were asked to fixate on a cross subtending 0.5° at a distance of 57 cm. Interocular fixation stability was quantified by calculating the minimum-area bivariate contour ellipse (BCEA) encompassing 68% of the difference between right and left eye fixation points during a 20-second binocular viewing epoch. For statistical analysis, BCEA values were normalized by a common logarithm transformation.
Results: The amblyopic subjects with persistent vision loss (one anisometropic, two strabismic, and one deprivation; uncorrected visual acuity range 20/60-20/300) showed significantly higher interocular fixation instability (larger 68% BCEAs) than the non-amblyopic subjects (uncorrected visual acuity range 20/20-20/800), and the successfully-treated strabismic amblyope (to the 20/20 level of visual acuity); $p < 0.01$.
Conclusions: Based on our results, interocular fixation instability differentiates amblyopic from non-amblyopic subjects and improves after successful treatment. Interocular fixation instability may therefore prove to be a single sensitive test for the presence of amblyopia. As a difference measure, it is less susceptible to head motion and calibration error, as well as to conjugate eye motion, and as such is expected to be somewhat immune to latent nystagmus. Interocular fixation instability may also be used to guide treatment, especially in preverbal children and to assess the efficacy of novel treatments. Further research is required to establish optimal interocular fixation instability thresholds and to determine how specific this measure is to amblyopia.
Commercial Relationships: Kristina Irsch, pending (P); **Robert B. Geary**, pending (P); **Jing Tian**, pending (P); **David L. Guyton**, pending (P); **Boris I. Gramatikov**, pending (P); **Howard S. Ying**, pending (P)
Support: RPB Disney Award (H.S. Ying)

Program Number: 814
Presentation Time: 4:00 PM–4:15 PM
Unmasking potential brain plasticity in amblyopic vision
Zhong-Lin Lu[1], Jiawei Zhou[2], Lin Li[3], Pan Zhang[2], Jie Xi[2], Yifeng Zhou[3], Chang-Bing Huang[2]. [1]Psychology, The Ohio State Unviersity, Columbus, OH; [2]Key Laboratory of Behavioral Science, Institute of Psychology, Chinese Academy of Sciences, Beijing, China; [3]CAS Key Laboratory of Brain Function and Disease, University of Science and Technology of China, Hefei, China.
Purpose: With abnormal visual cortical development, amblyopia is generally acknowledged as a spatial vision deficit in high spatial frequencies. The deficit may however reflect high internal noise rather than absence of cortical representation of high spatial frequency signal in amblyopia. To bypass the noise limitation, we measured supratheshold tilt aftereffects (TAE) following adaption to gratings of perceptually resolvable and unresolvable frequencies in subjects with amblyopia.
Methods: Six anisometropic amblyopes (average age: 22.3±2.6 yrs; 2 females) participated in the study. Performance in grating orientation identification (tilted +15° or -15° from horizontal) was measured in eight spatial frequencies. The spatial frequencies of the adapting sinewave gratings were chosen for each observer based on performance in the orientation task. In general, 1 or 2 easily resolvable, 1 resolvable, and 2 to 3 unresolvable spatial frequencies were chosen for each observer. Observers were asked to judge the orientation of a 4 c/d test grating (clockwise or counter-clockwise from horizontal) following adaptation. Five test orientations were used in each adaptation condition based on results from pilot studies. TAE thresholds were estimated from these measurements.
Results: Adapting to gratings of resolvable spatial frequencies yielded an average TAE threshold of 1.35 ± 0.14° (Mean ± S.E.), consistent with previous reports in normal observers (He & MacLeod, 2001). What is surprising is that adapting to gratings of unresolvable spatial frequencies still yielded considerable TAE with an average effect size of 0.48 ± 0.07°. Although the TAE thresholds at unresolvable spatial frequencies were smaller than those at the resolvable spatial frequencies ($t(28)=5.35$, $p <0.01$), all the TAE thresholds were significantly greater than 0 ($p<0.05$). Averaged across observers, the ratio of the cutoff spatial frequencies in the TAE and traditional orientation identification tasks is 1.53 (± 0.08).
Conclusions: Neural connections in the amblyopic cortex, at least in V1, may have profoundly developed to represent high spatial frequency information. The demonstration of extant neural connections for high spatial frequencies therefore unmasks improvement potentials and provides a strong theoretical basis for developing new therapies for amblyopia. Our paradigm may also serve as a non-invasive probe to diagnose the status of neural connections in other clinical conditions.
Commercial Relationships: Zhong-Lin Lu, None; **Jiawei Zhou**, None; **Lin Li**, None; **Pan Zhang**, None; **Jie Xi**, None; **Yifeng Zhou**, None; **Chang-Bing Huang**, None
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Program Number: 815
Presentation Time: 4:15 PM–4:30 PM
Initial Evaluation of the Novel EFG Therapy for the Treatment of Amblyopia
Fuensanta A. Vera-Diaz[1], Gayathri Srinivasan[1], Catherine Johnson[1], Eric Hussey[2], David Spivey[3], William Gleason[4, 1], Paulette Tattersall[1], Bruce D. Moore[1]. [1]New England College of Optometry, Boston, MA; [2]Private Practice, Spokane, WA; [3]Private Practice, Ft. Worth, TX; [4]Foresight Regulatory Strategies, Inc., Wilmington, MA.
Purpose: Amblyopia is a neurological development disorder that presents with deficits in spatiotemporal vision processing resulting from an active suppression process. The current standard of care for amblyopia involves visual penalization (using patching, often for several hours a day, or atropine) of the "good", non-amblyopic, eye. We propose and evaluate an alternative treatment method that does not penalize the patient's ability to see while being treated and promotes normal binocular vision: the Eyetronix Flicker Glasses (EFG). The objective of this study is to evaluate the feasibility and efficacy of the novel EFG Therapy for amblyopia.
Methods: 20 children (ages 6-17 years) participated in this initial open-label, multi-center study. Inclusion criteria included: mild to moderate anisometropic amblyopia [difference in logMAR best-corrected visual acuity (BCVA) of 0.2 logMAR (2 lines) or more between the amblyopic and fellow eye]; amblyopic eye BCVA +0.2 to +0.7 logMAR; anisometropia of >1.00DS or >1.50DC; full-time wear of glasses with best-correction for at least 8 weeks prior to the EFG Therapy. EFG is a spectacle frame with liquid crystal lenses and an electronic shutter that allows accurate and rapid alternating rate of occlusion. For this study the EFG were preprogrammed to 7Hz, 50% duty cycle. Subjects were instructed to wear the EFG daily for 1-2 hours during near vision activities. The primary outcome measure was the change of logMAR VA in the amblyopic eye between the dispensing and 3-month visit. Secondary outcome measures included changes in stereopsis and fusion.
Results: All but one subject showed improved VA in the amblyopic eye (Mean group improvement -0.09 ± 0.10 logMAR; 1 line). This improvement was significantly larger ($p=0.04$) than the variation in VA in the non-amblyopic eye. All but two subjects improved

stereopsis. Several subjects reported improvement in daily tasks such as playing hockey.
Conclusions: Preliminary data yield promising benefit of the EFG Therapy, comparable to previous studies using patching or atropine. In addition, the improvement in stereopsis and daily activities noted in many subjects suggest that the EFG Therapy promotes the development of normal binocular vision.
Commercial Relationships: Fuensanta A. Vera-Diaz, EyeTronix Inc. (F); **Gayathri Srinivasan**, EyeTronix Inc. (F); **Catherine Johnson**, Eyetronix, Inc. (F); **Eric Hussey**, EyeTronix Inc. (F); **David Spivey**, Eyetronix, Inc. (F); **William Gleason**, EyeTronix Inc. (F); **Paulette Tattersall**, EyeTronix Inc. (F); **Bruce D. Moore**, EyeTronix Inc. (F)
Support: Eyetronix, Inc.

Program Number: 816
Presentation Time: 4:30 PM–4:45 PM
Binocular iPad treatment of amblyopia leads to lasting improvement of visual acuity
Simone L. Li[1], Reed Jost[1], Sarah Morale[1], David Stager[2], Lori Dao[3], David Stager, Jr[3], Eileen Birch[1, 4]. [1]Crystal Charity Ball Pediatric Vision Evaluation Center, Retina Foundation of the Southwest, Dallas, TX; [2]Pediatric Ophthalmology & Center for Adult Strabismus, Dallas, TX; [3]Pediatric Ophthalmology & Adult Strabismus, Plano, TX; [4]Department of Ophthalmology, University of Texas Southwestern Medical Center, Dallas, TX.
Purpose: Traditional amblyopia treatments (patching/penalization) do not always restore 20/20 vision and the recurrence rate is high within 6 months after the cessation of traditional treatment. We and others recently demonstrated the benefit of binocular treatment for amblyopia in children (Li et al ARVO 2013) and adults (Hess et al 2012, 2013). However, no data to date have determined the durability of the visual acuity improvements as a result of binocular treatment. In this study, we examined whether visual acuity improvements obtained with 4-8 weeks of binocular amblyopia treatment were maintained at 3 and 6 months after the cessation of treatment.
Methods: We assigned 11 amblyopic children to binocular iPad treatment (5-12y). All children had been wearing glasses (if applicable) for at least 3 months and had stable best-corrected visual acuity (BCVA) prior to baseline. All were instructed to play the dichoptic iPad game apps for 4 h/week for 4 weeks and 8 children continued to play the games for an additional 4 weeks. BCVA was measured at baseline, at the 4- and 8-week outcome visits, and at 3 and 6 months after the cessation of treatment. None of the 11 children patched after the cessation of treatment.
Results: At baseline, mean BCVA ±se was 0.45±0.07 logMAR (N=11; range: 0.20-0.80 logMAR). With intent-to-treat analysis, BCVA improved significantly with 4-8 weeks of binocular treatment to 0.35±0.07 logMAR (N=11; $p<0.01$; range: 0.00 to 0.70 logMAR). BCVA improvement gained during the binocular iPad treatment was maintained at 3 months post-treatment (0.37± 0.08 logMAR; N=9) and at 6 months post-treatment (0.38±0.08 logMAR; N=9). Among all children who returned for the 3- and/or 6-month post-treatment visits, only one experienced a BCVA regression (≥0.2 logMAR), likely due to measurement error because her BCVA improved by 0.1 logMAR at the 6-month post-treatment visit.
Conclusions: Binocular iPad treatment for amblyopia yielded a significant improvement in BCVA after 4-8 weeks. The obtained improvements in BCVA were maintained. Therefore, binocular iPad treatment is a promising new approach for the treatment of amblyopia.
Commercial Relationships: Simone L. Li, None; **Reed Jost**, None; **Sarah Morale**, None; **David Stager**, None; **Lori Dao**, None; **David Stager, Jr**, None; **Eileen Birch**, None
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Program Number: 817
Presentation Time: 4:45 PM–5:00 PM
Integrated Visual-Auditory Perception in Amblyopic Adults: A Study Using the McGurk Phenomenon
Michael Wan[1, 2], Cindy Narinesingh[1], Herbert C. Goltz[1, 3], Manokaraananthan Chandrakumar[1], Agnes M. Wong[1, 3]. [1]Program in Neuroscience and Mental Health, The Hospital for Sick Children, Toronto, ON, Canada; [2]Ophthalmology, Boston Children's Hospital, Boston, MA; [3]Ophthalmology and Vision Sciences, University of Toronto, Toronto, ON, Canada.
Purpose: Although classically defined as a developmental disorder characterized by a loss of visual acuity, there is growing evidence that amblyopia affects several higher order perceptual processes. The impact of amblyopia on multisensory integration has not been investigated previously. The McGurk effect is a perceptual phenomenon resulting from an interaction between hearing and vision in speech perception. The purpose of this study was to assess visual-auditory integration in adults with amblyopia using the McGurk effect.
Methods: This is a prospective, single-blinded, comparative study. Adults with a history of amblyopia and visually normal controls completed a background questionnaire and underwent a baseline assessment of visual acuity, stereoacuity and eye alignment. Participants were then shown a standard video of congruent (control) and incongruent (McGurk) trials consisting of various combinations of visual and auditory phonemes and asked to report what they heard.
Results: Twenty-two adult subjects with amblyopia (19 female, mean age 32.8 years) and 25 visually normal controls (16 female, mean age 31.8 years) participated in the study. All participants performed at ceiling for congruent trials, with mean accuracy for all groups and viewing conditions exceeding 98%. With incongruent trials, participants with amblyopia were significantly less likely to report hearing a fused phoneme (i.e. demonstrate the McGurk effect) compared to controls ($p = 0.01$). While this difference was greatest during amblyopic eye viewing, it was also present during fellow eye and binocular viewing. No correlations were found between accuracy and visual acuity or stereoacuity.
Conclusions: This is the first study to demonstrate that adults with amblyopia have a lasting impairment of their ability to integrate visual and auditory signals, independent of visual acuity. Visual-auditory integration is an important perceptual ability and a key component of speech perception. The results of this study add to the growing body of evidence that amblyopia causes an array of deficits beyond the visual system.
Commercial Relationships: Michael Wan, None; **Cindy Narinesingh**, None; **Herbert C. Goltz**, None; **Manokaraananthan Chandrakumar**, None; **Agnes M. Wong**, None