

414 Amblyopia II

Wednesday, May 10, 2017 8:30 AM–10:15 AM
Room 324 Paper Session

Program #/Board # Range: 3823–3829

Organizing Section: Eye Movements/Strabismus/Amblyopia/Neuro-Ophthalmology

Program Number: 3823

Presentation Time: 8:30 AM–8:45 AM

An Evaluation of a School-Based Screening Program to Detect Amblyopia and Refractive Errors in Kindergarten Children

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Purpose: Some 10% of kindergarten children have undetected refractive errors and 3-5% need treatment to prevent amblyopia. In many jurisdictions, there is no universal screening program to detect these problems. We evaluated a school-based program for kindergarten children (aged 3-6) in 28 schools throughout Ontario.

Methods: Screening involved 5 tests (Cambridge crowding cards, Preschool Randot, Plusoptix S12 autorefractor, Spot autorefractor, Pediatric Vision Scanner), which took 10-15 minutes per child with a team of 5 screeners. Any child who did not pass all 5 screening tests was referred for an optometry exam with cycloplegia at school, with a parent or guardian present. If glasses were needed, they were dispensed at no cost. 2529 kindergarten children (aged 3-6 years) were screened. In Study 2, we further evaluated the efficacy of the in-school program by comparing the number of glasses prescribed through our vision checking program in 3 experimental schools (n = 581 kindergarten children) to the number of glasses prescribed in 3 comparable schools (n = 661 kindergarten children) where we did not offer our program (i.e. how many cases are detected by the status quo?). Data were analyzed using descriptive measures.

Results: 46% of the children passed screening and 54% were referred for optometry exams. 94% of parents of the referred children returned the consent form for the follow-up appointment, with 83% consenting to the in-school optometry exam. Most (80%) parents who opted out indicated that the child had already seen an eye doctor. As a result of the optometry exams, 7.2% of the screened children were discovered to have amblyopia risk factors (of which 5.3% were newly discovered) and 6.6% to have significant refractive errors (of which 4.6% were newly discovered). Results from Study 2 indicated that in the 3 control schools the number of children wearing glasses increased from 15 cases at the beginning of the school year to 20 cases by the end of the year (33% increase). In comparison, in the 3 experimental schools where we offered the program, the number of children wearing glasses increased from 14 cases at the beginning of the year to 56 cases by the end of the year (300% increase).

Conclusions: Both studies suggest that a school-based vision screening program can be effective in detecting eye problems that might otherwise be missed in children before Grade 1.

Commercial Relationships: Mayu Nishimura, None;

Daphne Maurer, None; Agnes M. Wong, None

Support: CIHR/NSERC Collaborative Health Research Projects

Program Number: 3824

Presentation Time: 8:45 AM–9:00 AM

Amblyopia in children with high AC/A ratio esotropia

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Purpose: To investigate the effect of high AC/A ratio esotropia on visual acuity in children with deviation only at near and its relationship with the use of bifocal glasses

Methods: We reviewed the charts of 78 children (aged 3-8 years old) diagnosed of high AC/A ratio esotropia with deviation only at near with glasses (orthophoria or only esophoria at distance). Visual acuity (HOTV LogMAR or ETDRS), stereoacuity at near, deviation angle at distance (6 m) and near (35 cm), cycloplegic retinoscopy, and anterior and posterior segment routine examination were carried out. Only patients with at least 1 year of followup were eligible. Patching was used for the treatment of amblyopia. We employed multiple regression to control for potential confounders.

Results: Of 78 children, 61 were eligible. All patients wore single vision glasses until evaluation 2 months after initial visit. Thereafter, 46 wore bifocals, whereas 15 of them wore single vision glasses. Twenty-seven patients were diagnosed with amblyopia at initial visit. Twenty-one remained amblyopic after 2 months of wearing single vision glasses. In this group, 13 children used bifocals after the 2-month visit and 8 of them continued with single vision glasses. Improvement of visual acuity in the amblyopic eye was larger in the bifocal vs single vision group after adjusting for initial deviation, refraction, age, and amblyopia, at 6 months (2.6 vs 2 logMAR lines, p=0.01; 1.4-fold rate) but not at 1 year (2.6 vs 2.3 logMAR lines, p=0.3). Improvement of stereoacuity was not significantly different between the two groups at 6 months (-0.39 logarcsec vs -0.31 logarcsec p=0.2) and 1 year (-0.41 logarcsec vs -0.38 logarcsec, p= 0.5).

Conclusions: High AC/A ratio esotropia may cause amblyopia in children with deviation only at near. Use of bifocals could help in the treatment of amblyopia at least initially, whereas it does not have influence on binocularity outcome.

Commercial Relationships: Jaime Tejedor; Francisco

J Gutiérrez-Carmona, None

Support: MINECO UAMA13-4E-2192

Program Number: 3825

Presentation Time: 9:00 AM–9:15 AM

Adultlike Sensitivity to Curvatures of V2 Neurons in Infant Monkeys

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Purpose: Non-human primates can discriminate texture-defined form as early as 6–8 weeks of age despite their relatively low visual acuity. The neuronal mechanisms underlying this remarkable visual capacity have not been extensively studied. Based on the findings that the receptive-field subunits of V2 neurons is as complex as in adults and the ability of V2 neurons to compare local features of neighboring stimulus elements is nearly adult like, our previous study implied that V2 neurons in infant monkeys could encode angles or curvatures. In this study we tested this idea more directly by using two-dimensional dynamic noise stimuli and a new analytical method called “Transform Domain Reverse Correlation (TDRC)”.

Methods: Unit recordings were made in V2 of anesthetized infant macaque monkeys (4 and 8 weeks) and adult monkeys. In TDRC analysis, two neighboring regions in the 2D noises are filtered by Gaussian windows and transformed into the spatial frequency domain. For each region, the amplitude spectra within certain frequency band was integrated along all orientations, and the joint distribution of orientations of the two regions were computed as the product the amplitudes for all pairs of orientations. A further

coordinate transformation mapped the data from the double orientation domain into the curvature-direction domain. Finally, the spike-triggered analysis is performed between the spikes and transformed stimuli in curvature-direction domain. The resulting map reveals the stimulus selectivity of individual neurons for angled or curved contours.

Results: As early as 4 weeks of age, about 40% of V2 neurons in non-human primates were sensitive to angled or curved contours in image sub-regions. The percentage of neurons that were sensitive to curvatures was similar in infants and adults. Moreover, there was no bias in optimal curvature direction in any age groups. The optimal curvature tuning width, the signal strength, and reliability (Z_{max}) for infant neurons were not significantly different from that for adults. Only the variance of curvatures of subunits for infant monkeys was lower in infants than in adults.

Conclusions: Our results provide a physiological substrate for the aforementioned perceptual finding that infant monkeys are capable of discriminating texture-defined visual borders as early as 6 weeks of age.

Commercial Relationships: Bin Zhang, None; Ye Wang, None; Xiaofeng Tao, None; Guofu Shen, None; Earl L. Smith, None; Izumi Ohzawa, None; Yuzo M. Chino, None

Support: R01 EY-008128 (YC), R01 EY-003611 (ES), and P30 EY-007551 (CORE) MEXT grants: KAKENHI 22135006 and 15H05921 (IO)

Program Number: 3826

Presentation Time: 9:15 AM–9:30 AM

The Role of Interocular Suppression in the Etiology of Amblyopia and its Response to Treatment

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Purpose: Recent psychophysical and animal model data have given rise to the hypothesis that amblyopia develops as a result of interocular suppression (IOS). This hypothesis is indirectly supported by reports that visual acuity and binocular vision can be improved with contrast-balanced binocular therapy designed to reduce IOS. To further test the hypothesis that IOS causes amblyopia, we determined whether (1) IOS precedes the development of amblyopia, (2) children who have persistent IOS despite successful treatment are at risk for recurrence of amblyopia, and (3) IOS is reduced by monocular and binocular amblyopia treatments.

Methods: 70 children (4–12 y) with anisometropia, esotropia, or both (alignment <4pd on day of testing) and 20 age-similar controls were tested on 4±2 visits over 16±9 months. At each visit, visual acuity was tested with ATS-HOTV or e-ETDRS, and severity of IOS was quantified with a dichoptic motion coherence task (Mansouri et al *Vis Res* 2008) or a dichoptic eye chart (Birch et al *IOVS* 2016) and expressed as the contrast ratio (CR) at which IOS was alleviated.

Results: Of 46 children who were nonamblyopic at their initial visit, 23 developed amblyopia during follow-up. Mean (±SE) CR was elevated relative to controls prior to the onset of amblyopia (3.95±0.60 vs 0.97±0.06; $t_{41}=4.61$; $p<0.0001$) and compared to the 23 children who remained nonamblyopic throughout follow-up (1.22±0.08; $t_{44}=4.51$; $p<0.0001$). Among the children who developed amblyopia were 8 children with no prior history of amblyopia (initial visit CR=4.38±1.17) and 15 with recurrent amblyopia (initial visit CR=3.80±1.50). 42 amblyopic children recovered normal visual acuity with treatment. While amblyopic, CR was 3.54±0.41, but improved to 2.73±0.41 following recovery ($t_{41}=2.10$; $p=0.042$). Post-recovery CR for children who received binocular treatment

($n=20$; contrast-balanced iPad games or dichoptic movies) was 1.95±0.52 and CR for children who were treated with patching was 3.54±0.60 ($n=21$; $t_{39}=1.99$; $p=0.053$).

Conclusions: IOS is present prior to the onset of amblyopia and diminishes when amblyopia resolves with treatment. IOS poses a risk for recurrent amblyopia if it persists when visual acuity recovers. These results provide additional support for the hypothesis that IOS plays a key role in the etiology of amblyopia and that treatments designed to reduce IOS can improve visual acuity and binocular vision.

Commercial Relationships: Eileen E. Birch, None;

Krista R. Kelly, None; Reed Jost, None; Angie De La Cruz, None

Support: NIH Grant EY022313

Program Number: 3827

Presentation Time: 9:30 AM–9:45 AM

Binocular outcomes following binocular treatment for childhood amblyopia

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Purpose: Childhood amblyopia can be treated with binocular games or movies that rebalance contrast between the eyes, which is thought to reduce depth of interocular suppression so the child can experience binocular vision (Birch et al., 2015; Li et al., 2015). We recently found that two weeks of binocular games improved visual acuity more than patching (Kelly et al, 2016). Yet, stereoacuity improvement did not accompany the visual acuity improvement. Here we evaluate additional binocular outcomes.

Methods: 47 amblyopic children (4–12y; ≤4pd) assigned to binocular treatment [movies ($n=29$) or game ($n=18$)] were compared to 19 amblyopic children assigned to 2 h/d patching. Amblyopic eye best-corrected visual acuity (BCVA) and binocular outcomes were assessed at baseline and 2 weeks, after 9–10 h binocular or 28 h patching treatment. *Binocular outcomes:* dichoptic contrast ratio balance point (CR; depth of suppression), Worth-4-Dot (W4D at 7 distances; extent of suppression scotoma), Randot Preschool stereoacuity (RPS).

Results: Mean±SD BCVA improved by 1.4 lines with binocular treatment (0.56±0.29 vs 0.42±0.28 logMAR; $t=10.04$, $p<0.001$) and 0.7 lines with patching (0.50±0.15 vs 0.43±0.17 logMAR; $t=3.64$, $p=0.002$); i.e., binocular treatment was more successful than patching ($t=2.71$, $p=0.009$). *Depth of suppression (CR)* improved with binocular treatment (baseline: 4.63±3.41 vs 2 week: 3.41±2.66; $t=3.81$, $p<0.001$) and patching (4.71±3.08 vs 3.04±2.07; $t=2.85$, $p=0.012$). For binocular treatment, CR improved more for children <7 years than children ≥7 years old ($t=2.38$, $p=0.029$). BCVA was correlated with CR at baseline ($r=0.39$, $p=0.007$) and at 2 weeks ($r=0.38$, $p=0.008$). *Extent of suppression* improved with binocular treatment (baseline: 0.53±0.41 vs 2 week: 0.41±0.44 log deg; $t=2.98$, $p=0.005$), but not with patching (0.36±0.33 vs 0.23±0.45 log deg; $t=1.54$, $p=0.14$). *Stereoacuity* improved with binocular treatment (baseline: 3.56±0.76 vs 2 week: 3.47±0.77 log arcsec; $Z=2.00$, $p=0.045$), but not with patching (3.21±0.88 vs 3.30±0.79 log arcsec; $Z=1.35$, $p=0.18$).

Conclusions: Contrast-rebalanced binocular treatment was not only successful in ameliorating the visual acuity deficit in childhood amblyopia, but also improved binocular outcomes more than patching, reducing the extent and depth of suppression and improving stereoacuity.

Commercial Relationships: Krista R. Kelly, None; Reed Jost, None; Eileen E. Birch, None

Support: Thrasher Research Fund 12954; National Eye Institute EY022313

Program Number: 3828

Presentation Time: 9:45 AM–10:00 AM

A Randomized Trial of a Binocular iPad Game Versus Part-Time Patching In Children 13 To 16 Years Of Age With Amblyopia

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Purpose: To compare visual acuity (VA) improvement in teenagers with amblyopia treated with a binocular iPad game versus part-time patching.

Methods: One hundred participants aged 13 to <17 years (mean 14.3 years) with amblyopia (20/40 to 20/200, mean ~20/80) resulting from strabismus, anisometropia, or both were enrolled into a randomized clinical trial. Participants were randomly assigned to treatment for 16 weeks of either a binocular iPad game prescribed for 1 hour per day (N=40) or patching of the fellow eye prescribed for 2 hours per day (N=60). The main outcome measure was change in amblyopic eye VA from baseline to 16 weeks, assessed by a masked observer.

Results: Mean amblyopic eye VA improved from baseline by 3.5 letters (2-sided 95% confidence interval (CI): 1.3 to 5.7 letters) in the binocular group and by 6.5 letters (2-sided 95% CI: 4.4 to 8.5 letters) in the patching group. After adjusting for baseline VA, the treatment group difference was -2.7 letters (95% CI: -5.7 to 0.3 letters) or 0.5 lines, favoring patching treatment. 62% of participants in the binocular group and 75% of participants in the patching group reported completing >75% of prescribed treatment. However, objectively recorded compliance data in the binocular group revealed that only 13% of participants actually completed >75% of the prescribed treatment (median percentage of prescribed treatment completed 21%, interquartile range 13% to 38%).

Conclusions: In teenagers aged 13 to <17 years, amblyopic eye VA improved minimally with the binocular iPad game used in this randomized clinical trial, but treatment adherence was poor.

Commercial Relationships: Vivian Manh, None;

Jonathan M. Holmes, None; Elizabeth L. Lazar, None;

Raymond Kraker, None; David K. Wallace, None;

Marjean T. Kulp, None; Jennifer Galvin, None; Birva Shah,

None; Patricia L. Davis, None

Support: EY011751, EY023198, and EY018810

Clinical Trial: NCT02200211

Program Number: 3829

Presentation Time: 10:00 AM–10:15 AM

A dichoptic augmented-reality paradigm as a treatment for adult amblyopes

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Purpose: Previous studies have shown that amblyopic patients had structurally intact binocular vision that manifested functionally monocular by suppression and plenty of evidences pointed out that binocular therapy might be effective for adults. We used a novel dichoptic paradigm implemented in augmented-reality (AR) platform to investigate the efficacy of the novel contrast-rebalance paradigm of daily take-home activities in restoring visual function and stereopsis of amblyopic eyes in adults.

Methods: 15 adults with monocular anisometropic amblyopia who failed in occlusion therapy were enrolled in our study. We set up a

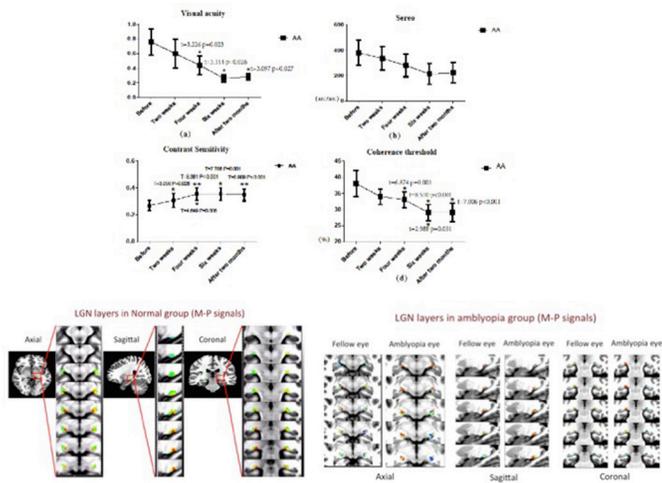
contrast-rebalance paradigm implemented in AR platform that was composed of a dual camera system with a head-mounted display and an image-processing system. Therefore, the real-world information from the cameras could be modulated and presented separately for two eyes. The original images and contrast-modulated, partially deprived images were presented in amblyopic eyes and fellow eyes respectively. Each subject was instructed to perform daily activity while wearing this AR platform at home for at least 1.5 hour a day for at least 6 weeks. Visual acuity, randot test were performed before training, after training and 2 months training. Dichoptic global motion coherence paradigm and binocular phase combination paradigm were used to quantify inter-ocular suppression. Functional magnetic resonance (fMRI) was used to investigate the functional alterations in LGN after training.

Results: The monocular acuity significantly improved in 13 patients and the stereopsis of all patients was reestablished after 6-week contrast-rebalance AR training. The degree of suppression was gradually reduced and the performance of two eyes was almost equal to each other after training. Significantly improved visual acuity, stereopsis and balanced interocular suppression still maintained at 2 months follow-up point after 6-week binocular training. FMRI showed significantly increased bold signal in LGN (especially in P layer) and V1.

Conclusions: The daily-activity-based dichoptic training with AR platform can reduce suppression and restore visual acuity as well as stereoscopic function in adult amblyopia beyond the critical period. This provides a promising treatment for adult amblyopia.



ARVO 2017 Annual Meeting Abstracts



Visual acuity, contrast sensitivity, interocular suppression and fMRI signals before and after training.

Commercial Relationships: Wen Wen, None; Xinghuai Sun, None; Hong Liu, None; Xiang Li, None