

# Research Summaries in Behavioral & Developmental Optometry 2012

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The College of Optometrists in Vision Development 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.

*The following article summaries were compiled from submissions from the students and residents who received Travel Grants to attend the COVD's 42nd Annual Meeting*

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**Leon AA, Medrano SM, Rosenfield M. A comparison of the reliability of dynamic retinoscopy and subjective measurements of amplitude of accommodation. *Ophthalmic Physiol Opt* 2012;32:133-41.**

The purpose of this study was to determine the reliability of dynamic retinoscopy as an objective measurement of amplitude of accommodation (AA) and compare it to other subjective measures of accommodative amplitude, specifically push down and minus lens techniques. Previous research has shown that AA determined by Donders and Duane using subjective measurements (such as the push up test) may overestimate the amplitude of accommodation. Previous research has also found that objective measurements of AA may be as much as 1.50 – 2.00 diopters lower than values cited in Donders' and Duane's tables.

To evaluate the reproducibility and within-session repeatability, the three tests were given to each of 79 subjects three times by one examiner and three times by a second examiner 30 minutes later. To evaluate the inter-session repeatability of the measurements the three tests were given to a separate 76 subjects on two different occasions by a single examiner. All patients were correctable to 0.2 logMAR or better at near and free of amblyopia, aphakia, and any binocular or accommodative dysfunction.

Statistical analysis for the within-session and inter-session trials indicated no significant difference between the findings of the two examiners but a significant difference between the findings of dynamic retinoscopy and the subjective methods. There was poor agreement between all 3 techniques. Dynamic retinoscopy showed the lowest mean AA and the highest test-retest reliability. The results demonstrated that dynamic retinoscopy is a more reliable measurement of AA than subjective methods.

**Scheiman M, Cotter S, Kulp MT, Mitchell GL, et al. Treatment of accommodative dysfunction in children: results from a randomized clinical trial. *Opt Vis Sci* 2011;88:1343-52**

This study examines the effects of vision therapy to improve accommodative function (amplitude and facility) in patients with convergence insufficiency and accommodative dysfunction. The Convergence Insufficiency Treatment Trial (CITT) was a randomized clinical trial of 221 children ages 9-17, including 164 children with concomitant accommodative dysfunction. Researchers looked at accommodative amplitude and facility findings for patients assigned to each of the following treatment groups: office-based vision therapy with home reinforcement, home-based computer therapy and pencil push-up therapy, home-based pencil push up therapy alone, and office-based placebo therapy. Among the children with accommodative dysfunction, 63 had a decrease in amplitude of accommodation, 43 had a decrease in accommodative facility, and 58 had both. The patients were treated for a 12-week period and progress was evaluated at 4, 8 and 12 weeks.

Results indicated that all three of the vision therapy procedures were more effective than placebo therapy in improving accommodative amplitude. The amplitude of accommodation increased by the following: office-based therapy with home reinforcement by 9.9 diopters, home based computer therapy by 6.7 diopters, pencil push up therapy by 5.8 diopters, versus only 2.2 diopters with placebo therapy. However, only office-based vision therapy was significantly more effective than placebo treatment in those with decreased accommodative facility. Office-based therapy resulted in an

improvement of 9 cycles per minute (CPM), compared with an increase of 7 CPM for home-based computer therapy, 5 CPM with pencil push up therapy, and 5.5 CPM with placebo therapy. A one-year follow-up showed that 87% of the active therapy patients maintained their accommodative function. Although the CITT study's main objective was to compare the effect of active treatment on symptomatic convergence insufficiency in children, accommodative therapy was incorporated and resulted in an improvement in accommodative amplitude and facility.

**Kundart J, Tai YC, Hayes JR, et al. Real-time objective measurement of accommodation while reading. J Beh Optom 2011;22:130-134.**

Accommodative disorders can cause visual symptoms, such as eye strain, headaches, and intermittent blur. Currently, dynamic retinoscopy, such as the Monocular Estimate Method (MEM), is the only objective method to measure accommodative response during reading. However, the MEM is technique sensitive and difficult to assess continuously. This study investigates the ability of an open-field autorefractor to collect real-time, continuous measurements of accommodative response while reading.

The Grand Seiko WAM-5550 was the open-field autorefractor used to collect accommodative data on nine participants. Those having functional or pathological vision problems were excluded. Because while reading, the eyes move across text, measurements were collected at the primary gaze position, and eccentric gaze positions (+15 degrees to -15 degrees) at 50 cm. Subjects read text at various viewing distances (25, 33, 40, and 50 cm) at primary gaze.

Results show a linear trend of viewing distance versus diopter of accommodation, indicating that the autorefractor is sensitive to various viewing distances. The study also established that off-axis effects are minimal because accommodative measures were not significantly different between primary and eccentric distances. Lastly, during reading, accommodation measures changed at different viewing distances but were stable within a specific test angle.

This study shows that open-field autorefraction can be used to continuously measure accommodative response during reading. However, there are limitations of viewing distance and eccentric viewing. WAM-5500 performed accurately up to 50 cm and within a viewing angle of +/-7.5 degrees. Despite limitations, this study provides another method of measuring accommodation responses objectively.

**Heyman CL. Accommodative response in children with visual impairment. Optom Vis Dev 2011;42:10-6.**

This study involved ten children 5-14 years of age who had been previously diagnosed with a form of macular pathology (Stargardt's, ocular albinism, macular hypoplasia, rod/cone or cone/rod dystrophy) causing a reduction in best-corrected visual acuity. Each subject's accommodative response was measured with the Grand Seiko WV500 autorefractor at distance of 33cm, 25cm and 20cm with high contrast, vertical, square-wave gratings.

Subjects were found to have one of five types of accommodative response. One subject showed a "negative slope lag:" an increase in accommodative lag as the demand increased. Five subjects showed a "fixed lag:" a tendency to under- accommodate the same amount under all demand conditions. One subject showed a "fixed accurate" accommodative response, similar to a normal response. One subject showed a "positive slope lag;" initially a large lag of accommodation with improved accuracy as the demand increased. Lastly, two subjects showed a "fixed lead:" over-accommodation that decreased as the demand increased.

In conclusion, accommodative response in pediatric patients with macular pathology is much more variable and unpredictable than in normal sighted children. Therefore, a clinician cannot predict these patients' accommodative response. Some form of near retinoscopy must be performed in order to determine the appropriate near prescription.

**Wolffsohn JS, Sheppard AL, Vakani S, Davies LN. Accommodative amplitude required for sustained near work. *Ophthalmic Physiol Opt* 2011; 31: 480-486.**

The purpose of this study was to determine the amount of an individual's amplitude of accommodation that can be used in sustained near task activities without producing symptoms, and to assess the endurance of the accommodative system under near point stress.

Twenty one pre-presbyopic patients, 6 female and 15 male, between the ages of 20 and 34 years old were enrolled in the study. Each patient's binocular subjective amplitude of accommodation was tested prior to and after a 30 minute reading task using a single letter target size N5. Push-up and pull-away amplitudes were measured, with the average amplitude taken as the subjective amplitude of accommodation. All patients were free of ocular pathology, achieved best corrected visual acuity of at least 20/20 in each eye. Refractive error was limited to less than -2.00D spherical and -0.50D astigmatic correction. Subjects wore their correction as a soft contact lens.

The mean pre-task subjective amplitude of accommodation was  $10.49 \pm 2.46D$  and remained relatively unchanged after 30 minutes of sustained near work; the post-near work mean amplitude was  $11.14 \pm 2.58D$ . The percentage of total amplitude of accommodation used in near work varied greatly between patients, ranging from  $45.3 \pm 3.7\%$  to  $96.6 \pm 4.3\%$ . The mean distance of eye to reading material was measured as  $13.4 \pm 3.3cm$  which decreased to  $12.7 \pm 3.2 cm$  after 30 minutes. The mean pupillary diameter also decreased after 30 minutes of sustained near activity.

The results of this study showed that the pre-presbyopic accommodative system is extremely durable and can sustain near point tasks even at a greater demand than 50% of its overall accommodative amplitude, which was previously seen as the limit for comfortable sustained near work. The mean sustained amplitude of accommodation was 80.6%, with no patients reporting any symptoms of fatigue. This suggests that for presbyopic patients, a lower add power may be used to achieve the same amount of near vision comfort, thus improving range of clear vision, reducing spectacle induced distortions and reducing the induced hyperopic shift in refractive error often accompanied by adaptation from the use of high add powers. The results of this study raise the possibility of restoration of dynamic accommodation through IOL implants or other surgical means, in conjunction with pseudoaccommodation, as a lower amount of near addition power may be sufficient for near tasks.

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## AMBYLOPIA

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**Bodack MI, Chung I, Krumholtz I. An analysis of vision screening data from New York City public schools. *Optometry* 2010;81:476-84**

In this study, 1,992 children of lower socioeconomic status, in preschool through fifth grade, in the New York City school system underwent vision screenings. Interns at SUNY College of Optometry helped administer the vision screenings using a series of tests incorporating elements from 2 screening batteries, the Modified Clinical Technique (MCT) and the New York State Optometric Association (NYSOA) battery. The vision screening battery included case history, distance and near visual acuities, +2.00 test for hyperopia, retinoscopy, cover test, stereopsis, color vision, near point of convergence,

extraocular motilities, amplitude of accommodation and direct ophthalmoscopy. If not all of the tests could be performed, the minimum database consisted of distance and near acuities, cover test, extraocular motilities, near point of convergence, color vision and stereopsis. Children who failed 1 or more of the screening tests were referred for a comprehensive eye exam.

Of all the children screened, 30% were referred for comprehensive eye exams. Twenty (20) percent of the preschool age children, and 33% of the school age children were referred. 41% of the children who failed passed distance and near visual acuity and were referred for another reason. Only 8% of the children screened wore glasses, and 49% of those children failed the screening, whereas only 28% of children not wearing glasses failed the screening. The researchers found that there was a significant difference in referral rates for binocular vision tests between the preschool and school age children; more school age children were referred for binocular vision problems, 20% versus 0.4%.

Had referrals been made only on the basis of distance visual acuity, 19% would have failed the vision screening. Since 41% of the children failed for a reason other than visual acuity, the study suggests that vision screenings based only on visual acuity would have missed children with non-acuity problems.

This study demonstrated the importance of screening for binocular vision problems that could contribute to learning difficulties. It is important for children with previously diagnosed vision problems as well as children without a previous vision diagnosis to undergo routine vision screenings because vision conditions can be missed or change over time.

**Pang Y, Allison C, Franz K, et al. A prospective pilot study of treatment options for amblyopia associated with myopic anisometropia. Arch Ophthalmol 2012;130:579-84.**

This study aimed to identify the effect of refractive error correction and patching in the treatment of myopic anisometropia. Seventeen participants between 4 and 14 years of age were evaluated in this study and followed for 32 weeks. Each participant had optimal best corrected visual acuity (VA) in the amblyopic eye between 20/40 and 20/400, and 20/40 or better in the non-amblyopic eye, and had more than 3.00D of myopic anisometropia. At the initial visit participants were fit with a spherical soft contact lens in the amblyopic eye. The patient's non-amblyopic eye was corrected with a spectacle correction. Visual acuity was assessed at weeks 4, 8, 12, and 16. Between weeks 16 and 32, the participants were instructed to include direct patching as part of their treatment. Moderate amblyopes (20/40 to 20/80) patched the non-amblyopic eye for 2 hours a day, whereas severe amblyopes (20/100 to 20/400) patched the non-amblyopic eye for 6 hours a day. Participants were also instructed to incorporate at least 30 minutes of detailed near activities each day with patching. Visual acuity was measured at 4 and 16 weeks after patching was initiated.

The results of this study showed that refractive correction and patching with near activities can significantly improve visual acuity in myopic anisometropia. After 16 weeks of refractive correction alone, the mean improvement in VA was 2.59 log MAR lines. After sixteen weeks of direct patching with near activities, had a collective improvement in VA. A mean VA improvement of 2.59 Snellen lines was achieved at the end of the 32 week study, 88% of participants demonstrated an improvement of 2 or more lines, and 53% demonstrated improvement of 3 or more lines, with 47% having a VA of 20/63 or better. This study also found an inverse relationship between age and amount of VA improvement. The final VA was also related to baseline VA, anisometropia and patching compliance.

The importance of this study was to identify the utility of spectacle correction and patching in a specific class of amblyopia.

**Levi DM. Prentice Award lecture 2011: Removing the brakes on plasticity in the amblyopic brain. *Optom Vis Sci* 2012;89: 827-38.**

Aside from refractive error, amblyopia is the most common cause of vision loss in young children, affecting 2-4% of the population. Amblyopia does not develop after the age of six to eight years, and so the notion that there is a critical period for the development of amblyopia has often indicated that there is also a critical period for the treatment of amblyopia.

For more than a century, the common belief has been that visual loss associated with amblyopia may be reversed if treated early, and conventional therapy has not been considered in older children and adults. However, there is now evidence demonstrating neural plasticity beyond the critical period. This review summarizes new studies on amblyopia treatment, including a review of critical periods.

Researchers are now aware that there are different critical periods for different functions, different parts of the brain and layers of the primary visual cortex, as well as for induction and recovery of sensory deprivation. Research has shown that binocular connections are the most vulnerable during the first 18 months of life, but remain susceptible to binocular effects from strabismus until age 7. In the past, there was a critical period for the treatment of amblyopia. However, clinical trials have found that the age for successful treatment may be older than once thought. Additional work, including perceptual learning, may prove to be useful in the treatment of amblyopia. Perceptual learning has been studied in patients with amblyopia and has been found to be task specific. Perceptual learning may also prove to be more efficient than patching alone for the treatment of amblyopia. However, the more severe the vision loss, the longer time will be needed to obtain its maximum effect.

Perceptual learning and video game play are two approaches used in this study, which may be effective in improving a range of visual performances, resulting in better visual acuity and stereopsis.

**Niechwiej-Szwedo E, Kennedy SA, Colpa L, Chandrakumar M, et al. Effects of Induced Monocular Blur versus Anisometric Amblyopia on Saccades, Reaching, and Eye-Hand Coordination. *Invest Ophthalmol Vis Sci* 2012;53:4354-4362.**

Previous studies have found that patients with anisometric amblyopia have impaired performance in programming and execution of saccades and reaching movements during visually-guided tasks. This study explored whether the reason for the decreased performance is due to the decrease in visual acuity in one eye alone or whether it is a result of abnormal visual development.

Twelve visually-normal participants were enrolled. All patients were correctable to 20/20 visual acuity and had normal stereoacuity. Twelve patients with mild anisometric amblyopia were also enrolled in the study. The mean visual acuity was 20/50 in the amblyopic eye and 20/20 in the fellow eye. All of the amblyopic patients had reduced stereopsis. All 24 participants went through experimental sessions in which they had to view a target on the computer screen. The target was presented 5-10 degrees on either side of a fixation cross. Subjects were told to look at and point to the target after it appears as quickly and accurately as possible with their right index finger.

The visually-normal participants were blurred to 20/50 visual acuity in one eye with a contact lens. Three experimental sessions occurred for each visually-normal participant: normal (non-blurred) viewing, viewing immediately after blur was induced, and viewing 5 hours after blur was induced. The experimental sessions for all participants took place under 3 different viewing conditions: binocular,

monocular dominant (non-blurred), and monocular non-dominant (blurred/amblyopic) eye viewing. Saccadic eye movements, reaching movements of the hand, and eye-hand coordination were recorded and analyzed.

The results of the study showed that saccades and reaching performance were not affected by induced monocular blur in visually-normal participants. In contrast, patients with amblyopia displayed a longer latency and greater variability of saccades and a lower peak acceleration during reaching movements. These results suggest that decreased visual acuity in one eye alone cannot be the reasoning behind the deficits in saccadic performance in patients with anisometric amblyopia; the longer saccadic latency found in amblyopic eye viewing may be due to slower visual processing because of a chronic suppression of the input of the amblyopic eye.

Reach-related saccades occurred more frequently in blurred conditions in visually-normal participants, and in the patients with amblyopia. Researchers propose that in the blur condition, the initial reaching movements of the hand were based on a less reliable visual input, and the reach-related saccades were generated to try and improve the accuracy and position of the reach. In the amblyopic patients, the reaching movements had a lower peak acceleration and an extended duration of an acceleration phase, which may be mechanisms to enhance reaching performance despite a blurred image. Also, unlike in normal participants. Researchers speculate that this fellow eye's involvement may be due to the developmental nature of amblyopia.

In conclusion, amblyopic patients have motor performance deficits not due to a decrease in visual acuity alone. These patients also have deficits in contrast sensitivity, and binocularity.

**Bhandari G, Sharma AK, Shrestha GS. Parental Understanding and Psychosocial impact of occlusion therapy on amblyopic children and their parents. J Beh Optom 2012;23:3-8**

The purpose of this study was to examine the psychosocial impact that occlusion therapy has on amblyopic children and their parents. Researchers also looked at the level of parental understanding of occlusion therapy.

Fifty two children, ages 2-13, diagnosed with various forms of amblyopia and prescribed occlusion therapy participated in this study. Inclusion criteria were: undergoing occlusion therapy for more than two months and the parents of the amblyopic children must have been present at the time that occlusion therapy was prescribed. Patients were excluded if there were any presence of ocular pathology (other than congenital cataracts) that caused a reduction in vision. Compliance with therapy, along with psychosocial/emotional impact on the children, were determined through questionnaires. Compliance was graded on a percentage system taking the amount of time the therapy was performed by the patient over the amount of time prescribed and graded as poor (patching <25% of the time), moderate (patching between 25-50% of the time), adequate (patching 51-75% of the time) and good (patching >75% of the time).

Of the 52 children enrolled in the study, the majority (28.8%) were diagnosed with strabismic amblyopia followed by isoametropic amblyopia (27%) and anisometric amblyopia (25%). The average initial age for patching was 5.06 years. The mean total hours of patching prescribed was 7.06 a day. The average compliance was 77.6%, best in ages 3-4 and poorest in ages 5-7. Only 42% of parents of children undergoing patching had adequate knowledge of the diagnosis and treatment for the child's amblyopia. The teasing was statistically significant in children over the age of 7. Sixty nine percent of parents reported no effect on the child's educational performance.

Despite a lack of parental understanding of amblyopia and emotional stressors affecting these children, the compliance with occlusion therapy was still at an adequate level.

## *ATTENTION DEFICIT DISORDER WITH/OUT HYPERACTIVITY (ADD/ADHD)*

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**Brossard-Racine M, Majnemer A, Shevall M, et al. Handwriting capacity in children newly diagnosed with attention deficit hyperactivity disorder. *Res Dev Dis* 32:2011; 2927-34.**

Attention deficit hyperactivity disorder (ADHD) is the most common neurobehavioral disorder encountered in childhood with a prevalence ranging from 3% to 12% of the school-age population. This study applies a standardized quantitative measure of handwriting performance in medication-naïve children newly diagnosed with ADHD and to identify predictors of performance. Forty children between six and eleven years of age, with an average age of 8.1 years, were enrolled in this study. The children were evaluated with the Evaluation Tool of Children's Handwriting-Manuscript (ETCH-M), the Movement Assessment Battery for Children (M-ABC), the Developmental Test of Visual Motor Integration (VMI), and the Parents' Conner Global Index (CGI-Parent). The ETCH-M words and sentences assesses children's handwriting speed and legibility by having them write letters, numbers and do a near-far copy task. The M-ABC discriminates between children with and without motor impairment and is comprised of 8 tasks in 3 subscales: manual dexterity, ball skills, and balance. The VMI test discriminates between children with or without visual-motor difficulties, by having patients copy a series of geometric designs. The CGI-Parent is a questionnaire to screen for behavioral difficulties.

The results of this study showed handwriting legibility and speed were extremely variable. Sixty six percent of words and 78% of numbers were legible on the ETCH-M. The average speed of execution was lowest on the near-far copying task and higher on sentence composition. Fifty percent demonstrated impairment on the MABC test, with 85% of children showing impairment in manual dexterity. Fifty five percent scored below 1 standard deviation on the VMI.

In this study, age was found to be an important predictor of handwriting performance in the majority of children (82.5%) in grades 2- 4. It may be reasonable to believe that the lack of developmental handwriting proficiency may be an indication of a maturation delay. The best predictor of legibility was a child's scores on the VMI.

## *BRAIN INJURY*

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**Thiagarajan P, Ciuffreda KJ, Ludlam DP. Vergence dysfunction in mild traumatic brain injury a review. *Oph Physio Optics* 2011;31:456-68.**

This article reviewed many studies on vergence abnormalities and the effectiveness of vision therapy in patients with mild traumatic brain injuries (mTBI). The mTBI patients consistently showed a statistically higher incidence of vergence abnormalities compared to the non-TBI patients in retrospective and prospective studies. The most common vergence anomaly was convergence insufficiency.

Studies looked at static and dynamic measures of vergences among symptomatic mTBI patients compared to normal patients. Five static measures were significantly deficient in mTBI patients:

increased stereoacuity threshold, reduced positive fusional vergence break and recovery, and receded NPC break and recovery. All of the dynamic measurements were reduced and slowed among the mTBI patients, even though the response amplitudes of divergence and convergence did not vary between normal and mTBI patients. To test for visual fatigue, vergence facility testing with flippers was repeated at the end of each test session. Although the vergence facility was originally lower among the mTBI patients, neither group showed deterioration over time. Lastly, patients with mTBI were found to have related accommodative dysfunctions such as reduced amplitudes, reduced facility, reduced peak velocity, increased steady state variability, and increased time constant.

Oculomotor rehabilitation (vision therapy) was found to be effective in correcting signs and symptoms of vergence dysfunctions in these patients. Neural plasticity plays a key role in the ability of the brain to recover and relearn, even in adults. Future studies should investigate the most effective therapy, testing and imaging, to reveal the underlying neural areas affected. Additionally, motor learning is implicated as mechanism for the success of oculomotor training.

### *CEREBRAL PALSY*

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#### **Marasini S et al. Ocular manifestations in children with cerebral palsy. *Optom Vis Dev* 2011;42:178-82**

The purpose of this study was to evaluate the frequency of ocular abnormalities in children with cerebral palsy in Nepal. Eye exams were performed on 36 patients, aged 6 months to 21 years (average age 5.5 years). The examinations included tests for visual acuity, refractive error, extraocular motility, ocular alignment, anterior and posterior segment health.

Refractive error was the most frequent type of ocular abnormality found (78% of patients). Only 8% of children had visual acuity (VA) of 20/20, 22% had VA from 20/30 – 20/60 and 28% had VA from 20/60-20/200. Thirty percent had myopia  $\geq 0.50$  diopter, 24% had hyperopia  $\geq 1$  diopter and 30% had astigmatism  $\geq 1$  diopter. Thirty six percent of patients had strabismus, with 61% of those patients having alternating exotropia. Nystagmus was present in 14% of patients. Seventy eight percent had normal optic nerves while 22% had optic atrophy.

This study helps to confirm that ocular defects are very common among children with cerebral palsy. The authors point out that parents and health care providers of children with cerebral palsy should keep in mind the ocular abnormalities that may be present in children with cerebral palsy. Children with cerebral palsy should be closely examined and referred in a timely manner so that proper measures can be taken to improve the quality of life of these individuals.

#### **Woo SJ, Ahn J, Park MS, et al. Ocular findings in cerebral palsy patients undergoing orthopedic surgery. *Opt Vis Sci* 2011;88:1520-3.**

This retrospective study examined 88 patients with cerebral palsy who had orthopedic surgery over the course of 2 years. All patients received an ophthalmologic examination including best corrected visual acuity, cycloplegic refraction, cover test and anterior/posterior segment evaluation. Patients who were difficult to examine had an examination under anesthesia. The prevalence and clinical features of ocular abnormalities were noted, as well as their association with gross motor function. Motor functional status in these patients was graded with the gross motor function classification system (GMFCS).

Seventy eight of the 88 patients had ocular findings, including refractive error (60%), strabismus (59%), posterior segment abnormalities (22%) and cornea/lens abnormalities (9%). Myopia (defined as  $\geq 1.5$  diopters) was the most common refractive error in 47% of patients. All patients with strabismus had a horizontal deviation; exotropia was present in 85%, and 19% had a combined vertical strabismus. Twenty five percent of patients had a best corrected visual acuity in the better seeing eye of 20/40 or less. A strong association with poor gross motor functions with ocular pathologies causing vision impairments and vertical strabismus was found.

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### *COLORED OVERLAYS*

**Drew SA, Borsting E, Stark LR, Chase C. Chromatic aberration, accommodation, and color preference in asthenopia. OVS 2012;89:1059-67**

Many reports show that some symptomatic individuals prefer certain color overlays to reduce symptoms and improve reading speed. In this study, researchers examined the relationship between asthenopia (eyestrain), color preferences, and accommodation/vergence function. Forty-seven undergraduate students participated in this study. Subjects completed a visual discomfort symptom survey, selected a preferred color using the Mark 2 Intuitive Colorimeter while looking at black text on a white background. Longitudinal chromatic aberration (LCA) was calculated for each subject. All subjects underwent evaluations of accommodation and vergence.

This study found that color preferences correlated with eyestrain severity as well as accommodation/vergence function. Three patterns were found: subjects with frequent symptoms preferred saturated blues, reducing accommodative demand; subjects with weak accommodative/vergence functions preferred saturated greens, also reducing accommodative demand; subjects with normal accommodation/vergence and without eyestrain did not have a color preference, or preferred deeper yellow, orange, and red colors, increasing accommodative demand. Drew et al. found that the blue color reduced LCA demand more than green; noting that more frequent symptoms may reflect a more pronounced functional impairment.

The authors note that these findings may have significant implications for the clinical treatment of accommodation/vergence dysfunction.

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### *CONVERGENCE INSUFFICIENCY*

**Borsting E, Mitchell GL, Kulp MT, Scheiman M, et al. Improvement in academic behaviors after successful treatment of convergence insufficiency. Optom Vis Sci 2012;89:12-18.**

The main purpose of this study was to look at 218 children ages 9-17 who participated in the Convergence Insufficiency Treatment Trial (CITT) and compare their Academic Behavior Survey before and after 12 weeks of treatment. Academic Behavior Survey (ABS) is a six question survey that assesses a parents concern for his/her child when performing school related tasks.

Subjects were divided into three different groups according to level of success in treatment of convergence insufficiency (CI); successful, improved, and non-responder. There was a reduction in overall ABS score by 4.01 in the successful group and 2.98 in the improved group. The non-responder group had a reduction of 1.27 in the overall ABS score. The reduction in ABS score was statistically significant in the successful and improved groups when compared with the non-responder group. The difference between the successful and improved groups was not statistically significant.

Researchers found that there was a decrease in adverse behavior in school as recorded by the ABS survey in symptomatic patients treated for CI who, after treatment, were classified as “successful” or “improved.”

**Rosenfield, M. Computer vision syndrome: a review of ocular causes and potential treatments. *Ophthalmic Physio Optics* 2011;31: 502-15**

This article summarizes several studies on the potential causes for computer vision syndrome (CVS). Computer vision syndrome is the combination of eye and vision problems associated with the use of computers, as defined by the American Optometric Association. Computer vision syndrome can cause patients to experience a wide variety of symptoms including eye strain, dry eye, double vision, and blurry vision. These symptoms can be attributed to insufficient refractive error correction, inadequate oculomotor abilities and dry eye.

Studies have found that as little as 0.50-1.00D of uncorrected astigmatism can contribute to decreased visual comfort when on the computer. These amounts of astigmatism should be corrected in symptomatic patients. Appropriate near prescriptions for presbyopic patients are essential as well. Computers and handheld electronic devices can be used at a variety of working distances and viewing angles with a variety of text sizes. Care must be given to assess each patient’s individual needs.

Oculomotor abilities responsible for computer viewing can be broken down into accommodative and vergence responses. When a patient cannot accommodate to appropriate plane for their working distance, blur and eye strain. Studies are inconclusive as to whether CVS is associated with accommodative (focusing) anomalies, as studies looking at the accommodative response and facility found no relationship between these tests and patients’ symptoms. Some studies have found a relationship between changes in accommodative/vergence demands and changes in the trapezius muscle, which can lead to upper back and neck symptoms.

Adequate vergence ranges are required for near work as well. The patient must have the ability to converge and diverge their eyes to appropriate working distance in order to maintain fusion. Fixation disparity testing showed that patients with a small exo fixation disparity had a lower symptom score.

Computer use can worsen dry eye symptoms. Blink rate is reduced during computer viewing which increases the instability of the tear film. Blink rate decreases further with decreased contrast and font size. When computers are viewed at primary gaze there is increased corneal exposure and consequently faster rate of tear evaporation.

The first step in treating computer vision syndrome is an appropriate refractive correction. A full binocular vision assessment should then be performed at the distance and viewing angle of the patient’s computer/tablet/etc. Evaluation of the cornea, tear film, and blink should be included. Appropriate treatment including lenses, vision therapy, when indicated, should be recommended. Rest breaks should also be encouraged. Optometrists must continue to adjust their care to keep up with increasing visual demands.

**Anderson HA, Manny RE, Glasser A, Stuebing KK. Static and Dynamic Measurement of Accommodation in Individuals with Down Syndrome. Invest Ophthalmol Vis Sci 2011;52:310-7.**

The purpose of this study was to objectively measure both static and dynamic aspects of accommodation in individuals with Down Syndrome to enable a more complete assessment of accommodative function. Thirty-six subjects with Down Syndrome between the ages of 3 and 40 years were recruited from the University of Houston Eye Institute's patient population and the local Down Syndrome Association. Data from the subjects with Down Syndrome was compared with a population of one hundred and forty control subjects who were recruited for studies of age-related changes in accommodation during the same time frame. All subjects had a vision and binocular assessment including distance and near acuities, distance and near cover tests, stereopsis testing, static (i.e. maximum accommodative response, accommodative lag) and dynamic (i.e. latency, peak velocity and microfluctuations) accommodative measures and adaptive abilities assessment.

This study identified multiple deficits in accommodative function in patients with Down Syndrome. Patients with Down Syndrome had a decrease mean maximum accommodative response to minus lens blur; the mean response was 2.52 diopters. Patients with Down Syndrome also had increased accommodative lag (average 1.81 diopters). Over 50% of the subjects with Down Syndrome had atypical accommodative responses to the dynamic step stimulus, especially with latencies and microfluctuations. The findings of accommodative function suggest that accommodative inaccuracy is primarily related to a sensory pathway deficit in individuals with Down Syndrome. Differences in refractive error, binocular status, and cognitive functioning between the subjects with Down Syndrome and the controls represent a potential limitation of this study.

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### *ESOTROPIA*

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**Habot-Wilner Z, Spierer A, Barequet IS, Wagnaski-Jaffe T. Long-term results of esotropia surgery in children with developmental delay. J Am Academy Ped Ophthalmol Strab 2012;16:32-5.**

This retrospective study examines the long term effects of esotropia surgery on children with developmental delay.

A retrospective chart review of 24 developmentally delayed children who underwent bilateral medial rectus recession for esotropia treatment was conducted. The average age at surgery was  $2.8 \pm 2.5$  years, and the average pre-operative angle of esotropia was  $49.8^{\Delta} \pm 13.3^{\Delta}$ . Surgical success was considered as Developmental delays included CP, hydrocephalus, Williams Syndrome, Prader Willi, Down Syndrome and unspecified delay in development. The average follow up period was 5.3 years. Nine out of 24 subjects (38%) achieved surgical success, with 10 (67%) being under-corrected and 5 (33%) developing a consecutive exotropia. Eight patients underwent a second surgery. One patient underwent a total of 4 surgeries. After all procedures, the surgical success rate was 63%. After 5 year follow up, the rate of consecutive exotropia was 21%, suggesting a long term shift toward consecutive exotropia in this population.

## *EXOTROPIA*

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**Holmes JM, Leske DA, Hatt SR, et al. Stability of near stereoacuity in childhood intermittent exotropia. J Am Academy Ped Ophthalmol Strab 2011;15:462-7.**

This study investigated near stereoacuity in children previously untreated for intermittent exotropia. Subjects included 95 children, ages 2-16, with intermittent exotropia. Stereoacuity was measured using the Preschool Randot (PSR) test for 2 successive examinations.

Results found that deterioration of intermittent exotropia was not frequent. When looking at 3 octave changes (3 doublings of stereoacuity value, such as 100 seconds to 800 seconds), 2% of children showed deterioration at 1 year and 7% at 2 years. When looking at 2 octave changes, 8% deteriorated at 1 year and 12% at 2 years. Although the sample size was small, all children who deteriorated and had subsequent stereopsis measurement, 71% improved to normal levels of stereoacuity.

The authors acknowledge that stereoacuity thresholds are variable, and deterioration of stereoacuity in intermittent exotropia at 1-2 years is infrequent. The authors do not recommend surgery for intermittent exotropia to prevent stereoacuity loss.

## *HYPEROPIA*

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**Leat SJ et al. Prescribing for hyperopia in childhood and teenage by academic optometrists. Opt Vis Sci 2011;88:1333-42**

This study was a retrospective analysis of clinical data from February 2007 to January 2008 of the records of 698 patients aged birth to 19 years, with hyperopia of +0.25D or more in the most hyperopic meridian in both eyes. All records were taken from the Waterloo Eye Study database, which includes all patients that received a comprehensive eye exam in the Primary Care or Pediatric Clinic at the School of Optometry, University of Waterloo, Ontario, Canada. The purpose was to determine prescribing patterns for hyperopia, as well as investigate the factors that led to the prescribing of hyperopic spectacle correction. These patterns of prescribing in an academic setting were also compared to established guidelines published by various optometric and ophthalmologic groups.

Patients were divided into three age groups: 0 to 3 years, 4 to 6 years and 7 to 19 years. The amount of hyperopia in which all children were prescribed spectacles varied between each age group. From ages 0 to 3 years, hyperopia of 5D or greater was corrected. From ages 4 to 6 years, hyperopia of 3.25D or greater, and from ages 7 to 19 hyperopia 2.25D or greater were corrected. There was a trend to under correct both hyperopia and astigmatism, most often in the younger age groups.

Researchers found that the amount of hyperopia and astigmatism, as well as patient's age, distance and near phoria and presence of symptoms all were found to influence the decision to prescribe.

The study found that previously published guidelines for prescribing for hyperopia and the prescribing philosophies of the optometrists in this academic setting were very similar. As patient's age increased, practitioners were more likely to correct for lower levels of hyperopia.

**Bosworth RG, Petrich JAF, Dobkins KR. Effects of spatial attention on motion discrimination are greater in the left than right visual field. *Vis Res* 2012;52:11-19**

The purpose of this study is to investigate if the two cerebral hemispheres and their corresponding visual field will differ in spatial attention abilities. Nine subjects, with a mean age of 22.2 years, participated in this study.

The study utilized a full/poor attention paradigm to present stimuli in the left visual field (LVF) and right visual field (RVF) in order to measure discrimination thresholds. Under full-attention condition, subjects performed only the main discrimination task and were told to ignore the additional stimuli. Under the poor-attention condition, subjects performed the main discrimination task while also being asked to pay attention to the additional stimuli.

Two main types of stimuli were tested: motion discrimination and orientation discrimination. The purpose of testing two different stimuli was to determine if a difference in spatial attention between the dorsal and ventral visual processing stream exists. For motion discrimination, a motion coherence task and fine direction of motion discrimination task were performed.

The results found a negligible effect of attention on orientation tasks in either LVF or RVF. However, the results showed a greater effect of attention on both types of motion tasks for the LVF than the RVF. The information gathered from this study provides evidence for greater spatial attention in the LVF/right hemisphere for motion discrimination. The authors conclude by discussing possible reasons for the lack of attention effect on the orientation task as well as possible explanations for the attention effects for motion discrimination in the LVF but not the RVF.

**Khuu SK, Khambiye S. The influence of shape-from-shading information on the perception of global motion. *Vis Res* 2012;55: 1-10.**

The purpose of the experiment was to examine the relationship between 3 dimensional (3D) shape from shading information and motion perception at global and local stages of analysis. The study also looked at whether the visual system detects local motion from temporal pairing of different 3D shapes, the effect of 2 dimensional (2D) shaded dots on local motion detection, and the impact of additional noise on coherent motion detection.

The experiment was divided into three parts. Each test used various global dot motion stimuli. Four observers with normal visual acuity were selected for these experiments. Experiment 1 tested local motion detection by changing the reversal in the 3D shape of moving dots. Subjects had difficulty detecting local motion of dots that changed shape from frame to frame (e.g. convex to concave). Local information based on shape occurs before motion is processed by the visual system. Experiment 2 tested the effects of removing 3D information from the dots but keeping the same contrast polarity and using rotational motion only. The research found that when the 3D cue is removed, global motion is detected regardless of changes in the direction of shading. These results revealed that the visual system uses temporal pairing of 3D shapes to detect global motion. Experiment 3 used the same stimuli from experiment 1 with added 100 noise dots. The signal dots maintained 3D

shape, but noise dots either stayed the same or reversed shading. Researchers found that if the noise dots matched the same 3D shape of the stimuli dots, global motion detection was affected.

In conclusion, these experiments showed that 3D shape impacts global motion detection. Researchers believe that local information based on 3D shape is segregated from shading information. Motion analysis occurs after this shape and shading information is analyzed.

## *MYOPIA*

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### **Pan, CW, Ramamurthy D, Saw SM. Worldwide prevalence and risk factors for myopia. *Ophthalm Physiol Opt* 2012;32:3-16**

The purpose of this article was to evaluate myopia risk factors in population-based studies and to summarize worldwide patterns and trends for myopia prevalence.

Myopia is a complex trait that includes genetic and environmental factors. Recent population-based studies on children indicate that the prevalence of myopia varies across populations and ethnicities, but tends to be higher in urban than in rural areas and in people of Chinese ethnicity. Many studies have limitations including the definition of myopia and type of refraction (i.e. cycloplegic or non-cycloplegic). A review of recent studies also indicates that potential environmental factors related to myopia development include:

1. Studies in Australia and Singapore have found less myopia in children who spend time outdoors. Light intensity increasing depth of field, and dopamine levels from the retina are 2 theories for this finding.
2. Some studies have found that patients who do near work for 30 or more minutes or at a close working distance, are more likely to develop myopia while other studies have not found this relationship.
3. Numerous studies show consistent correlations between higher education and the presence of myopia.
4. One study found a two and eight fold increased risk for developing myopia in children with one and two myopic parents, respectively. Other studies have found a higher prevalence of myopia in patients with one or both myopic parents.
5. Peripheral refractions have found an increase in hyperopic peripheral refractions in patients with myopia.
6. Animal studies have found that image degradation and accommodation may play a role in myopia development in humans.

The article concluded that although studies assessing the effect of gene-environment interaction on the etiology of myopia are controversial with inconsistent findings, environmental factors still play a crucial role in myopia development. The authors suggest that longitudinal cohort studies or randomized clinical trials be conducted.

### **Donovan L, Sankaridurg P, Ho A, Naduvilath T, et al. Myopia progression rates in children wearing single-vision spectacles. *Optom Vis Sci* 2012; 89: 27-32.**

A meta-analysis examined the progression of myopia in children between the ages of 7-12, using 20 articles from the National Library of Medicine PubMed literature database. The studies compared myopia progression according to ethnicity, European or East-Asian descent. The results were categorized by progression of baseline age, gender, and ethnicity. It was found that younger children demonstrated greater annual rates of progression of myopia, females progressed slightly higher than male (0.8 diopters/ year versus 0.7 diopters/year), and the progression rate in Asians were higher than with Europeans (0.82 diopters/year versus 0.55 diopters/year).

**Charman WN. Myopia, posture and the visual environment. *Ophthalmic Physiol Opt* 2011;31:494-501.**

The peripheral retina, visual environment, and posture may explain why some individuals become. A longitudinal study with young airline pilots indicated that individuals with myopic peripheral retinæ experienced stable refractions. Those with hyperopic peripheral retinas experienced progressive myopic shifts in axial refraction. One theory for this development is that a local retinal signal, which causes a local increase in growth, is generated to bring the image into focus. An axial myopic shift results since constraints in eyeball shape force growth to occur as an axial length increase.

Prior studies have looked at emmetropization and an emmetropization “mechanism” for possible relationships to myopia development. Many studies have looked at axial focus, but recent studies looked at the role of the peripheral retina. Some suggest that there are neurons in the peripheral retina tuned to orientation. One theory, relating to defocus in the peripheral retina, relates to oblique astigmatism. At each object point, sagittal and tangential focal line images are present. An eye that is hyperopic, or too short, has the tangential surface closer to the retina causing an increase in neuronal output resulting in accelerated ocular growth. An eye that is myopic, or too long, has the sagittal surface closer to the retina, resulting in slowed ocular growth. When the two surfaces are at symmetrical distances from the retina, the neuronal outputs from both surfaces are balanced, and growth will stabilize. In other words, the hyperopic peripheral retina can stimulate further growth but the myopic peripheral retina cannot slow growth that has already occurred.

One assumption in some emmetropization models is that in outdoor visual environments, vergences of dioptric stimuli are close to zero, while the vergences of dioptric stimuli for indoor visual environments are variable. When indoors, a consistent relationship between the image surfaces and the retina is unlikely, and the emmetropization process is interrupted. Short daily periods of outdoor visual environments may allow emmetropization to resume.

Head position and orientation may also influence the dioptric vergence ranges. When tasks are long in duration, children often display relaxed postures. In many cases, these postures result in very short working distances and large head turns, which may increase the stimuli range and cause the spatial distribution of dioptric stimuli to each eye to be significantly different, respectively. Proper emmetropization would be unlikely.

Further research should be performed to determine whether or not peripheral retina, visual environment, and posture are factors in myopia.

**Katz L, Lambert W. A new look at myopia development: possible links with childhood stress and diet. J Beh Optom 2011;22:69-73.**

This retrospective study surveyed 417 undergraduate psychology students to determine possible links between myopia and childhood stress and diet. The survey consisted of a total of 29 items. Of the 29 items, 15 of the items referenced psychological stress, 6 processed foods, and 8 fresh foods. Questions included refractive status, perceived childhood stress levels and intake of processed and fresh foods, between 6 and 13 years old. The authors made three primary hypotheses: 1) myopes perceived more childhood stress, 2) myopes consumed more processed foods, and 3) myopes consumed less fresh foods.

Preliminary data showed that more females than males were myopes. Also the analysis showed no relationship between myopia and race or age. Statistical analysis showed that myopes reported significantly less perceived childhood stress ( $p=.008$ ) when compared to emmetropes. For processed foods there was no difference between the myopes and the emmetropes ( $p=.743$ ). However, myopes reported consuming less fresh food than emmetropes. This difference was statistically significant ( $p=.016$ ).

The authors noted some of the limitations of this study, including sample size, demographics and the retrospective nature of the survey. Although the students had the option on almost every question to state, “not sure” or “I don’t know,” the questions required them to think back to their childhood and self-evaluate. The authors acknowledge the study’s limitation and report the need for future studies to evaluate the possible link of childhood stress and diet in the development of childhood myopia.

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*NEAR WORK*

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**Sreenivasan V, Irving EL, Bobier WR. Effect of heterophoria type and myopia on accommodative and vergence responses during sustained near activity in children. Vis Res 2012;57:9-17.**

The primary objective of this study was to evaluate the relationship between phoria type and myopia on changes to vergence and accommodation during near-task attention. Upon evaluation, 53 children (ages 7-15) were placed into corresponding categories according to their near phoria (esophoria  $> 2$  prism diopters, normal, exophoria  $> 4$  prism diopters) and cycloplegic refraction. Measures of near phoria and binocular and monocular accommodation were quantified before and at repeated intervals while the subjects attended to a near task at 33 cm for 20 minutes. Adaptations in vergence and accommodation were determined through shifts in the tonic near phoria and tonic accommodation respectively.

Results of the study demonstrated that emmetropic exophores manifest convergent adaptation whereas their esophoric counterparts exhibit more divergent postures following prolonged fixation. For all phoria types, myopic children exhibited larger divergent shifts compared to emmetropic children. Both myopic and emmetropic children showed an increase in tonic accommodation with myopic children

showing a greater adaptation compared to emmetropes. Additionally, exophores demonstrated greater binocular accommodative response when compared to esophores who showed greater monocular accommodative response. Monocular accommodative response remained fairly stable between all groups. On the whole, accommodative lags were higher in myopes than emmetropes. Although these patterns of adaptation define differences between myopes and emmetropes, they do not explain myopic patients' AV/A ratios, thought to contribute to myopia progression.

**Gwaizda J, Deng L, Dias L, et al. Association of education and occupation with myopia in COMET parents. *Optom Vis Sci* 2011;88:1045-53.**

The purpose of this study was to examine the refractive error and the educational level and occupation of parents of myopic children who were enrolled in a study on myopia.

In this study, myopia was defined as the spherical equivalent refraction (SER) of  $< -0.75D$ , while hyperopia was defined as a SER  $> 1.0D$ . 627 parents of 469 myopic children ranging from ages 6 to  $<12$  provided refractive data based on non-cycloplegic autorefraction (85% of parents) or the most recent spectacle prescription (15% of parents). Parents were asked their highest level of education completed, ranging from 'did not complete high school' to 'completed graduate or professional school'. Parents were also asked their primary or lifetime occupation, ultimately placing them into three categories: white collar, blue collar, or other (mainly homemakers). The data was obtained at four clinical centers: New England College of Optometry, University of Alabama at Birmingham School of Optometry, University of Houston College of Optometry, and Pennsylvania College of Optometry.

This study found that 60.93% of parents were myopic, 36.04% were emmetropic, and 3.03% were hyperopic. There was also a correlation between myopia and level of education; myopia increased as level of education increased. Similarly, parents who did not finish high school were significantly less myopic. In addition, parents in white-collar jobs were significantly more myopic than parents in blue-collar jobs. However, because of the nature of the recruitment materials, the results of this study cannot be generalized beyond this sample.

Researchers cautioned that the high prevalence of myopia, 60.93%, which is double the prevalence found in American adults, may possibly be explained by a higher inclination on the part of myopic parents to participate in the study for the sake of finding a preventative treatment for their myopic children.

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*READING*

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**Dixon D, Taub MB, Hoenes R, Maples WC. A comparison of short and long reading passages in symptomatic vs. asymptomatic subjects. *Optometry* 2012;83:101-6.**

The ReadAlyzer is an objective test that measures eye movements while reading and was used in this study. This study was conducted to evaluate whether or not passage length affects reading performance. Secondly, the study also sought to determine whether or not the College of Optometrists in Vision Development Quality of Life (COVD-QOL) questionnaire results correlate with ReadAlyzer results.

The study recruited 40 Southern College of Optometry students who previously had a comprehensive eye exam at the college who were free of amblyopia, strabismus, nerve palsy and/or nystagmus.

The subjects first filled out the COVID-QOL questionnaire. Students were broken up into two groups according to their score on the survey; if scoring below 15 or above 23, subjects were assigned to the asymptomatic group or symptomatic group respectively. Subjects who scored between 15 and 23 were excluded from the study. There were 20 students placed in each group. Each subject was given the same short passage (100 word) and same long passage (800 word), to read. The order in which the subjects read the passages was randomized to reduce fatigue.

Statistical analysis indicated a significant difference between using a short and long paragraph in both asymptomatic and symptomatic patient groups combined. In other words, both groups had more difficulty reading the long passages. There was no significant difference when comparing the symptomatic to the asymptomatic groups. The study was not able to answer whether the COVID Quality of Life questionnaire results correlated with ReadAlyzer results. This may be because the questionnaire is not specific to oculomotor dysfunctions, but instead assesses the overall vision system and how it affects the patient.

When using this test clinically, inclusion of a long passage with the ReadAlyzer should be considered in order for the test to be a more sensitive tool and to mimic more “real-life” situations.

**Chanceaux M, Vitu F, Bendahman L, et al. *Word processing speed in peripheral vision measured with the saccadic-choice test. Vis Res 2012;56:10-9.***

This article reviews word processing speed in peripheral vision. Researchers developed a saccadic choice- test, divided into two parts; one in which the subject had to detect an animal in a scene from a distractor with no animal, and second, in which the subject had to detect a five letter word from a distractor (a nonsense 5 letter word). The words used in this study were 5-letter words, all with high-frequency use, were printed in a font greater than critical print size, and not flanked by other words.

Eighteen subjects ranging in age from 21-29 participated in this study. Subjects’ eye movements were analyzed with an eye movement recording device. This study found that the saccadic latency to detect the animal stimuli was 120-130ms. However, saccadic latency to the word detection took about 200ms. Also accuracy levels were poor for the word/non-word detection (74%) compared to 92% for the animal/non-animal detection tasks. This study also found that there was a greater difficulty in processing words in the visual periphery.

Based on the results of this study, the authors conclude that peripheral word processing must be too slow to guide eye movements.

**Nahar NK, Gowrisankaran S, Hayes JR, Sheedy JE. *Interactions of visual and cognitive stress. Optometry 2011; 82: 689-696.***

Eyestrain is a frequent manifestation and complaint during prolonged near visual tasks. While measures of eyestrain typically are based on subjective symptom questionnaires, the use of electromyography (EMG) can be used as an objective measure of discomfort, by gauging the activity of the orbicularis oculi muscle. Previous studies have shown that EMG measurements from the orbicularis oculi can be a sensitive measure of eyelid squint, and that visually stressful conditions during reading caused an increase in the orbicularis oculi activity.

This study was designed to test the effects of visual and cognitive stress using EMG, by assessing the ocular and muscular responses to long duration reading. Thirty-five subjects (ages 18-30), all with 20/20 vision and no history of ocular pathology, participated in the study. Subjects read under varying visual and cognitive difficulty levels for 30 minute intervals. Visual test conditions included: high contrast, induced astigmatism and low contrast. Cognitive stress levels were tested by video viewing (no stress condition) to easy reading (low stress condition) to difficult reading (high stress condition). Electrodes were placed on the upper and lower orbicularis oculi, frontalis, and trapezius

muscles. Eyelid aperture size, pupil diameter and pulse rate were monitored with a video camera, pulse meter, and ISCAN eye tracker respectively.

The results demonstrate that reading with induced refractive error caused increased orbicularis oculi EMG magnitude and reduced aperture size, indicating an eyelid squint. For low contrast conditions, no change in orbicularis oculi EMG was noted. Both, increasing the cognitive load and decreasing the contrast revealed a trend for increased aperture size, and a decreased magnitude of the orbicularis oculi EMG. In addition, there was no statistical difference in pulse rate, pupil diameter, or EMG activity of the frontalis and trapezius muscles between the different conditions in the study. The results suggest that visual stress may be mediated by two different mechanisms: a local mechanism, for induced refractive error, and a central mechanism that counteracts the local mechanism with high cognitive demand.

***Kwoon MY, Legge GE. Spatial-frequency requirements for reading revisited. Vis Res 2012;62:139-47.***

The goal of the study was to ask whether the spatial-frequency requirement for rapid reading is related to the effects of cutoff frequency on letter recognition and the size of the visual span. The authors' hypothesis was that reading speed is closely linked to the size of the visual span.

The study involved 7 subjects from the University of Minnesota. All subjects were native English speakers with normal or corrected to normal acuities and with normal contrast sensitivity. Subjects participated in both trigram (random string of 3 letters) and reading speed tasks for the central vision condition. A separate group of 5 subjects with similar prerequisites as above (normal acuities, contrast, etc.) were tested in the trigram and reading speed tasks for peripheral viewing. Images were blurred using a filter at cutoff frequencies from 0.8 cycles per letter (CPL) to 8 CPL.

The results of the study showed that as cutoff frequency increased the peak values of the profiles became larger. The peak values of profiles in peripheral vision were smaller than those in central vision for the same frequency. The average critical cutoff for the size of the visual span was 1.37 CPL for central vision and 2.03 CPL for peripheral vision. Above these cutoff values, the size of the visual span is independent of the cutoff spatial frequency. Reading span also increased with increased cutoff frequency. Reading speed in peripheral vision was significantly slower than central vision across all cutoff frequencies.

In conclusion, the current study found that the spatial frequency requirements for reading are similar for the requirements for the size of the visual span and single letter. Both the size of the visual span and reading speed increased with increasing cutoff frequency up to the cutoff of 1.4 CPL. These results are consistent with the hypothesis that the visual span plays a limited role in reading speed. The researchers note that reading could tolerate increased blur until a point at which letter recognition becomes sensitive to letter contrast. At this point, the size of the visual span shrinks and reading speed decreases.

***Kao CH, Chen CC. Seeing visual word forms: spatial summation, eccentricity and spatial configuration. Vis Res 2012;62:57-65.***

This study was performed in order to determine what type of information the human visual system uses in order to recognize and process words. In the study, Chinese characters were manipulated in four different ways in order to test what effects visual information had on the visual system. The four types of characters included in the study were real characters, non-characters, Jiagu characters (an old character form), and scrambles (nonsense). Researchers wanted to determine if it was the relationship between components of a word or familiarity of the words themselves that leads to

spatial recognition. Researchers postulated that if the recognition mechanism used to process information was based on the configuration of word components, then Jiagu characters should be detected on par with characters but at a lower threshold than scrambles. If the recognition mechanism were based on component familiarity, then the threshold for character and non-characters should be lower than for Jiagu characters. Researchers also examined cortical magnification by placing targets at different retinal eccentricities.

A two alternative forced choice set up was used for experimentation in order to determine threshold. In the detection task, a stimulus was presented at 1,2,4 and 8 degrees on one side of fixation while there was no target on the other side. The observer had to identify the side where the stimulus was located. The discrimination task involved 2 targets of the same size being shown, on either side of fixation; subjects were required to identify one of the 2 characters as the real character. Results showed that detection thresholds were equal for all 4 types of characters for the same stimulus size and eccentricity. This finding implied that the detection mechanisms depend on the local features of the word. For the discrimination task, the threshold for determining real and non-characters was higher than for discrimination between real/Jiagu characters and scrambles. These findings suggest that the discrimination mechanism is not sensitive to the spatial configuration of the components, but the familiarity of the components themselves.

**Lawton, T. Improving magnocellular function in the dorsal stream remediates reading deficits. *Opt Vis Dev* 2011 42:142-54.**

The purpose of this study was to determine the effectiveness of Direction Discrimination Training (DDT) on dyslexic children's reading rates. In addition to reanalyzing two previous studies on DDT training in dyslexics, another study, the Increased Complexity Study (ICS), was conducted. This new study involved training with more complex stimuli and in increased frequency of training than used in prior studies. The DDT training was followed by computer based reading speed task.

The DDT task involved the correct identification of the movement of a vertically oriented pattern surrounded by a vertically oriented sine wave grating. After each correct response, the test grating's contrast was decreased to determine threshold. The reading task involved the presentation of grade-appropriate lines of lines of text presented on a computer, 6 words at a time. The words were displayed for decreasing time intervals to correspond to increased reading rate.

Subjects included 6 children in the follow up study and 3 children in the ICS.

The results shows an improvement in dyslexic children's reading rates with more intensive training on direction discrimination. Reading rates increased with an increase in the number of training sessions and an increase in background pattern complexity. Spelling, word identification and comprehension also improved. These researchers found that the improvements in reading skill only happened if reading was practiced after direction discrimination.

This study supports that DDT training can improve direction-selective magnocellular neurons in the dorsal stream, which are thought to be "sluggish" in dyslexic individuals. As a result, the neural timing of dorsal stream is improved and it further facilitates linkage with the ventral stream to improve reading skills, figure/ground discrimination, processing speed, and attention. More importantly, it was found that these developments were sustained over time.

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*SACCADES*

**Kim EH et al. The frequency of horizontal saccades in near and far symmetrical disparity vergence. *Vis Res* 2012;63:9-19**

The purpose of this study was to identify whether the frequency of horizontal saccades during symmetric vergence movements depends on the vergence velocity. Saccades are considered a type of version, or conjugate, eye movement. Convergence and divergence are types of eye movements that are considered disconjugate, or vergence, that move the eyes inward or outward.

This study included 10 subjects, five male and five female. The subjects averaged 22.9 years of age, and had no history of brain dysfunction or injury. All subjects had stereopsis of 50 seconds of arc, with a near point of convergence of 6cm or less. The test stimuli consisted of a symmetrical disparity vergence target, placed on the subject's midline. Stimuli included near and far convergence and divergence steps.

The results of the study include:

1. The peak velocity of the responses vary depending on the initial vergence angle and direction of vergence. Average convergence peak velocities from a near vergence angle were slower than those from a far angle. In contrast, average divergence peak velocities were slower than those from a near angle.
2. A greater percentage of saccades was found with vergence responses with reduced peak velocities (i.e. near convergence and far divergence).
3. The average onset of time of initial saccades in convergence responses occurred later than that for divergence responses.

The authors speculate that the initial saccades generated enhance the vergence movement in the transient phase. They also speculate that there is an increased duration of diplopia during slower movements which may stimulate saccades. The authors further speculate that once reason for the relationship between vergence peak velocity and the initial vergence angle is due to a greater initial vergence angle range than previous studies. They also note that their study supports an interaction between the vergence and saccadic subsystems.

**Orlansky G, Hopkins KB, Mitchell GL, Huang K, et al. Reliability of the Developmental Eye Movement Test. *Optom Vis Sci* 2011;88:1507-19**

The Developmental Eye Movement (DEM) test is an objective test that uses the visual-verbal format to assess a patient's saccadic eye movements in order to assess his/her ability to use eye movements accurately for reading. This study looked at the reliability of the DEM. 181 children from ages 6 years, 0 months to 11 years 11 months participated in the study. All subjects had normal binocular and accommodative status, visual acuity of 20/25 or better in each eye, and no known diagnosis of ADHD or learning disabilities. Subjects were administered 3 different versions of the DEM at an initial visit and the same 3 versions at a subsequent visit 1-4 weeks later. Vertical, horizontal, ratio and horizontal error scores were all compared within and between each visit. Children were classified as failed, borderline or passed based on the percentile ranks from the DEM Manual.

The study found that vertical and horizontal adjusted times within sessions and between sessions were repeatable. The ratio scores however showed an improvement within sessions with only 47% of children staying in the same classification group. This improvement points towards a learning effect. Horizontal error scores also fluctuated greatly and only 38% of children remained in the same category within the same session.

The ratio and error scores are those used most frequently to monitor the progress of children in vision therapy programs for saccadic dysfunctions. The variations between sessions indicate that around 44% of children based on ratio scores and 31% based on error scores would change classification without any intervention. This study demonstrates that the ratio and the error portion of the DEM should be

used with caution in diagnosing and monitoring the progress of children with oculomotor dysfunctions.

### *SPECIAL NEEDS*

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**Bodack MI. Eye and vision assessment of children with special needs in an interdisciplinary school setting. *Optom Vis Dev* 2011;42:220-6.**

This study involved a retrospective chart review of 221 children examined at an optometric clinic at the Herbert G. Birch Early Childhood Center in Queens, New York, over a 3 year period of time. This clinic was established at the request of occupational therapists at the center. Students included children ages 3 to 5, with developmental delays including autism, Down Syndrome, and Cerebral Palsy.

Previous studies have found that up to 60% of patients with Cerebral Palsy patients have optic neuropathies because of damage to the cerebral visual pathway. Hyperopia, accommodative issues and strabismus are more common in these patients. Patients with Down Syndrome have been found to have an increased incidence of strabismus, hyperopia, and accommodative disorders. Patients with Autism commonly have sensory hypersensitivities which may play a significant role in how patients respond during testing.

The majority of patients, 74-84%, were able to complete VA testing, while 1-6% were not responsive to any test (i.e. matching pictures, Cardiff). Thirty two percent of the children had autism spectrum disorder. Eleven percent of the children examined were prescribed glasses. Of the patients with Cerebral Palsy, all were responsive to the picture chart used for visual acuity. Of the patients with Down Syndrome, only one had a low refractive error that did not require vision correction. Sixty percent of the patients with Down Syndrome had strabismus.

Benefits of the program included the facilitation of follow-up care for children. Additionally, the therapists learned about vision problems in these children, and were better able to recognize potential problems and get the child the appropriate care. Disadvantages of the program included a lack of parental involvement, which could affect compliance with treatment and understanding of the diagnosis.

### *STEREOPSIS*

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**Yang, SN, Schlieski T, Selmins B, et al. Stereoscopic viewing and reported perceived immersion and symptoms. *Opt Vis Sci* 2012; 89; 1068-80.**

The study examined the prevalence and magnitude of perceived immersion and symptoms in tasks of 2 dimension (2D) and 3 dimension (3D) and relates these values to viewers' characteristics and viewing position.

Two hundred and three teens and adults age 13 years and older were recruited to participate in the study. Subjects were required to view a movie in either a 2D or 3D format from a Blu-ray DVD, from the same distance but at different angles. A 17-item questionnaire measured the subjective viewing symptoms before, during and after movie viewing. Additionally, a 4-item questionnaire assessed subjects' previous 2D viewing experiences, and a 5-item questionnaire measured the viewers' sense of immersion. A comparison of the symptoms in viewing 2D and 3D movies at different visual angles and distances was made.

This study showed that both 2D and 3D viewing conditions resulted in similar increases in torsion/pulling in the eyes, neck aches and double vision after movie viewing. The 3D condition resulted in greater symptoms than the 2D condition. Symptoms included pain and a pulling sensation inside the eyes, blurred vision during and after viewing, dizziness during viewing and disorientation during and after viewing. Subjects less than 35 years of age had greater vision and motion sickness symptoms for 3D viewing than older subjects. Subjects greater than 46 years of age had greater vision, ocular and motion sickness symptoms for 2D viewing.

Researchers suggested that problems with 3D glasses or vergence responses could contribute to these findings, and that younger patients may be more susceptible to a greater vergence demand.

## *STRABISMUS*

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### **Silbert AL, Matta NS, Silbert DI. Incidence of strabismus and amblyopia in preverbal children previously diagnosed with pseudoesotropia. J Am Acad Ped Ophthal Strab 16:2:118-119**

The purpose of this retrospective study was to determine how many children previously diagnosed with pseudoesotropia before 3 years of age actually developed strabismus or amblyopia.

Records from January 1, 2001 to February 26, 2010 were reviewed for all children diagnosed with pseudoesotropia seen by the same pediatric ophthalmologist. Inclusion criteria were normal refractive error and ocular alignment (according to American Association for Pediatric Ophthalmology and Strabismus criteria), and age <36 months at the time of the first exam. A comprehensive examination was performed on all children including cycloplegic refraction and a routine follow-up was scheduled in 6 months and again at 3 years of age.

Out of a total 1,249 charts coded as esotropia, 394 (32%) of them were coded as pseudoesotropia but only 306 met the inclusion criteria. Of the 306 children, 201 (66%) returned for their scheduled follow-up. A total of 25 children (12%) were found to have strabismus or refractive amblyopia at their follow-up: 20 children (10%) developed strabismus (15 esodeviation, 3 exodeviation, 1 duanes, 1 Prader-Willi syndrome + esotropia) and 5 children (2%) developed mild refractive amblyopia. Results of this study were similar to a previous study by Pritchard and Ellis that showed 12% of patients with pseudostrabismus develop a true strabismus.

The prevalence of strabismus in those diagnosed with pseudoesotropia (10%) is significantly higher than the prevalence in the general population (2.1- 3.3%). Hence, it is extremely important to perform closer follow-up on all children diagnosed with pseudoesotropia because of their higher risk to developing strabismus and amblyopia at a later age.

## *VERGENCE*

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### **Goss D, Becker E. Comparison of near fusional vergence ranges with rotary prisms and with prism bars. *Optometry* 2011;82,104-7.**

This study compared the results of fusional vergence testing with rotary prisms in the phoropter and prism bars out of the phoropter. Fifty subjects, age 18-35, with corrected visual acuity of at least 20/20, no ocular pathology, no strabismus, and no obvious binocular vision problems, were split into two groups. The first group performed rotary prism testing before prism bar testing while the second group performed prism bar testing before rotary prism testing. All tests were done with a near target placed at 40 cm. Base-in vergence testing was performed before base-out testing. Test subjects were asked to report blur, break, and recovery for each condition.

The results show that the average prism bar vergences were higher than those for rotary prism vergences. The difference was greater for base-out than base-in. The researchers hypothesized that the differences could be due to: greater peripheral input when using prism bars; non-continuous increase in prism power using the prism bar, and the possible occurrence of a saccade with prism bar testing.

The researchers concluded that it is not appropriate to substitute vergence ranges determined using prism bars with those determined using rotary prisms when tracking patients during follow-up visits or for comparing with norms.

### **Kim EH, Granger-Donetti B, Vicci VR, Alvarez TL. The relationship between phoria and the ratio of convergence peak velocity to divergence peak velocity. *Invest Ophthalmol Vis Sci* 2010;51, 4017-4027.**

The main objective of this study was to investigate the relationship between phoria and vergence dynamics described by the ratio of convergence average peak velocity to divergence average peak velocity.

Twelve subjects (ages 18-29) with normal binocular vision (as assessed by Randot stereopsis and near point of convergence testing) participated in this study. One subject was esophoric, two were orthophoric and nine were exophoric at their initial baseline phoria assessment. The dissociated near phoria was measured subjectively using a Maddox rod with Bernell muscle imbalance card, and objectively using an infrared limbus tracking system. The subjects binocularly viewed a pair of vertical lines placed at a distance of 40cm, which equated to a 2.5 D accommodative demand.

For the first experiment, subjects were dark adapted for 5 minutes and an initial baseline phoria measurement was obtained. After the initial measurement of phoria, vergence steps were measured in midline range, then at near and distance ranges. After each range, a phoria measurement was obtained.

This experiment examined the relationship between baseline phoria, associated phoria, and the change between the two.

The second experiment (sustained fixation task) required subjects to fixate on convergent targets at different distances. After each distance, the phoria was measured, then the subject was dark adapted 5 minutes and the phoria was measured again.

The results of this study showed that the baseline and adapted phoria were significantly correlated to vergence peak velocity ratio, but changes in phoria were not correlated to baseline. The study found that the amount of change in phoria (adapted minus baseline) was independent of the baseline phoria, indicating that baseline phoria level was independent of phoria adaptation.