate measurement due to the fact that 52% of the children who were symptomatic based on the QLQ were ineligible for participation in the study due to poor visual acuity. Some of these children may have had accommodative and/or vergence dysfunctions that may or may not have resolved with glasses. Thus follow-up of children with symptoms and/or clinical findings is important if glasses are prescribed.

The authors conclude that accommodative and vergence testing should be performed on children with academic difficulties and with visual symptoms.

Taub MB, Shallo-Hoffmann J, Steinman S, Steinman B. The effect of colored overlays on reading eye movements in adults. *J Behav Optom* 2009;20:143-149.

Scotopic Sensitivity Syndrome (SSS) came about in 1983, when Irlen described a specific set of visual symptoms that include difficulty with reading, increased sensitivity to glare, and poor sports performance due to difficulty in judging height and depth. It is suggested that

patients with this syndrome experience these symptoms due to increased sensitivity to particular frequencies of the light spectrum.

Tinted lenses that affect specific wavelengths of light are prescribed to treat SSS. Several studies have shown tints to be effective for increasing reading speed and comprehension. However, few studies have shown positive effects of tints on SSS when using objective measures. Thus, the purpose of this research is to objectively study the effects of tinted lenses on those diagnosed with SSS.

This study included 60 adult subjects. Subjects with particular visual problems, such as a lazy eye, eye turns, or ocular diseases were excluded from this study. Subjects were equally divided into one of two testing groups, either symptomatic or asymptomatic, depending on their responses to a survey regarding frequency and severity of symptoms of SSS. The study included reading tasks and objective recording of eye movements using the Visagraph II.

The results of this study indicated no effect of tinted lenses on reading in either group. The study also found that the symptomatic group always had less accurate eye movements when reading than the asymptomatic group. A closer look at these two groups showed 25 out of 30 (83%) subjects in the symptomatic group showed objective measures of visual problems other than SSS. These visual problems include difficulty using both eyes together (binocularity), and difficulty adjusting focus at different distances (accommodation). 8 out of 30 (27%) subjects in the asymptomatic group also objectively showed binocular and accommodative problems.

The authors conclude that many of those diagnosed with SSS have undiagnosed vision problems including binocular and/or accommodative vision disorders.

Grisham D, Powers M, Riles P. Visual skills of poor readers in high school. *Optometry* 2007;78:542-9.

The purpose of this study was to determine if there is a correlation between poor readers and poor visual skills among high school students.

The data obtained are from high school students who were designated by their teachers as poor readers. 461 students, average age of 15.4 years, were evaluated for visual skills and visual acuity. The following measurements were assessed: distance visual acuity, near point of convergence, convergence and divergence fusion ranges at near, accommodative amplitude and accommodative facility.

Researchers found that 15.4% of students had a poor near part of convergence (>9cm), 25% had “very weak accommodation” (<11diopters), 24% had “weak/very weak accommodative facility” (<9 cycles per minute). This study found that boys were more likely than girls to be referred for reading problems. The reasons for this remain unclear. In addition, 80% of the students passed visual acuity testing with 20/40 or better, yet only 20% had adequate visual skills. Almost 50% of those children with poor visual skills were deficient in more than one area.

MEMORY

Clay OJ, Edwards JD, Ross LA et al. Visual function and cognitive speed of processing mediate age-related decline in memory span and fluid intelligence. *Aging Health*. 2009; 21: 547-66.

This study was performed to see if there was any relationship between vision and cognitive decline in older adults (over the age of 62). There are different theories to explain cognitive decline. One theory is 'sensory deprivation' which states that decreases to sensory input (eg. vision loss) will result in cognitive deterioration from neuronal atrophy. Another theory, 'the common cause hypothesis,' suggests that sensory function and intellectual ability both decline due to changes in the brain. A final theory is the 'processing speed theory' which suggests that a decrease in processing speed leads to cognitive changes. The authors looked at visual sensory functioning (visual acuity and contrast sensitivity), processing speed, memory span (tests to measure verbal and visual abilities of sequential memory), and fluid intelligence.

The results of this study show that declines in some cognitive abilities are related to age-related changes in visual function and processing speed. In particular, the study shows that there is a strong association between sensory functioning and cognitive decline, which supports the sensory deprivation theory. Results also showed that age is not associated with declines in memory span or fluid intelligence.

PEDIATRICS

Multi ethnic Pediatric Eye Disease Study Group. Prevalence of Amblyopia and Strabismus in African American and Hispanic Children Ages 6 to 72 months: The Multi-ethnic Pediatric Eye Disease Study. *Ophthalmology*. 2008; 115:1229-36.

The purpose of this study was to determine the prevalence of strabismus and amblyopia in African American and Hispanic children 6-72 months of age.

Overall, 2.5% of children were diagnosed with strabismus. There was no difference between ethnicities. Strabismus was more common and associated with cosmetically larger eye turns in older children (over 3 years of age) among both African Americans and Hispanics. Esotropia was less common (1.1% African American, 0.9% Hispanic) than exotropia (1.5% Hispanic, 1.4% African American). Esotropias were more likely to be constant than exotropias. Additionally, most deviations were in the range or 10-30 prism diopters at distance and near.

Overall, 2.1% of the children were diagnosed with amblyopia. Amblyopia was 2.6% higher in Hispanic children than in African American children. However, in both populations most cases of amblyopia were related to large differences in refractive error between the two eyes. Of the amblyopic children, 57% had anisometropic amblyopia, while 22% of the amblyopic children had bilateral ametropic amblyopia. Only 19% of the amblyopia cases were due to strabismus.

To date this is the only study that specifically looks at the prevalence of amblyopia and strabismus among African American and Hispanic children.

Voo I, Lee DA, Oelrich FO. Prevalences of ocular conditions among Hispanic, white, Asian and black immigrant students examined by the UCLA Mobile Eye Clinic. JAOA 1998: 255-61.

The UCLA Mobile Eye Clinic performed free vision screenings and eye examinations at public elementary schools, family clinics, and community centers in Los Angeles, California. This study reports on the results at one school where 2,229 newly immigrated children, between the ages of 8 and 16, were examined between December 1990 and June 1996. Only those children who identified themselves as white, black, Asian or Hispanic were included in the study. As only 9 children identified themselves as black, the study looked at the other races when comparing data. The eye examination tested visual acuity, refractive error, extraocular muscle imbalance (tropia and phoria), gross intraocular pressure, color vision for males, and a fundoscopic examination. Only 2.5% of the children received a dilated/cycloplegic exam

Uncorrected impaired visual acuity (IVAsc) was defined as worse than 20/40 in at least one eye. Asian children had the highest prevalence IVAsc at 16.5%. The prevalence of IVAsc in Asians was statistically significant when compared to Hispanic children (7.1% prevalence), but not statistically significant when compared to white children (11.8% prevalence). The prevalence of extraocular muscle imbalance was highest among whites at 3.4%, but not significantly significant when compared with Hispanics and Asians. Asians had the highest prevalence of refractive error, followed by whites and then Hispanics. Myopia was most common among Asians. When comparing males to females, the prevalence of a refractive error was most common and statistically significant in females. Astigmatism was also significantly more common in females than males in each ethnic group. Color vision deficiencies were more common in Asians (prevalence 4.2%) followed by whites (3.1%) and Hispanics (1.9%).

This study shows that some of the prevalence data for immigrant children is different than previously reported data for white children particularly in the areas of color vision and extraocular muscle imbalance.

READING SPEED

Yu D, Cheung SH, Legge GE, Chung ST. Reading Speed in the peripheral visual field of older adults: Does it benefit from perceptual learning. Vis Res. 2010;21; 860-9.

The macula is responsible for crisp clear central vision. When the macula is damaged through diseases like macular degeneration, it can appear as if there is a spot in front of one's eye(s) and make it difficult for patients to see clearly if they look directly at an object. Some patients will try to see objects by using their peripheral vision. This eccentric viewing can be difficult for patients to master. Previous studies have shown that increasing peripheral awareness through vision training can improve reading speed in young adults.

This study looked at whether increasing peripheral awareness through vision training could improve reading speed in normally sighted adults over sixty years of age. The participants

were divided into 2 groups those who went through training and a control group, who did not go through training. Participants worked on increasing visual span, which researchers defined as “the number of characters that can be recognized without moving the eyes.” Using a computer program letters were flashed above or below where the patient was looking. The participant was then asked to name the letters. After four days of intensive training, reading speed in the periphery was re-tested and compared to pre-training speeds. Peripheral reading speed increased 60% in the training group and 16% in the control group. Training of peripheral vision and visual span may help patients who have lost crisp central vision to diseases, like macular degeneration.

REFRACTIVE ERROR

Deng L, Gwiazda J, Thorn F. Children's refractions and visual activities in the school year and summer. *Optom Vis Sci.* 2010, 87: 406-13

This study looked at the amount of time children spent on different visual activities during the school year and summer break, to determine if there is a relationship to refractive error.

A total of 147 children, ages 6-18 were included in the study. Children were compared based on refractive error, either myopic or non-myopic. Children completed surveys with questions regarding the number of hours spent on sports, reading, computer use/ video games, and watching television, per day for both weekdays and weekends during the school year and summer vacation. All of the findings were then analyzed to determine the overall results.

The investigators found that the children who were myopic spent less time outdoors playing sports and other activities during the school year than children who are not myopic. During the summer there was not a statistically significant difference between the two groups. Both groups also studied for similar amounts of time, both more during school and less in the summer. Children with myopia watched more television during the school year and they read more for pleasure during the summer than their non-myopic peers.

The results of this study were similar to those of prior studies which found that children who spent more time doing outdoor activities during the school year were less likely to be myopic. The authors suggest potential reasons for the relationship between being outdoors and myopia development. One theory suggests that being in the sunlight may increase the levels of dopamine in the body, which could inhibit the growth of the eyes. Another theory is that sunlight causes pupillary constriction and increased depth of focus which slows eye growth. Studies such as this one are important for discovering trends in the development of myopia in children.

VISION DEVELOPMENT

Lewis TL, Maurer D. Effects of pattern deprivation on visual development. *Optom Vis Sci* 2009. 86;640-6

Researchers summarized findings on visual development based on studies of children treated for dense cataracts. They proposed 5 principles.

1. The aspects of vision that develop the earliest are less likely to be affected by abnormal visual input than areas that develop later. For example, critical flicker fusion frequency, which develops at 2 months, is not as affected by abnormal visual deprivation at an early age as is grating activity, which develops at ages 4-6.

2. Early visual input is needed to help with later vision development. For example, infants with cataracts treated in the first 6 months of life, have difficulty detecting high spatial frequencies, a skill that develops at age 2.

3. The dorsal and ventral streams, which are responsible for motion detection and form detection respectively, depend on normal visual input. Deficits in global motion were 5 times worse than in normal's, while deficits in global form were 1.6 times worse than in normal's even though sensitivity to form develops later than sensitivity to motion.

4. After monocular deprivation, the phakic and aphakic eyes are competitive for low level vision but are complementary for high level vision. In other words, the aphakic eye competes with the phakic eye for cortical connections for acuity. However, when looking at motion coherence tests, even with a cataract in one eye, both eyes have similar deficits.

5. There are many sensitive periods for vision development. These include a period of development, vulnerability and recovery. These findings give rise to future research questions regarding adult plasticity and alternate treatments for amblyopia.

Linden, M. L., Heynen, A. J., Haslinger, R. H., & Bear, M. F. Thalamic activity that drives visual cortical plasticity. *Nature Neuroscience*. 2009;12:390-2

Linden, Heynen et al performed an experiment on young mice to study two methods of blocking visual signals and the effect that each method had on brain development. They placed electrodes in the brain at the dLGN so that they could measure electrical signals from each eye and from the dLGN to the visual cortex. They measured the responses from mice with two normal eyes, and also measured responses from mice having one visually deprived eye (blocked vision). One of the deprivation methods used was to occlude one eye. The other method used an injection of a toxin to affect the retina. Next, they compared the development of the brain that resulted during each of these scenarios by comparing the electrical signals and how they changed as compared to the signals before vision was deprived.

When they compared the electrical signals, they found that the overall signal reaching the dLGN from both normal eyes and visually deprived eyes was relatively similar. They found that when comparing the lid closure to the retinal inactivation groups the types of neuronal firing was different. The authors note that the difference in dLGN activity found in the eyelid closure group and the retinal deactivation group affect the cortex differently. These findings help give information regarding plasticity of the visual system.

Trachtman J. Vision and the hypothalamus. *Optometry*. 2010; 81: 100-115.

This article reviews the relationship between the hypothalamus and its functions with an emphasis on vision. The hypothalamus is a significant part of the sympathetic nervous system; it produces many neurotransmitters and peptides and is important in regulating the pituitary gland.

The hypothalamus controls peptides that are released in response to stress. The peptides cause the pituitary gland to then release hormones which act on the nervous system to stimulate or inhibit certain behaviors. Recent research has found that behavioral responses to stress can cause difficulty with memory and learning and can, in certain cases, lead to panic disorders, depression, and bipolar disorder. A decrease in other peptides released by the hypothalamus has been associated with a variety of diseases including Alzheimer's, Huntington's disease, Parkinson's disease.

There are 3 retinohypothalamic pathways from the retina to the hypothalamus, as well as connections of sympathetic nervous system fibers to parts of the eye. Peptides, neurotransmitters and cytokines from the hypothalamus have been found to control intraocular pressure, inflammation and lacrimation.

Since the hypothalamus plays a central role in the sympathetic nervous system, an interruption of the innervation between this part of the brain and the eye can result in pupillary anomalies such as Horner's syndrome. This syndrome is characterized by a lid droop, a smaller pupil in one eye, and sometimes facial flushing. Other syndromes sometimes caused by viruses which can affect the hypothalamus and pupils, include Adie's tonic pupil and Argyll Robertson pupils. As clinicians, when patients report that they cannot read for long periods of time, indicating a potential problem with their accommodation (focusing system), it may be important to note if they have trouble sleeping, poor concentration, a water imbalance, increased appetite, blood sugar irregularities or problems regulating their body temperature, as these symptoms together may indicate a problem with hypothalamic function. Additionally drugs that are peptide antagonists may cause systemic or visual side effects. In conclusion, the hypothalamus is important for many systemic and visual functions.

Kavsek M, Granrud CE, Yonas A. Infants' responsiveness to pictorial depth cues in preferential-reaching studies – a meta-analysis. *Infant Beh Dev*. 2009; 32: 245-253.

This study attempts to determine the age at which an infant can use what are called "pictorial cues" to perceive depth. Pictorial cues include any method used in a picture to create a sense of depth, space, or distance such as object shading, size proportion, and drawing in perspective. Pictorial cues allow the observer to appreciate a sense of three dimensions while looking at a two-dimensional picture, and can be recognized using only one eye.

Researchers analyzed several prior studies in this area. All studies reviewed used a preferential reaching design. Subjects, aged five to eight months, were tested monocularly and binocularly and were exposed to 2 images placed at the same distance in front of the infant. Both images used pictorial depth cues; one image appeared farther than the other based on these cues. If the infant can detect depth using the cues, it is expected that, in the monocular

condition, he/she will reach out toward the closer appearing object. When viewing binocularly, the infant should use binocular cues and detect that both objects are at an equal distance in front of him/her and not have a preference for one object over the other.

Although results of several of the studies initially suggested that the earliest an infant can detect these pictorial depth cues is 7 to 7.5 months of age, this reanalysis of the combined data found that 5-month old infants can respond to pictorial depth cues.

Researchers note that there are 2 streams of information processing traveling through the visual system, the dorsal and the ventral. The ventral stream is sensitive to pictorial information. The dorsal stream is more sensitive to binocular information and integrates vision with motor activity. In other words, if an object is within an infant's reach, it is processed by the dorsal stream. If it is not within reach, it is processed by the ventral stream. The researchers speculate that these streams of information processing have a role in the ability of infants to detect depth and respond to testing and stress that further studies in this area are needed.

VISUAL MOTOR INTEGRATION

Sortor JM, Kulp MT. Are the results of the beery-buktenica developmental test of visual motor integration and its subtests related to achievement test scores? *Optom Vis Sci* 2003, Nov; 80(11) 758-63.

Scientific literature has shown a positive relationship between visual perceptual skills and academic performance in math and reading. Visual-motor integration is one such visual perceptual skill. It describes the ability to move the hands in an appropriate response to visual information.

Sortor and Kulp tested 155 children in grades 2 to 4 to determine if there was a relation between math and reading ability and some visual perceptual skills. All children were administered the Beery-Buktenica Developmental Test of Visual-Motor Integration (BDVMI) and its subtests, Visual Perception and Motor Coordination. A child's performance on this test was compared to his/her performance on school-administered tests to gauge a child's ability to perform well in school (i.e. Stanford Achievement Test and the Otis-Lennon School Ability Test).

The authors found that there was a significant difference on the perceptual tests between children in the lower and upper 25th percentile for math and reading performance. There was also a significant relation between math achievement and the BDVMI and its subtests. Therefore, the authors recommend that visual perceptual ability should be measured in children struggling with math and reading.

Tassinari JD, Eastland RQ. Vision therapy for deficient visual motor integration. *J Optom Vis Development*. 1997; 28: 214-226

Visual-motor integration (VMI) is a term used to describe how the brain and eyes work together to plan, perform, and monitor motor tasks. To put it simply, it can be known as eye-hand coordination. VMI is used in everyday activities, such as walking up and down stairs, tying

shoe laces, and hitting a baseball. VMI is also used in the classroom, during tasks such as copying from the board, working math problems, writing, and drawing.

Not every child has well-developed VMI. Many children with poor VMI do not perform well in school, and poor VMI is strongly associated with learning disabilities. If someone does not have adequate VMI, some symptoms include poor/sloppy writing or drawing, inability to stay on lines, excessive erasing, relying on one's hands to keep place while reading, and poor eye-hand coordination. Also, if a child does well on oral tests, but poorly on written ones, it could be a sign of poor visual skills and not poor understanding.

One method to assess VMI is the 'Beery Developmental Test of VMI,' which involves copying 24 shapes of increasing complexity. Tassinari and Eastland looked at 46 children with deficient VMI. All children had a diagnosis of a learning disorder and all had other vision problems (saccadic dysfunction or visual processing problems) and were treated with vision therapy. The Beery developmental test of VMI was administered before and after therapy. A symptoms survey was also given to parents and teachers before and after therapy. The results showed improvement in the VMI test by 95%, when looking at any improvement in test score, and by 93% when looking at symptoms. When looking at improvement by two standard error measurement (SEM) they found a success rate of 72%. Looking at SEM takes into account improvements in score that may not be clinically significant.

The authors also looked at patients with a severe deficit (SD) (standard score >1 standard deviation below the mean) and a moderate deficit (MD) (standard score between 0.5 and .95 below the mean) and found that 74% of the SD and 95% of the MD group improved to passing, while 83% of the SD and 61% of the MD improved by a gain in the SEM greater than 2.

The authors also noted that the decrease in improvement to passing was lower in the SD group and postulate that there may be a permanent and malleable component to the deficit. Additionally patients in the SD group were more symptomatic than patients in the MD group.

The authors conclude that VMI can be treated successfully with vision therapy.