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ABSTRACTS

British Congress of Optometry and Vision Science, Glasgow, 2013

The 2013 meeting of the British Congress of Optometry and Vision Science took place in Glasgow in September 2013 and attracted 100 delegates from the UK and mainland Europe. This annual meeting aims to highlight the diversity of vision research being conducted in the UK and to provide post-graduate students and other early career researchers with the opportunity to present their work in a supportive environment. This year's event, hosted by Glasgow Caledonian University over 9–10th September, was the largest meeting of its kind in recent years, with over 50 presentations on topics ranging from corneal biomechanics to visual perceptual learning, the majority being delivered by research students from UK Optometry departments. The keynote speaker was Professor Dennis Levi from the University of California, Berkeley (*Figure 1*) who gave a fascinating overview of his work on amblyopia and plasticity in the visual system, and the meeting concluded with a guest lecture by Professor Christine Wildsoet (*Figure 2*) also from Berkeley, who discussed the development and control of myopia.

Figure 1. Keynote speaker Dennis Levi, with conference organiser Anita Simmers.

Figure 2. Guest lecturer Christine Wildsoet.

Andrew Logan from Glasgow Caledonian University (*Figure 3*) won the prize for the best student oral presentation and the award for best poster presentation was given to Samantha Strong (*Figure 4*) from the University of Bradford. Next year's meeting will take place in September 2014 and is due to be hosted by Cardiff University.

Anita Simmers and Graeme Kennedy
School of Health and Life Sciences, Glasgow Caledonian University, Glasgow, UK

Talks

Removing the brakes on plasticity in the amblyopic brain

Dennis M. Levi
School of Optometry, University of California, Berkeley, CA, USA

In the last 10 years there has been a rekindling of interest in amblyopia; a new understanding of the underlying patho-physiology based in part on new brain imaging methods such as functional MRI, and a massive shift in our thinking about the treatment of amblyopia fueled in part by a number of important clinical trials. Experience-dependent plasticity is closely linked with the development of sensory function. However, there is also growing evidence for plasticity in the adult visual system. This plenary session re-examines the notions of critical period and sensitive period for a variety of visual functions. One critical issue is the extent to which alternative neural structures are recruited to restore these visual functions. Recent experimental and clinical evidence for the rehabilitation of amblyopia will be discussed.

Controlling myopia progression – lessons learned and yet to be learnt from animal studies

Christine F. Wildsoet
Center for Eye Disease & Development, School of Optometry, University of California, Berkeley, CA, USA

The rising prevalence of human myopia throughout the world has dispelled any notion that genetics alone determine its onset and progression. While the underlying environmental influences remain

Figure 3. Glasgow Head of Department Niall Strang congratulates best oral presentation winner Andrew Logan.

to be fully understood, studies using animal models, e.g. in chicks, guinea pigs, tree shrews and monkeys, have provided important insight into the visual factors influencing and signal pathways underlying eye growth regulation. Novel optical treatments for myopia control are one of the products of this research and new drug treatments and visual hygiene interventions are likely to be forthcoming. Advanced bioengineering principles are also being applied in myopia research. This paper will review relevant recent studies to support the argument that positive intervention in childhood myopia is not only feasible, but should become the new standard of care.

Synthetic face adaptation reveals neural tuning of face identity

Andrew J. Logan, Gunter Loffler and Gael E. Gordon
Visual Neuroscience Research Group, Glasgow Caledonian University, Glasgow, UK

Purpose: To quantitatively investigate the neural tuning of the channels which encode face identity.

Background: Prolonged viewing of a face can influence the appearance of subsequently-viewed faces. We aimed to quantify the magnitude of face adaptation for unfamiliar synthetic faces as a function of face identity and face distinctiveness.

Methods: Observers adapted to synthetic faces of a particular identity and distinctiveness. Face discrimination sensitivity was then assessed for the adapted identity (congruent condition) and novel identities (incongruent). Baseline face discrimination sensitivity was measured with a low-level noise adaptor.

Results: There was no effect of face adaptation within the incongruent condition. Congruent face discrimination thresholds, however, were significantly elevated. The magnitude of this elevation was related to the distinctiveness of the adapting face, ranging monotonically from 1.37 (least distinctive adaptor) to 2.38 (most distinctive).

Conclusions: Synthetic face adaptation resulted in an identity-specific reduction in sensitivity. Adaptation did not transfer between identities. The magnitude of the adaptation in the congruent-identity condition showed a monotonic dependence on face distinctiveness: the more distinct the adaptor, the stronger the adapting effect. This suggests a norm-based representation of faces with neural populations tuned to face identity and distinctiveness that respond with increasing magnitude as faces become more different from the mean.

Dizziness and vertigo symptoms in an elderly population waiting for cataract surgery

Alison Alderson[1], *Christopher J. Davey*[1], *Elvira Supuk*[1], *Andy Scally*[2], *Clare Green*[3], *Norman Litvin*[3] *and David B. Elliott*[1]
[1]Bradford School of Optometry and Vision Science, University of Bradford, UK, [2]School of Health Studies, University of Bradford, UK, and [3]Ophthalmology Department, Bradford Teaching Hospitals Foundation Trust, Bradford, UK

Purpose: To identify factors associated with dizziness and vertigo symptoms in a population of patients aged 65 years and over who have been listed for routine cataract surgery.

Background: The prevalence of dizziness and vertigo-like symptoms in the older population is reported as being between 8% and 51%. Studies have suggested a link between dizziness symptoms and poor vision, eye disease, myopia and a history of cataracts.[1]

Methods: All patients 65 years and older who were listed for routine phacoemulsification at Bradford Royal Infirmary and Optegra Yorkshire Eye Hospital were invited to participate in the study. A questionnaire was issued asking for details regarding falls history, activities of daily living and type of spectacles worn. Dizziness was assessed using the short form of the dizziness handicap inventory (DHIsf).[2] Details of patient age, gender, ethnicity, general health, medications, type and power of spectacle correction, visual acuities pre-surgery and ocular co morbidity were extracted from hospital records.

Results: Three hundred participants were recruited and completed the dizziness, falls and general information questionnaires. To date full details from hospital records have been obtained for 50 participants. Statistical analysis was carried out using Stata12. Females ($F_{1,48} = 16.17$, $p < 0.001$) and those participants who had more falls ($F_{1,48} = 39.60$, $p < 0.001$) were significantly more likely to suffer dizziness symptoms. No significant relationship was found between dizziness symptoms and any visual parameters.

Conclusions: Dizziness was found to be associated with female gender and history of falls in an elderly population waiting for cataract surgery, but not with vision. Further data collection will ascertain whether these associations change post cataract surgery.

Acknowledgements: This research has been funded by the Dunhill Medical Trust; E. Supuk is being funded by FODO.

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Age differences in visual short-term memory for object recall and location recognition

Raju P. Sapkota[1], *Ian van der Linde*[1,2] *and Shahina Pardhan*[1]
[1]Vision & Eye Research Unit (VERU), Postgraduate Medical Institute, Anglia Ruskin University, Cambridge, UK, and [2]Department of Computing & Technology, Anglia Ruskin University, Cambridge, UK

Background: Our ability to remember object's visual features, such as colour, shape, and location for short durations (called visual short-term memory, VSTM) declines with age (Hartman, et al, 2001).

Purpose: The goal of this study is to examine the effects of age, memory load and item recency on VSTM for complex visual tasks that require object-location binding.

Methods: Two experiments were conducted: 1-object recall; 2-location recognition. Seventeen young subjects (M_{age} = 23.3), and 17 normally ageing subjects (M_{age} = 66.5) participated. In both experiments, our memory display comprised two or four Snodgrass stimuli presented sequentially (each 650 ms) at random locations. At test, in experiment 1, a spatial marker appeared at one of the memory stimuli locations. Participants reported name of the stimulus shown at this location. In experiment 2, a test stimulus was shown above the memory display area, together with numbered markers at each memory stimulus location. Participants reported the number corresponding to the location of the test stimulus in the memory display. Performance data (% correct) were analysed using 2 × 2 mixed ANOVA, with sequence length (two levels, SL2 and SL4) as a within-subjects factor, and age (two levels, young and elderly) as a between-subjects factor.

Results: A significant effect of age on memory performance was observed: Experiment 1, $F_{1,32} = 31.81$, $p < 0.001$; Experiment 2, $F_{1,32} = 13.49$, $p = 0.001$. This occurred at both low (SL2) and high (SL4) memory loads. Both experiments yielded steeper recency curves for elderly participants.

Conclusions: Elderly participants have reduced VSTM capacity for object-location and experience more precipitous memory decay, relative to younger participants, particularly in object recall.

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Rehabilitation for visual field loss after stroke: exploring scanning training interventions in Scotland

Christine Hazelton[1], *Alex Pollock*[1], *Glyn Walsh*[2] *and Marian Brady*[1]

[1]Nursing Midwifery and Allied Health Professions (NMAHP) Research Unit, Glasgow Caledonian University, UK, and [2]Department of Vision Sciences, Glasgow Caledonian University, UK

Background/Purpose: Around one fifth of stroke survivors have persisting visual field loss,[1] which can affect daily activities and reduce quality of life.[2] Scanning training is a commonly used rehabilitation intervention but the supporting evidence is limited and there are variations in current practice[3]; exploration of these variations is necessary to inform future research. This study aimed to identify the scanning training interventions currently available in Scotland and fully describe and compare the key components of each.

Methods: A purposeful 'snowball' method was used to survey practice across a wide variety of professions and clinical settings. Two Expert Panel meetings were held: professionals with expertise in motor, language and cognitive skills graded the functional abilities required to use each intervention. The details of eye movement training provided were objectively measured using video capture analysis techniques.

Results: Ten scanning training methods were identified, with four modes of delivery. Detailed information was gathered on the functional skills required, with considerable variation shown in the levels of motor abilities, language, and cognition needed. Clear training parameters, including the visual field size and eye movements stimulated, were obtained. Findings show an emphasis on improving volitional saccades within the central field.

Conclusions: A variety of scanning training interventions are used in Scotland, which vary in mode of delivery, functional abilities required for use and visual skills trained. This information has important implications for clinical practice and will inform the development of clinical trials.

Acknowledgements: This project has been funded by The Stroke Association, in the form of a Junior Research and Training Fellowship awarded to the presenting author.

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Standardisation of optometric data in the context of reading assessment

Caroline A. Wilson, Brendan T. Barrett and James M. Gilchrist

Bradford School of Optometry and Vision Science, University of Bradford, Bradford, UK

Background: Individuals with reading difficulty are often assessed by professionals across a range of disciplines. Many common neuropsychological tests employed use a standardised method of scoring, where raw scores are converted to standard scores (mean of 100, SD of 15). This facilitates easier comparison of an individual's performance across tests. To achieve this we aim to develop a standardised approach to the testing and interpretation of data from tests commonly used by optometrists and orthoptists.

Methods: We examined 96 children aged 8–10 years in two schools. Data were collected using standardised neuropsychological tests of reading efficiency and comprehension, phonological skills, visual perception and memory. Common optometric data measuring accommodative and vergence function were collected from pupils in a school setting. Measures of near point of convergence (NPC) and amplitudes of accommodation were tested for normality and transformed to *Z* scores. The data were further transformed to be presented as standard scores with a mean of 100, standard deviation of 15.

Results: Taking the view that any value below 1SD below the mean is considered below average, the results suggest a cut-off value of >9 cm for NPC and <10D of accommodation monocularly.

Conclusion: Converting data to a common standard scale holds promise for presenting results alongside the results from other tests used by non-vision professionals, allowing a more complete profile of the strengths and weaknesses of a particular individual to be examined.

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Perceptual noise exclusion deficits in dementia revealed by a reading-in-noise test

Velitchko Manahilov[1], *Niall Strang*[1], *Laura Priester*[1] *and Peter Connelly*[2]

[1]Department of Life Sciences, Glasgow Caledonian University, Glasgow, UK, and [2]Murray Royal Hospital, Perth, NHS Tayside, UK

Purpose: To test whether a new reading-in-noise (RIN) test could differentiate cognitive changes in dementia from those in normal aging.

Background: Dementia research has been mainly focused on investigating impairments in episodic memory and executive functions, overlooking visual processing. To test the possibility that people with dementia may have visual processing deficits, we employed a new test for reading words degraded by positional letter noise which may provide information about the efficiency of visual stages forming global word representations and accessing memory templates.

Methods: Eight patients with dementia and nine age-matched controls were tested. Text samples contained frequently used real words and pseudowords (easily pronounced strings of letters without meaning). Positional noise was produced by random Gaussian displacement of letter position below or above the horizontal line. Reading duration

of correctly read words/pseudowords was estimated in trials without and with positional noise.

Results: Patients without and with dementia read non-degraded words with similar speeds. However, positional noise produced a significant dementia-related elevation of reading duration for both real and pseudowords. In controls, the effects of positional noise on reading duration was significantly smaller for real words than for pseudowords, while these effects were similar in patients with dementia.

Conclusions: Dementia patients have an impaired ability to exclude perceptual noise when reading real and pseudowords. These dementia-related deficits could result from inefficiency in grouping letters into global word percepts and their matching to stored representations. The results suggest that the RIN test may play a role in early stage dementia screening.

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A novel home-based binocular therapy for childhood anisometropic amblyopia

Manuela Bossi[1], *Elaine J. Anderson*[1,2], *Vijay K. Tailor*[3,4], *Peter J. Bex*[5], *John A. Greenwood*[1], *Annegret Dahlmann-noor*[4] *and Steven C. Dakin*[1,3]
[1]UCL Institute of Ophthalmology, University College London, London, UK, [2]UCL Institute of Cognitive Neuroscience, University College London, London, UK, [3]National Institute for Health Research Biomedical Research Centre for Ophthalmology at Moorfields Eye Hospital NHS Foundation Trust, London, UK, [4]Strabismus and Paediatric Service, Moorfields Eye Hospital, London, UK, and [5]Schepens Eye Research Institute, Harvard Medical School, Boston, MA, USA

Treatment of childhood amblyopia currently consists of refractive correction (if required) followed by penalization of the fellow eye with either patching or pharmacological occlusion (e.g. atropine; Stewart, Moseley, & Fielder, 2011). Although well-established, such treatments continue to raise concerns about compliance (arising from the social stigma of patching) and safety (e.g. crossing the road following application of atropine; Holmes, Melia, Bradfield, Cruz, & Forbes, 2007; Levi, McKee, & Movshon, 2011; Mathers, Keyes, & Wright, 2010). Furthermore while such interventions improve acuity they do not target stereo-vision despite its importance in everyday life (Birch, 2013). Here, we describe a novel treatment specifically aimed at improving binocular vision. Children spend an hour a day at home watching movies while wearing modified 3D glasses (Greenwood et al., 2012). This system allows us to 'balance' the visibility of the image across the eyes; specifically, a personalised level of digital Gaussian blur is applied to the unaffected eye so that crowded-acuity is matched across eyes. Additionally (through the course of the movie) each child periodically plays a simple game (involving dichoptic video-game characters) and their performance yields a day-by-day index of compliance and intra-ocular suppression. For an ongoing exploratory study of children with anisometropic amblyopia we report substantial (approximately ≥3 lines LogMAR) improvements in acuity in 4/6 children. These results are achieved after an average of only 50 h of viewing (typically achieved in approximately 2 months). Furthermore, treatment results in normal stereo-vision in all children tested so far. These preliminary results compare favourably with the outcome of patching, but over a significantly shorter time scale. Unlike occlusion therapy this treatment seems popular with patients and parents (maximising compliance and outcome) and leads to substantial gains in monocular acuity and binocular vision.

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Temporal characteristics of L- and M- cone isolated steady-state ERGs

Deepika Kommanapalli[1], *Declan McKeefry*[1], *Ian J. Murray*[2], *Jan Kremers*[3] *and Neil R. A. Parry*[4]
[1]Bradford School of Optometry and Vision Science, Bradford University, UK, [2]Faculty of Life Sciences, University of Manchester, UK, [3]Department of Ophthalmology, University Hospital Erlangen, Germany, and [4]University of Manchester Academic Health Science Centre and Vision Science Centre, Manchester Royal Eye Hospital, UK

Purpose: (1) To characterise the temporal frequency response functions of L- and M- cone isolated ERGs using triple silent substitution stimuli. (2) To determine the extent to which high and low frequency flicker responses may be underpinned by different post-receptoral pathways.

Background: Previous psychophysical[1,2] and electrophysiological studies[3,4] have demonstrated that cone isolating stimuli can be used to examine the contribution of L and M-cones to cone-opponent, chromatic and non-opponent, luminance mechanisms and that these contributions predominate at low and high temporal frequencies, respectively.

Methods: Triple silent-substitution sine-wave flicker stimuli between 5 and 100 Hz were generated on a four primary LED ganzfeld stimulator (Diagnosys ColorDome). ERGs were recorded from six trichromatic observers using DTL corneal electrodes. Recordings were also performed on and two dichromats (one protanope and one deuteranope) in control experiments to verify the extent of cone isolation. Following acquisition, the ERGs were subjected to FFT analysis, which allowed us to plot the amplitude and phase of the fundamental response component as a function of temporal frequency.

Results: At low temporal frequencies (<10 Hz) the responses of the L- and M-cone ERGs were of similar amplitude generating L:M response amplitude ratios of close to unity. In addition, the phase differences between the L- and M-cone responses in this low frequency range were close to 180°. At higher temporal frequencies the L-cone response was much larger than the M-cone ERG generating L:M cone response ratios of greater than unity. The difference in phase in this frequency range was closer to 0°.

Conclusions: These differences in response properties between the L- and M-cone ERGs at low (<10 Hz) and higher (>10 Hz) temporal frequencies are consistent with their contributions to cone-opponent, chromatic and non-opponent, luminance processing.

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The importance of individual calibration and the impact of disparity and blur cues in the assessment of accommodation and vergence using the PowerRefractor III

Lesley Doyle, Kathryn Saunders and Julie-Anne Little
Vision Science Research Group, School of Biomedical Sciences, University of Ulster, Coleraine, UK

Purpose: Photorefraction, as a method to assess accommodation and vergence provides remote and non-invasive measures of refractive power and eye position.[1,2] The oculomotor system is driven by disparity, blur and proximity cues.[3] The PowerRefractor III (PlusOptix, Germany) uses average instrument calibration values when calculating refraction and eye position, introducing the possibility of small individual errors. Individual calibration of refraction using both positive and negative lenses has been shown to be necessary for accurate refractive measures.[4] The purpose of this investigation was to develop a protocol to assess different accommodative cues and investigate the necessity of eye position calibration.

Methods: Accommodation was assessed at five distances for 11 participants, aged 6–16 years under four cue conditions; (i) all cues available; removal of (ii) disparity, (iii) blur or (iv) both, with accommodative demand/response slopes calculated for each condition. Refraction and eye position calibrations were carried out using a combination of positive and negative lenses and base in and out prisms.

Results: Compared to condition (i), mean accommodative response gain was reduced in all other cue conditions becoming significant for condition (iv) (repeat measures ANOVA, $F_{3,29} = 6.87$, $p = 0.001$). Mean slope values (±SD) for refractive power and eye position calibration were 0.85 ± 0.21 and 1.04 ± 0.24 respectively, with the former significantly less than unity ($t_{1,9}$, $p = 0.03$).

Conclusions: The removal of both disparity and blur are shown to degrade accommodative responses to a naturalistic stimulus. This study reinforces the importance of individual calibration for refractive power measures and demonstrates additional benefit of eye position calibration.

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Vision screening – what are we missing?

Amritpreet Kaur Basra-Badh[1], *David Whitaker*[1], *Brendan Barrett*[1] *and Alison Bruce*[2]
[1]Bradford School of Optometry and Vision Science, University of Bradford, UK, and [2]Orthoptic Department, Bradford Teaching Hospitals Foundation Trust, Bradford, UK

Purpose and background: To examine the refractive error profile of 5–6 year old children attending primary schools in Bradford, West Yorkshire. Many vision screening programmes do not include any form of refraction and rely instead upon monocular measures of vision. This raises the possibility that significant hyperopia will be missed.[1,2]

Methods: Two hundred and ninety children aged between 5 and 6 years old participated in the study using an opt-out parental approval process. Non-cycloplegic retinoscopy was conducted to provide an estimate of refractive error. All of the children had previously been screened in the 2012/13 academic year by the Orthoptic Department at Bradford Royal Infirmary. This screening consisted of monocular vision measures and ocular alignment assessment. The clinician performing retinoscopy was blind to the results of the vision screening.

Results: The prevalence of significant hyperopia (MSE ≥ +2.00 DS) was 6.32% (CI 95%: 4.32–8.32). The prevalence of myopia (MSE of −0.50 DS or more) was 3% (1.6–4.4). The prevalence of astigmatism (≥1.00 DC) was 18.6% (15.41–21.79). The prevalence of anisometropia (≥1.50 D difference in MSE) was 2.1% (0.44–3.76, all were bilateral hyperopes). Only 56% of eyes with significant hyperopia (≥+2.00 DS MSE) were identified using a 'fail' vision criterion of >0.2 logMAR and 35% of those with astigmatism (range −1.00 to 2.75 DC) passed the vision criterion of ≤0.2 logMAR. Of the hyperopes with ≥+2.00 DS MSE, 5.56% had strabismus, none of the anisometropes had strabismus. Seventy-five percent of strabismics and only 40% of anisometropes failed the vision test.

Conclusion: In this population clinically significant hyperopia and astigmatism are common in children who had previously passed a vision screening test. Dry retinoscopy is a quick test to perform and is more acceptable to parents and children than cycloplegic retinoscopy. This study demonstrates the value of incorporating a refractive error assessment into children's vision screening.

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Ocular volume in ametropia

Manbir Nagra, Bernard Gilmartin and Nicola S. Logan
School of Life and Health Sciences, Aston University, Birmingham, UK

Purpose: To use 3-dimensional Magnetic Resonance Imaging (MRI) to characterise ocular volume in ametropia.

Background: Correlation between increasing myopia and longer axial length (AL) has been well established, but relationships between myopia and other biometric parameters have been investigated less due to technical limitations in imaging the eye *in vivo*.

Methods: Seventy-one adult subjects were scanned using a Siemens 3-tesla scanner. Mean Spherical Error, MSE (D) mean -2.54 ± 4.07 (range −10.56 to +9.50), PCI AL (mm) mean 24.49 ± 1.57 (range 20.32–28.12). Calculation of ocular volume followed acquisition of T_2-weighted MR images (voxel size 1 mm^3); an automatic flood-filling algorithm was applied and standard voxel counting used to calculate total ocular volume, and volume anterior and posterior to the posterior pole of the crystalline lens.

Results: Mean total volume (mm^3) was 8138.75 ± 1159.91 (range 5036.00–11777.00); mean anterior volume 1100.42 ± 137.80, and mean posterior volume 7038.34 ± 1150.01. Posterior and total volumes showed significant correlation with MSE ($p < 0.01$) and AL ($p < 0.01$), but the relationships between anterior volume vs AL, posterior volume, total volume, and MSE were not significant ($p > 0.05$). Regression analysis showed MSE accounted for 47.3% of the variance in total volume, and separately, AL accounted for 74.7%. MSE used in conjunction with AL, improved the overall variance by 3.2%.

Conclusions: Greater total ocular volume is largely attributable to the increased vitreous chamber depth synonymous with myopia. Absence of correlation between anterior volume with other biometric factors distinguishes it as an independent variable unaffected by MSE or structural changes in myopia.

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The relationship between retinal shape and relative peripheral refractive error in emmetropic, myopic and hyperopic individuals

Janis B. Orr, Lyle S. Gray, Dirk Seidel and Mhairi Day
Department of Life Sciences, Glasgow Caledonian University, UK

Aim: To investigate the relationship between the retinal shape and peripheral refractive error in a group of young, visually normal, emmetropic, myopic and hyperopic individuals.

Methods: Forty-two (mean ± SD age: 22.94 ± 3.56 years) emmetropic, myopic and hyperopic students, from the GCU student population, participated with informed consent. The mean spherical equivalent (MSE) refractive error ranged from −8.75 to +7.50 D. All experimental measurements were taken under cycloplegia (cyclopentolate hydrochloride 1%). Axial length was measured using the IOLMaster (Carl Zeiss, Jena, Germany) from 0 to 30° in 5° steps, nasally and temporally. Individual retinal shape profiles were created for the nasal and temporal retina using an optical model (Cameron et al., 2013). The retinal shape profiles were then fitted to a saturation curve in order to obtain retinal shape coefficients. Peripheral refractive error was measured using the Grand Seiko FR-5000 autorefractor (Grand Seiko Co. Ltd., Hiroshima, Japan) from 0 to 30° in 5° steps, nasally and temporally. Relative peripheral refractive error was calculated by subtracting the central refractive error from the peripheral refractive error measurements. Both instruments were rotated around a stationary eye, in order to take peripheral measurements.

Results: There was significant asymmetry between the nasal and temporal retina in the myopic group, but not in the emmetropic or hyperopic groups. The relative peripheral refractive error was significantly different between the refractive error groups. Relative peripheral hyperopia was found in the myopic group, whereas relative myopia was found in the emmetropic and hyperopic groups. There was a significant asymmetry in the relative peripheral refractive error between the nasal and temporal retina in the myopic group, but not in the emmetropic or hyperopic groups. The retinal shape and relative peripheral refractive error were significantly correlated in all refractive error groups.

Conclusions: There was a significant asymmetry in retinal shape between the nasal and temporal retina in myopic individuals, but not emmetropic or hyperopic individuals. There was a significant asymmetry relative peripheral refractive error between the nasal and temporal retina in myopic individuals, but not emmetropic or hyperopic individuals. The retinal shape and relative peripheral refractive error were significantly correlated in emmetropic, myopic and hyperopic individuals.

Anisometropia incidence and resolution across a 3-year period: results from the NICER Study

Karen M. M. Breslin, Lisa O'Donoghue and Kathryn J. Saunders
Vision Science Research Group, School of Biomedical Sciences, University of Ulster, Coleraine, UK

Purpose/background: Anisometropia is associated with visual problems including amblyopia, binocular defects and asthenopia and occurs despite both eyes being under the same environmental influence. Prospective investigation of anisometropia has received little attention. This study aims to explore 3-year change in anisometropia amongst white Northern Irish schoolchildren.

Methods: The Northern Ireland Childhood Errors of Refraction (NICER) study, a population-based cross-sectional study of refractive error, initially examined 339 6–7-year-olds and 669 12–13-year-old white children. Cycloplegic refractive error (1% cyclopentolate) and ocular components measurements were determined using binocular open-field autorefraction and partial coherence interferometry. Data collection was repeated 3 years later on 295 9–10 year-old (younger cohort) and 429 15–16-year-old (older cohort) participants. Anisometropia was defined as the absolute difference in spherical equivalent refractive error.

Results: The prevalence of anisometropia did not change significantly across the 3 year test period for either the younger (8.5%, 95% CIs 3.9–13.1 and 7.5%, 95% CIs 4.2–10.8 at 6–7 and 9–10 years respectively) or older cohorts (9.4%, 95% CIs 5.9–12.9 and 9.1%, 95% CIs 4.5–13.7 at 12–13 and 15–16 years respectively). However, whilst prevalence remained static, the individuals contributing to these figures were not identical across sampling points. During the 3 year interval some individuals became anisometropic [n = 15 (5.8%) and n = 12 (3.1%) younger and older cohort respectively] and others became isometropic [n = 17 (70.8%) and n = 18 (40%) of those originally anisometropic (younger and older cohort respectively)]. Changes in axial length and corneal radius of curvature could not explain the resolving or incident anisometropic errors and they were not significantly associated with baseline refractive error.

Conclusions: Prevalence data suggest that anisometropia is stable throughout childhood. However this study reveals a more dynamic picture on an individual level, with anisometropia appearing and resolving in a significant number of children during school years.

Acknowledgement of funding: The College of Optometrists.

Persistence of ocular malleability may facilitate myopic progression in the ageing eye

Deborah S. Laughton[1,2], *Amy L. Sheppard*[1,2], *Edward A. H. Mallen*[3] *and Leon N. Davies*[1,2]
[1]Ophthalmic Research Group, School of Life and Health Sciences, Aston University, Birmingham, UK, [2]Aston Research Centre for Healthy Ageing (ARCHA), Aston University, Birmingham, UK, and [3]Bradford School of Optometry and Visual Science, University of Bradford, Bradford, UK

Background: Accommodation-driven transient axial elongation has been suggested as the origin for the connection between high levels of near work and myopia progression in children and adults. However, some presbyopia theories have suggested the choroid becomes stiffer with age, consequently restricting the ability of the eye to elongate axially during accommodation.

Purpose: Therefore, the aim of this study was to evaluate the effect of ageing on accommodation-driven axial elongation to determine whether this mechanism could be a trigger for myopic progression in adulthood.

Methods: Axial elongation was measured by the Haag-Streit *Lenstar* biometer in response to 0.00, 3.00 and 4.50 D accommodative stimuli in 28 emmetropes (MSE = −0.16 ± 0.33 DS) and 28 myopes (MSE = −3.45 ± 1.88 DS), aged 18–42 years. All results were corrected to reduce errors arising from the increase in crystalline lens thickness with accommodation. Accommodative responses were measured sequentially by the Grand Seiko *Auto Ref/Keratometer*.

Results: The degree of axial elongation positively correlated with the accommodative stimulus. The magnitude of the axial elongation remained constant with age in all subjects to the 3.00, 4.50 D accommodative targets and per dioptre of accommodation exerted, with no significant difference between refractive groups. Mean corrected axial elongation was 10.2 ± 16.3 μm when observing a 4.50 D accommodative stimulus.

Conclusion: This study reports no change in posterior pole rigidity with age, suggesting it is feasible to hypothesise accommodation-driven transient axial elongation may promote myopia progression in adults. The results of this study have important implications for current myopia and presbyopia development models.

Acknowledgements: Deborah Laughton is supported by a College of Optometrists postgraduate scholarship award.

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Posters

Figure 4. Niall Strang congratulates best poster presentation winner Samantha Strong.

Identification of two sub-divisions within human motion-sensitive area V5

Samantha L. Strong[1], *Edward H. Silson*[2], *Andre D. Gouws*[2], *Antony B. Morland*[2] *and Declan J. McKeefry*[1]
[1]Bradford School of Optometry and Vision Science, University of Bradford, Bradford, UK, and [2]York Neuroimaging Centre, University of York, York, UK

Purpose: Recent neuroimaging research[1,2,3] has suggested that humans may have a network of smaller motion-sensitive areas within the previously unified area hMT/V5+. This past research has identified two sub-divisions (TO-1 and TO-2). Our current research aims to provide a detailed methodology for identifying these areas, whilst also assessing the variability and characteristic differences between them.

Methods: fMRI data was obtained using block-designed radially moving dot stimuli displayed in either the left or right visual field. The amount of runs of the localiser per participant was varied to assess potential differences in number of repeats. Standard full-field motion localisers were useful to determine any differences from 'standard V5' activity and standard retinotopic paradigms were used to assess the existence of retinotopic organization.

Results: TO-1 and TO-2 were successfully identified in 11/12 hemispheres. Centre-of-mass Talairach co-ordinates of these sub-divisions are consistent with previous literature. At least three runs of this design are required in order to consistently locate TO-2. 'Standard V5' motion localisers appeared to produce activation that is slightly biased towards TO-1, and any degree of retinotopic activation was only found in TO-1.

Conclusions: Three runs of this design successfully distinguishes between the anterior and posterior portions of hMT/V5+ further suggesting that hMT/V5+ should be considered as two distinct areas: TO-1 and TO-2. Previous research assuming hMT/V5+ is one area is most likely mainly focusing on the functionality of TO-1, but there is often a certain degree of overlap to TO-2.

Acknowledgements: SLS is supported by a studentship from the ILSR (University of Bradford).

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A new method for determining the effectiveness of hp-guar tear supplement in an adverse dry environment

Ali Abusharha and Ian Pearce
Department of Vision Sciences, Glasgow Caledonian University, Glasgow, UK

Purpose: This study aims to assess the ability of two different treatments techniques to manage tear film disruption that results from exposure to a low relative humidity (RH).

Method: Two environmental conditions (40%RH/21°C and 5%RH/21°C) were created using a controlled environmental chamber. At 5% RH Systane eye drop was instilled in two different modalities, Protection and Relief. At protection visit the drop was instilled before the exposure, while in relief technique, subjects were exposed to low RH for 15 minutes, and then the Systane drop was instilled. Ocular surface temperature (OST), evaporation rate, lipid layer thickness (LLT), noninvasive tear breaks up time (NITBUT), tear production, osmolarity and ocular comfort were assessed in normal and dry environmental conditions with the use of Systane in two different treatment modalities.

Result: All tear film parameters (except OST) were significantly affected by the exposure to low RH. The use of Systane in both techniques resulted in improvement in NITBUT and ocular comfort during exposure to 5%RH ($p < 0.05$). Tear osmolarity ($p = 0.01$) and LLT ($p = 0.018$) were improved in protection technique while in the relief method tear production was increased significantly ($p = 0.01$) in compare to 5%.

Conclusion: Both treatment mechanisms were shown to be effective. It was apparent that using Systane for protection was superior to relief for osmolarity and lipid layer thickness. Therefore, for maximum benefit patient should be advised to use Systane prior to exposure to dry condition, such as this found in commercial aircraft.

Haemodynamic and electrophysiological correlates of visual perceptual learning

Ross Aitchison[1], *Uma Shahani*[1], *Sobanawartiny Wijeakumar*[2], *Pamela Knox*[1], *Anita Simmers*[1], *Laura McKernan*[1] *and Ana Vega Carreiro de Freitas*[3]
[1]Department of Life Sciences, Glasgow Caledonian University, Glasgow, UK, [2]Department of Psychology, University of Iowa, Iowa City, USA, and [3]Faculty of Medicine, Federal University of Espírito Santo, Brazil

Purpose: To compare haemodynamic and electrophysiological responses in amblyopic and normally sighted observers whilst they undertook a perceptual learning (PL) task.

Methodology: Clinical assessments were made prior to and at the end of the training. Performance at the task was monitored simultaneously with physiological recordings from over V1 on days 1, 3 and 5 during the PL task. Functional near-infrared spectroscopy (fNIRS) and electroencephalography (EEG) were used to record activation over V1. A two-channel oximeter (OxiplexTS) was used to record chromophore concentrations (chromophore). EEGs were recorded on a 32-channel system. Global motion and inter-ocular contrast thresholds were measured using 2-AFC RDKs. The stimuli were viewed through head mounted display goggles, which allowed manipulation of input to each eye.

Training: A dichoptic PL task (Tetris®), involving manipulation of position and orientation of falling 4-block shapes, was undertaken for 5 days (3 × 15 minutes/day). It was modified such that the each eye viewed several blocks. Binocular interaction was required to complete the task.

Results:

(1) Post-training, visual and stereo-acuity measures improved compared to pre-training levels in both groups of observers.
(2) Changes in (HbO) were smaller in amblyopes than in normal observers. In both groups, (HbO) on day 5 was greater than on day 1, peaking on day 3.
(3) Post-training, FFT analysis of EEGs recorded during PL on day 5 showed an increase in power at gamma band frequencies.

Conclusion: Our results, which include clinical and physiological measures, have shown that visual perception 'improves' as a result of PL.

Dynamics of disparity vergence dynamics during 3D viewing are influenced by ocular rigidity

Mohammed Alhazmi[1,2], *Lyle S. Gray*[2], *Dirk Seidel*[2] *and Laura Sweeney*[2]
[1]Department of Optometry, King Saud University, Saudi Arabia, and [2]Department of Life Sciences, Glasgow Caledonian University, UK

Purpose: To determine the effect of eye size and ocular rigidity upon the characteristics of disparity vergence eye movements under 3D viewing conditions.

Methods: Thirty subjects (mean age ± SD of 26.56 ± 4.66 years) with normal binocular vision and VA of 6/6 or better participated with informed consent in the study. Axial length (24.16 ± 1.40 mm) was measured using partial coherence interferometry (IOLMaster, Carl Zeiss, UK). Ocular rigidity coefficients (0.0160 ± 0.002) were determined using Schiotz tonometry. Subjects viewed a high contrast Maltese cross for 5 minutes presented on a 3D LCD display (LG Electronics; 1920 × 1080 pixels) at a distance of 2 m. Disparity vergence varied sinusoidally at temporal frequencies of 0.05, 0.1, 0.3, 0.5 and 0.7 Hz and amplitudes of 0.8, 3 and 6°. Eye movements were recorded continuously at a sampling rate of 100 Hz using the IRIS Simulink eyetracker (Skalar Medical B.V., The Netherlands). For data analysis subjects were divided into three equal groups according to their ocular rigidity.

Results: Response gain was significantly higher for the crossed disparity stimulus, ($p < 0.001$) although these responses showed significantly higher phase lag ($p = 0.028$) compared to uncrossed disparity. Response gain decreased and phase lag increased significantly over time as subjects viewed the stimulus ($p < 0.001$). This effect was significantly greater for subjects with lower ocular rigidity ($p < 0.001$). Response gain reduced and phase lag increased with increasing stimulus amplitude ($p < 0.001$). Increasing the stimulus frequency significantly decreased the response gain and increased the phase lag ($p < 0.001$). Ocular rigidity and axial length were significantly negatively correlated ($r^2 = 0.76$, $p < 0.001$).

Conclusion: The sinusoidal disparity vergence response deteriorates in quality after very short viewing times for 3D presentation. This deterioration in response appears to be exacerbated in larger eyes with lower ocular rigidity. These results suggest that stereoscopic displays may present a more challenging environment for subjects with larger eyes and/or lower ocular rigidity.

Dose-dependency of blur adaptation

Kiren Aziz Khan, Matthew Cufflin and Edward Mallen
Bradford School of Optometry and Vision Science, University of Bradford, Bradford, UK

Purpose/background: This pilot study aims to test the hypothesis that blur adaptation is dose-dependent. If periods of defocused vision are interleaved with clear viewing, will blur adaptation still cause an improvement in defocused visual acuity (VA)? Alternatively, will clear viewing inhibit the adaptation process? Previously, continuous periods of defocused viewing have resulted in significant improvements in defocused VA after adaptation.

Methods: The study included six observers (four emmetropes and two myopes). All observers wore full refractive correction (if required) throughout the experiment. 1D of defocus was introduced using spherical convex lenses. An automatic system was used to place the blurring lens before the RE for varying periods. Participants watched a DVD at distance during each 15 minutes adaptation trial. VA was measured using Test Chart 2000 before and after adaptation. Various permutations of blurred and clear periods were implemented for each trial, i.e. equal blur and clear periods, longer blur periods or longer clear periods.

Results: Preliminary results indicate that blur adaptation occurs to varying degrees depending on the periods of incremental blur exposure. Improvements in defocused VA occur with equal blur and clear periods of vision, as well as for longer blur periods. However, longer clear periods show smaller improvements in defocused VA.

Conclusions: Intervening periods of clear vision cause minimal disruption to improvements in defocused VA after blur adaptation. This indicates that blur adaptation is a robust phenomenon. Exposure to defocus may have a cumulative effect; as the dose of blur builds up, so does the adaptive effect.

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The effect of retinitis pigmentosa on activities of daily living

Ahoora Baranian[1,2], *Matthew Timmis*[1,2], *Keziah Latham*[2,3] *and Shahina Pardhan*[2]
[1]Sport and Exercise Sciences Research Group (Life Sciences), Anglia Ruskin University, [2]Vision and Eye Research Unit (Postgraduate Medical Institute), Anglia Ruskin University, Cambridge, UK, and [3]Vision and Hearing Sciences, Anglia Ruskin University

Purpose: To identify which activities of daily living (ADLs) people with Retinitis Pigmentosa (RP) find most difficult to complete.

Method: The Dutch ICF Activity Inventory (D-AI)1 was used to investigate which ADLs at goal level were difficult to complete. Two hundred and sixty-two subjects (140 females, 122 males, age 54 ± 15 years) with RP completed the D-Al; this assesses the difficulty of 47 rehabilitation goals nested within 10 objectives of the WHO-ICF framework. Likert scales were used and responses were scored from 0 to 6, where 0 is not applicable/important, through 1 (not difficult) to 5 (impossible to achieve without support). Eighteen participants were not registered as visually impaired, 83 were sight impaired and 161 severely sight impaired. A guide dog and/or cane was used by 141 participants to aid mobility, and 121 used no mobility aids.

Result: The three most difficult items, defined by the highest mean Likert difficulty scores were: mobility (2.96 ± 1.00), general tasks including filling in schedules and forms (2.68 ± 1.31) and emotional health including the acceptance of visual status (2.67 ± 1.00). Mobility and general tasks were significantly more difficult for those with greater visual impairment ($p < 0.001$). Mobility ($p < 0.05$) and general tasks ($p < 0.001$) were more difficult for those who used mobility aids. Emotional health did not depend on registration status ($p = 0.34$) or on the use of mobility aids ($p = 0.09$).

Conclusion: Mobility is a difficult task for people with RP, with increased difficulty for those with greater severity and who use mobility aids. Findings also indicate other areas of significant difficulty. These goals will be followed up with an additional questionnaire investigating difficulties at task level, and the investigation of difficult tasks using motion analysis.

Reference: 1. Bruijning JE, van Rens G, Knol D & van Nispen R. Psychometric analyses to improve the Dutch ICF activity inventory. *Optom Vision Sci* 2013; 90: 806–819.

Biomechanical modelling of the accommodation system

Benjamin J. Coldrick[1]*, John G. Swadener*[1] *and Leon N. Davies*[2]
[1]Biomedical Engineering Research Group, Aston University, Birmingham, UK, and [2]Ophthalmic Research Group, Aston University, Birmingham, UK

Purpose: Model the human accommodation system using a new finite element model, incorporating novel modelling methods.

Background: Despite extensive analysis and measurement, there is still debate over both the accommodation process and its age related decline. Finite element analysis (FEA) has been increasingly used to aid in understanding both accommodation and presbyopia (e.g. Burd, Judge et al., 2002; Weeber and Van Der Heijde, 2008; Lanchares, Navarro et al., 2012), however, there have been a number of limitations and oversimplifications in these previous models.

Methods: A new FEA model of the accommodation system was developed, incorporating the crystalline lens, capsule (with its thickness variation around the lens) and a novel representation of the zonular fibres (incorporating an anterior, equatorial, posterior and vitreous zonule group), utilising non-linear material and geometric modelling methods. The accommodative process was replicated through displacement of the zonular bundles, accurately replicating the ciliary body movement.

Results: The deformations of three lens models (29, 45 and 60 years old) were in agreement with *in vivo* measurements in terms of the diameter, curvature, axial movement, ciliary body force and volume change. The overall thickness changes deviated slightly from the measured data, showing the thickness change was distributed through the lens rather than being concentrated in the nucleus region (Dubbelman, Van der Heijde et al. 2003).

Conclusions: The new FEA model was capable of replicating the important aspects of the accommodative process across ages. With further development, the model will allow detailed investigations to be conducted into the development of presbyopia.

Acknowledgements: The research was funded by an EPSRC Case award with additional funding from AMO.

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The effect of measurement assumptions when investigating peripheral eye length and peripheral refraction

Lorraine A. Cameron, Lyle S. Gray, Dirk Seidel and Mhairi Day
Department of Life Sciences, Glasgow Caledonian University, Glasgow, UK

Purpose: Peripheral eye length and refraction measurements require instruments to be rotated, with respect the eye. For larger measurement angles instruments are moved laterally to allow the measurement beam to pass through the pupil. Instrument calculations assume the eye has a single refractive index and spherical refracting surface. Researchers assume that the retinal location corresponds with the measurement angle, regardless of refractive error and accommodation level. We aim to investigate the effect of measurement assumptions upon peripheral measurements.

Methods: The path length (PL) and retinal location (RL) of the measurement beam are calculated using ray tracing through four surface model and single surface model eyes. The four surface eye contains aspheric surfaces, different refractive indices, crystalline lens curvatures corresponding to 0 and 4D of accommodation and vitreous chamber depths corresponding to an emmetrope (EMM) and −5.00D myope (MYO). Measurement angles range from 0 to 40°. The effects of lateral movement (0.5–2 mm) are calculated for >30°.

Results: Measurement assumptions underestimate PL during 0D and 4D of accommodation in EMM and MYOs, with a maximum underestimation of 0.0043 mm. Lateral movement causes significant underestimations in PL and increases in magnitude as lateral movement increases. The measurement assumptions have no effect upon the RL up to 25°. The assumptions significantly affect the RL > 25° in all conditions. The effects of the assumptions on the RL are dependent upon accommodation level, refractive error and magnitude of lateral movement.

Conclusions: Peripheral eye length and refraction measurements are accurate using measurement assumptions up to a measurement angle of 25°, with no lateral movement of the instrument.Beyond 25°, PLs are accurate but the precise RL does not correspond with the measurement angle. In order to accurately compare measurements between individuals and at different accommodation levels, the measurements should be corrected using the equations provided.When lateral movement is required, the PL and RL calculated using the assumptions are inaccurate and we provide equations correcting for the assumptions.

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The influence of axial length on normal visual field function

Fiona E. Cruickshank, Nicola S. Logan and Robert P. Cubbidge
Ophthalmic Research Group, Aston University, Birmingham, UK

Purpose: It is well documented that many factors influence retinal sensitivity to light, however, whether a correlation between axial length and visual field sensitivity exists is as yet undetermined and relevant to understanding the structural variations which occur in ametropia. It is known that the loss of photoreceptor and neural cells as a result of the normal aging process is responsible for a decrease in field sensitivity over time. As a strong correlation between axial length and refractive error has been widely demonstrated, it seems reasonable to suggest that in these cases, physical stretching of the retina as a result of increased vitreous chamber depth in axial myopia may lead to impaired retinal sensitivity due to decreased photoreceptor cell sampling.

Methods: A target sample of 40 healthy adults between 18 and 21 years is being recruited from Aston University's student cohort. Visual acuity, non-contact ocular biometry and non-cycloplegic cen-

tral and peripheral autorefraction are measured. Visual field sensitivity is assessed using the Humphrey Field Analyser 750 with a specifically designed custom grid to allow sensitivities to be determined at locations corresponding to biometry data.

Results: Recruitment and data collection are ongoing (currently $N = 8$). Preliminary cross-sectional data shows a mean sensitivity of 30.65 dB (SD 0.64) and a mean axial length of 23.67 mm (SD 1.66). Regression will be carried out to determine the optimum curve fit.

Conclusions: The continuation of this work will determine whether visual field sensitivity can be examined as a correlate to physiological changes in ocular structure in a healthy population.

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Effectiveness of four methods to recover bacteria from used contact lenses

Victoria Cruikshank, Sven Jonuscheit, Michael Doughty and Sue Lang

Department of Life Sciences, School of Health and Life Sciences, Glasgow Caledonian University, Glasgow, UK

Aims: To assess the effectiveness of four methods to recover organisms from worn contact lenses (CL).

Methods: Four methods of bacterial recovery were evaluated using 30 CL artificially contaminated with *S. aureus*, namely the agar-sandwich, glass bead, sonication, and swabbing techniques. Effectiveness of bacterial recovery was determined by quantifying colony-forming units (CFU). In a second experiment, the most effective method was verified by applying the method to 20 used CL, which were collected from habitual CL-wearers (GCU Eye Clinic). Recovered CFUs as well as isolates of a specific bacterium, *S. aureus*, were assessed.

Results: The first experiment revealed the swabbing technique as the most effective method to determine microbial contamination of CL, with bacterial growth being noted for 93% of CL. The mean (±SD) CFU was 13.5 ± 14.2. The agar-sandwich and sonication methods were less effective, with a CFU of 6.6 ± 8.5 and 12.5 ± 8.5 respectively. Of the 20 CL from asymptomatic individuals, *S. aureus* was recovered in 20% of CL. All of these isolates carried biofilm-associated genes (100% *clfA* and *fnbB*) and formed biofilms *in-vitro*.

Conclusion: The swabbing technique was the most suitable technique for recovering organisms from CL surfaces.

Tear lubricants effects on tear physiology and wettability in contact lens wear

Raied Fagehi, Alan Tomlinson and Katherine Oliver

Department of Life Sciences, Glasgow Caledonian University, Glasgow, UK

Purpose: To investigate the effect of sustained use of eye drops on tear evaporation, osmolarity, and lens wetting in contact lens (CL) wear.

Methods: Twelve habituated subjects (four male and eight female; age 37.54 ± 15.93 years) wore Acuvue Oasys (Johnson & Johnson) lenses for the 4 weeks of the study. The subjects attended for five visits; visit 1, baseline, without lens wear; visit 2, 1 week of lens wear without applying drop; visit 3, after a week of lens wear and using the first drop four times per day (allocated randomly, either Refresh Contacts or Optive Plus (Allergan, Irvine, CA, USA); visit 4 after a week with lenses but no drops; visit 5 a week of lenses wear, using the second eye-drop.Tear evaporation and osmolarity were evaluated at each visit at a temperature of 21°C and two relative humidities (RH), 40% and 10%. Contact lens wettability (de-wetting) was evaluated (at 21°C and 40% RH) by thin film interferometry measuring onset latency, drying duration, peak latency and maximum speed of drying.[1]

Results: CL wear increased evaporation at both 40/10% RHs ($p = 0.07$, 0.02 respectively). Generally a week's use of eye drops did not significantly reduce evaporation at either RH ($p = 0.411$ at 40%, 0.787 at 10% RH). The evaporation rates after use of Refresh and Optive Plus were the same at both RHs. No significant effects were found for the eye drops on the tear osmolarity.All the wettability parameters were significantly improved after 1 week's use of both eye drops (Refresh & Optive). The beneficial effect with Refresh for drying duration and peak latency was greater than for Optive Plus ($p = 0.006$, 0.028 respectively).

Conclusions: In the present study the integrity of the lipid layer (LL) (and tear evaporation) was not significantly affected by the use of eye drops in CL wear. This is probably because the LL of 'young' CL wearers was adequate and could not be enhanced, sufficiently to overcome the disruptive effect of the presence of the lens. CL wettability did improve with both drops with a slight superiority for Refresh Contacts.

Reference: 1. Fagehi R et al. Application of thin film interferometry to measurement of contact lens wettability in-vivo; ARVO 2011 E-abstract: 6524.

Multisensory integration distorts visual time perception

Corinne Fulcher[1], *John Hotchkiss*[1], *Craig Aaen-Stockdale*[1], *Neil W. Roach*[2], *David Whitaker*[1] *and James Heron*[1]

[1]Bradford School of Optometry and Vision Science, University of Bradford, UK, and [2]Visual Neuroscience Group, School of Psychology, The University of Nottingham, Nottingham, UK

Purpose: Examples from the spatial domain suggest that the relative reliability of individual sensory estimates governs the degree to which one modality will dominate during multisensory integration. Here we examine whether these principles extend to the temporal domain by investigating sub-second visual duration perception in the presence of discrepant auditory duration information.

Method: Observers made visual duration discrimination judgments ('which was longer, the first or second stimulus?') between bimodal reference stimuli (320 ms duration visual stimuli presented concurrently with 100–650 ms duration auditory 'distracter' stimuli) followed by variable (200–440 ms) unimodal visual test stimuli. Subjects were instructed to make their decisions based on visual stimuli alone.

Results: Small discrepancies between audio-visual durations were associated with expansions or contractions of perceived visual duration when auditory distracters were relatively long or short, respectively. Further increases in auditory duration discrepancy resulted in declining influence over perceived visual duration. A more diffuse pattern of tuning was observed when auditory durations were substantially shorter than 320 ms.

Conclusion: Our results suggest that the integration of auditory and visual duration information depends on at least two factors: (1) the relative difference in temporal sensitivity between the modalities and, (2) the degree of discrepancy between visual and auditory durations. For longer auditory distracter durations, the perceived extent of this discrepancy is exaggerated by the classic 'sound longer than vision' bias, resulting in a greater perceptual segregation between visual and auditory durations. This segregation is less marked for shorter auditory durations which may be explained by smaller onset/offset differences for shorter auditory distracter durations.

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A flexible morphological augmented vision device for frequency limited visually impaired

Ryan M. Gibson[1], *Ali Ahmadinia*[1], *Scott G. McMeekin*[1], *Niall C. Strang*[2,3] *and Gordon Morison*[1,3]
[1]School of Engineering and Built Environment, Glasgow Caledonian University, UK, [2]School of Health and Life Sciences, Glasgow Caledonian University, UK, and [3]Vision Group, Glasgow Caledonian University, UK

There is a significant number of visually impaired individuals who suffer sensitivity loss to high spatial frequencies, for whom current optical devices are limited in degree of visual aid and practical application. Advances in image and video processing hardware are enabling digital image processing techniques to provide augmented visual aid within innovative platforms such as Head Mounted Display (HMD) devices. The high spatial frequencies of an image can be extracted by edge detection techniques and overlaid on top of the original image to improve visual perception among the visually impaired. Augmented visual aid devices require highly user-customisable algorithm designs for subjective configuration per task, where current digital image processing visual aids offer very little user-configurable options. Mathematical Morphology has been utilised to provide a highly significant user-reconfigurable edge overlay visual enhancement system, where camera captured real-world video scenes are processed and enhanced by an FPGA device and presented on a display in real-time. The presented morphology visual enhancement system obtains a large degree of flexibility, where the edge size, magnitude and colour are user-tuneable during operation in real-time in addition to meeting real-time constraints obtaining 93 fps for high-definition (1920 × 1080) image resolution. The proposed edge enhancement device is capable of processing standard HMD and television resolution dimensions in real-time, offering a degree of user algorithm customisation and flexibility that has not been previously implemented in visual aid devices or morphological architecture.

Tear film biomarker profiling of subjects with dry eye disease

Suzanne Hagan[1,2], *Alan Tomlinson*[1], *Anne Marie Clark*[2] *and Katherine Oliver*[1]
[1]Vision Sciences, Glasgow Caledonian University, UK, and [2]Biological Sciences, Glasgow Caledonian University, UK

Purpose: To assess a panel of cytokines, in tear samples from subjects with dry eye disease (DED) and normal, using a multiplex bead array.

Background: DED is a chronic condition with a complex aetiology, commonly associated with ageing, contact lens wear, immune-deficiency syndromes and refractive surgery.[1] Although one of the three fastest-growing eye problems in ageing populations, DED is significantly under-diagnosed as no 'gold standard' diagnostic tool exists. Tear fluid multiplex studies indicate roles for cytokines in ocular surface inflammation, which may serve as future biomarkers of DED.[2–4]

Methods: Tear fluids (1 μL) from DED subjects and healthy controls were assayed for seven cytokines (IL-1β, IL-2, IL6, IL-8, IL-17, IFN−γ and TNF−α) using the Fluorokine® Multianalyte Profiling Kit (R and D Systems). Standard curves of known concentrations were used to calculate cytokine concentrations and data underwent in-house statistical analysis.

Results: IL-8 was detectable in 12/15 DED (mean = 1156 pg/mL) and 17/20 normals (mean = 457.7 pg/mL). A trend was noted for increased IL-8 in DED subjects, vs normals. Moreover, all seven cytokines were detected in two DED subjects at elevated levels.

Conclusions: IL-8 was the most highly expressed and consistently-detected protein in all tear samples. Although this expression did not reach significance, a trend was noted for increased IL-8 in subjects with dry eye. IL-8 may therefore serve as a potential biomarker of DED.

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Agreement and reproducibility across six instruments for measuring keratometry

Catriona Hamer, Phillip Buckhurst, Hetal Buckhurst and Christine Purslow
Optometry Department, School of Health Professions, Plymouth University, UK

Purpose: To determine the agreement and reproducibility of keratometry measurements across six instruments.

Background: Several devices for measuring keratometry are available to eye care practitioners, with varying methodology. Whilst considered interchangeable, it is important to be aware of differences and the possible clinical impact.

Method: Keratometry (represented by mean spherical equivalent or MSE and J0/J45) was recorded in 100 healthy subjects (34 ± 10.5 years) using six instruments in a randomised order: IOLMaster, Pentacam, OPD Scanner, Medmont, Javal Schiötz and TMS-5. A subgroup of 30 subjects was assessed by a second observer within the same session to determine the inter-observer variability. One randomly selected individual was assessed on 10 separate screening sessions by a single observer to determine the intra-observer variability for each instrument.

Results: The OPD scanner and Javal S provided significantly different results for MSE ($p < 0.001$) and appear to show a systematic difference (flatter and steeper, respectively) compared the other instruments. J0 and J45 were similar for all instruments ($p > 0.05$). Bland and Altman comparison plots indicated that the Pentacam and IOLMaster showed the greatest level of agreement for both MSE and J0/J45. The ICC for the inter-observer comparison for MSE ranged from 0.955 to 0.995, less agreement was found for J0 and J45 (0.3–09) where the TMS-5 showing the greatest correlation and the Javal Schiötz, the lowest. Within a single session measurements of MSE also showed a high COV (0.1–0.3), with the IOL Master performing best.

Conclusion: The variability between instruments increases when looking at corneal astigmatism compared to assessment of MSE.

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Characterisation of the dorsal and ventral pathways using external noise paradigm

Mahesh Raj Joshi, Seong Taek Jeon and Anita Simmers
School of Health and Life Sciences, Glasgow Caledonian University, Glasgow, UK

Background: Visual processing is bifurcated into dorsal and ventral stream implicated for processing of motion and form respectively (Ungerleider and Mishikin, 1982, in: Analysis of Visual Behavior, Cambridge, MIT press). Owing to the different physical properties and limitations in the stimuli used to evaluate these streams, directly comparing the outputs from two streams has been difficult. Current study evaluated the sensitivity to global motion and form perception in varying noise levels.

Methods: We used Glass pattern [Glass, 1969, Nature, 223, 578–579] and random dot kinematogram (RDK) to evaluate and compare each pathway directly by making the experimental parameters as equivalent as possible in both tasks. Four normal observers discriminated global direction of 500 moving dots or overall orientation of 250

dipoles from 12 o'clock. For each trial, direction/orientation of a dot/dipole was sampled from a normal distribution with one of the eight predetermined direction/orientation variances ranging from ±1° to ±120°, whereas the mean direction/orientation to be discriminated was determined by the 3-down-1-up staircase.

Results and conclusion: When plotted against noise levels, the thresholds remained constant at low variances and started to increase as variance increased. Except for one observer, individual thresholds for Glass pattern were consistently higher than those for RDK across the different variance levels; mean log threshold ratio (Glass/RDK) was 1.503 ± 0.24. In the future, functional mechanisms of both pathways will be quantitatively modelled with consideration of noise.

Dichoptic perceptual learning in childhood amblyopia: an exploratory study investigating the use of equal inputs to each eye

Paul J. Knox and Anita J. Simmers
Department of Life Sciences, Glasgow Caledonian University, UK

Purpose: It has previously been shown that a dichoptic-based perceptual learning task can be successful in improving the visual deficit in childhood and adult amblyopia if the contrast of the inputs to each eye are adjusted to equate visibility. The aim of this study was to investigate if the a dichoptic paradigm would bring about similar gains in acuity and stereoacuity if the contrast of the inputs to each eye were not adjusted for visibility but were equal.

Methods: Nine children with amblyopia (mean age 8.2 ± 3 years) took part in the study. The subjects played a simple computer game involving the manipulation of the position and orientation of falling blocks. The game was modified to be presented dichoptically and contrast was set at 70% to each eye. The subjects played the game for 1 h/day for five consecutive days. Clinical measurements of visual acuity, suppression and stereoacuity were taken before and after the 5 h of play.

Results: A statistically significant improvement ($p = 0.0001$) in the mean visual acuity (VA) of the amblyopic eye (AE) was demonstrated – from 0.53 ± 0.17 logMAR pre-training to 0.40 ± 0.18 logMAR post-training. 67% of the amblyopes gained a clinically significant 0.1 logMAR or more of improvement. Forty-four percent of subjects showed an improvement in stereoacuity after training. A significant group difference in stereoacuity was found pre and post-training ($p = 0.048$). There was no difference found in pre and post-training levels of suppression.

Conclusions: This dichoptic-based task with inputs of equal contrast to each eye brought about gains in visual function in a group of children with amblyopia. The gains in VA (AE) were comparable to those of a previous study where the inputs were adjusted for visibility but gains in stereofunction were smaller and occurred in fewer participants than in the previous study.

Face discrimination in amblyopia

Robin Legge, Gunter Loffler, Anita Simmers and Niall Strang
Department of Life Sciences, Glasgow Caledonian University, Glasgow, UK

Background: This study aimed to confirm or deny the existence of a face-specific processing deficit in amblyopes, comparing psychometric face recognition thresholds in a 2AFC task involving the consecutive monocular presentation of bandpass-filtered face images. In each trial a single face stimulus was presented, followed by two face stimuli, one of which was identical to the lead stimulus. Subjects were required to discriminate which of the two trailing faces matched the target stimulus. Subjects also performed a second task which was not intended to invoke face-processing systems, comprising a 2AFC spatial-relations matching task.

Results: Anova indicated significantly raised thresholds for strabismics viewing with their amblyopic eye in comparison with their dominant eye ($p = 0.02$), and in comparison with the dominant ($p = 0.006$) or fellow eye ($p = 0.000$) of normally-sighted subjects. All other group comparisons failed to reach significance. Anova for the spatial relations task indicated significantly raised thresholds for strabismics viewing with their amblyopic eye in comparison with the dominant ($p = 0.003$) or fellow eye ($p = 0.010$) of normally-sighted subjects, and with the dominant eye of anisometropes ($p = 0.018$). All other group comparisons failed to reach significance. Pearson correlation demonstrated a strong correlation between threshold obtained on the face, and on the uncertainty condition for strabismics in both the dominant eye (0.706) and the amblyopic eye (0.657). A strong correlation was also found for the amblyopic eye of anisometropes (0.688). No other inter-condition correlation was found.

Conclusion: Performance of strabismic amblyopes viewing with their amblyopic eye was significantly impaired on both the face-discrimination and the spatial relations task. The strong correlation between strabismic discrimination thresholds in the two conditions comprising this experiment runs contrary to the notion that a face-specific deficit is being observed.

Reliability of computerized testing for assessing near binocular functions

Wei Lin, Christine Dickinson and Catherine Porter
Faculty of Life Sciences, University of Manchester, Manchester, UK

Purpose: To evaluate repeatability of computerized methods (CM) for assessing near binocular functions and their comparability with traditional methods (TM).

Background: Computerized programs for binocular assessments are commercially available, but little is known about their reliability.

Methods: Thirty-three young adults were tested by CM and TM for phoria, fusional reserve (FR) including base-in (BI) and base-out (BO), and accommodative facility (AF). After 1 week, all tests were repeated. The CM tests were performed by Binocular Vision Assessment software (HTS Inc., USA: www.visiontherapysolutions.net/index.php). Reliability was evaluated by Bland-Altman method using coefficient of repeatability (COR) for inter-session comparison and coefficient of agreement (COA) for between-method comparison.

Results: In CM, the FR on BO-recovery and AF test showed that their means increased significantly by 5.39Δ and 2.61 cycles per minute (cpm) in session 2 ($p < 0.05$), and these two tests were also found to be less repeatable than TM based on the higher COR of CM than TM (34.60Δ vs 23.60Δ and 8.39 vs 4.50 cpm). Levels of inter-session repeatability of CM which were similar to TM were found on the tests of phoria and FR (BI-break, BI-recovery and BO-break) because the CM and TM shared similar COR (differences < 1.5Δ). Furthermore, all the tests showed poor agreements between CM and TM with high COA, e.g. 10.68Δ for phoria, 41.81Δ for FR on BO-recovery and 11.98 cpm for AF.

Conclusions: None of the CM tests showed a higher level of repeatability than the equivalent TM and for all of the functions measured there was poor agreement between the two methods.

The 'contrast sensitivity clock': evaluation of a simple test for measuring contrast sensitivity and glare

Chris Longley and David Whitaker
Bradford School of Optometry & Vision Science, University of Bradford, Bradford, UK

Background: The role of the optometrist in assessing visual fitness for driving is at a critical juncture. On the one hand we have those that promote the use (and even the relaxation) of a very basic assessment of vision using a number plate. On the other hand we have an amendment to a recent European Union Directive (2009/113/EEC, Brussels

2009) calling for enhanced assessment of driver's visual performance to be carried out at regular intervals by competent clinicians.

Purpose: One performance measure referred to within the directive is the influence of disability glare on contrast sensitivity. However, the lack of an accepted UK standard measurement technique has led to the UK Department for Transport to reject the relevant parts of the aforementioned directive. This project involves testing a device that hopefully will satisfy this requirement.

Method: Here we present preliminary data gathered using a novel testing device we term 'The Contrast Sensitivity Clock': a quick, easily understood and highly portable test that involves reading clock wise round a ring of letters, reducing in contrast until they become indistinguishable. This is done firstly without the glare source present and then done again with the glare source.

Results and conclusion: We have so far found significant contrast sensitivity differences between groups of patients with and without cataract, indicating this could well be a viable means for assessing contrast sensitivity in practice and thus facilitating the implementation of current EU driving regulations.

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Tear evaporation and inflammatory mediators in dry eye

Eilidh Martin, Suzanne Hagan, Katherine Oliver and Alan Tomlinson

Department of Life Sciences, Glasgow Caledonian University, Glasgow, UK

Purpose: To evaluate the association of tear evaporation rate (TER) modified by therapeutic intervention and the levels of inflammatory mediators in dry eye (DED).

Background: DED is a common ocular condition affecting between 10% and 20% of the population over the age of 40 and this can be expected to increase with an aging population (Moss et al, 2000). Several inflammatory mediators have been shown to be present at a higher concentration in dry eye but there has not, to our knowledge, been a treatment study comparing levels of inflammatory mediators with TER (Enriquez-de-Salamanca et al, 2010). The hypothesis was advanced that therapies which reduced TER would down regulate inflammatory mediators and vice versa (Calonge et al, 2010).

Methods: The study assessed the effectiveness of three eye drop formulations (carmellose sodium with added lipid (C-L), guar gel (G-G) and carmellose sodium (C-S),) routinely used in the treatment of DED. Nineteen DED subjects participated in this randomised three arm cross-over study. Each formulation was applied three times per day, for 1 week periods with a minimum of 1-week washout between treatments. Measurements of evaporation rate (the primary outcome measure) were assessed pre and post treatment with each solution. Tear samples (1 μL) were collected non-traumatically and analysed for IL-1β, IL-2, IL-6, IL-8, IL-17, IFN-γ and TNF-α.

Results: A reduction in TER was defined as a positive response, an increase as negative, with some none responses. The C-L solution produced 7+ves and 5−ves (with seven no change), G-G 8+ves, 8−ves (three no change) and C-S 7+ves, 7−ves (five no change). These *changes in TER* were accompanied by changes in inflammatory cytokines consistent with the hypothesis in 10 (out of possible 12) instances for C-L, 7/16 for G-G and 10/14 for C-S.

Conclusion: Overall, the hypothesis was supported by the results in 27 out of 42 patient therapy sessions. The greatest consistency was found for the C-L formulation.

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White noise and text adaptation reveal the impact of prior visual experience on contrast sensitivity

Colm McGonigle[1,2], *Sheila Rae*[1,2], *Ian van der Linde*[2,3], *Peter Allen*[1,2] *and Shahina Pardhan*[2]

[1]Department of Vision and Hearing Sciences, Anglia Ruskin University, Cambridge, UK, [2]Vision and Eye Research Unit (VERU), Postgraduate Medical Institute, Anglia Ruskin University, Cambridge, UK, and [3]Department of Computing and Technology, Anglia Ruskin University, Cambridge, UK

Purpose: Contrast adaptation has been proposed as an error signal for emmetropisation.[1,2] Individuals are likely to have a pre-existing level of adaptation, dependent on their habitual visual experience, which will manifest itself in the contrast sensitivity function. In this study, we investigate whether resetting prior visual experience, using white noise and text as adapting stimuli, differently influences contrast adaptation in myopes and emmetropes.

Methods: Contrast sensitivity (CS) was measured for spatial frequencies 1.0, 2.0, 4.8, 9.6 and 19.1 c/deg in three conditions: (1) pre-adaptation (pre-adapt); (2) post-adaptation following 30 minutes viewing uniform white noise (post-adapt noise); (3) post-adaptation following 30 minutes reading black-on-white Times Roman text on a screen (post-adapt text). Fourier analysis of the text revealed peak power corresponding horizontally to the stroke width of the letters (9.6 c/deg) and vertically corresponding to rows of text (1.6 c/deg). All subjects were optimally corrected for the viewing distance.

Results: Uniform white noise adaptation revealed a statistically significant elevation in log CS in all participants at 1 c/deg. The change in CS pre-adapt and post-adapt noise was negatively correlated with the baseline pre-adapted log CS at 1 c/deg ($r_{20} = -0.67$; $p < 0.01$), at 4.8 c/deg ($r_{20} = -0.86$; $p < 0.01$) and at 9.6 c/deg ($r_{20} = -0.65$; $p < 0.01$). CS changes post-adapt noise and post-adapt text were significantly correlated with post-adapt noise log CS at 1 c/deg ($r_{20} = -0.79$; $p < 0.01$), 2 c/deg ($r_{20} = -0.74$; $p < 0.01$) and 9.6 c/deg ($r_{20} = -0.53$; $p < 0.05$). When analysed by refractive error group, no significant difference was found in the magnitude of CS adaptation.

Conclusions: Participants with lower baseline log CS showed the greatest contrast adaptation after viewing the white noise and text adaptors, suggesting that previous visual experience is critical in determining the magnitude of contrast adaptation. In post-text adaptation, a significant negative correlation at the spatial frequencies corresponding to the text (1.6 c/deg) and stroke (9.6 c/deg) width was found.

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Haemodynamic responses to reversing checkerboard stimulation in young and old adults

Laura McKernan[1], *Ross Aitchison*[1], *Ana de Freitas*[1], *Sobana Wijeakumar*[2], *Anita Simmers*[1], *Niall Strang*[1] *and Uma Shahani*[1]

[1]Department of Life Sciences, School of Health & Life Sciences, Glasgow Caledonian University, Glasgow, UK, and [2]Department of Psychology, University of Iowa, IA, USA

Purpose: To use functional near infrared spectroscopy (fNIRS) to record changes in oxy (HbO) and de-oxyhaemoglobin (Hb) concentrations in two populations of adults in response to checkerboard stimulation.

Methods: Data were collected on a two-channel oximeter that used the Frequency Domain Multi-Distance (FDMD) method. Stimuli were reversing checkerboards with check widths of either 15 or 30 minutes of arc and were presented to 10 young (mean age 22 years) and 12 old (mean age 70) adults. All adults were normal and healthy and had normal vision. Recordings were taken over the occipital cortex over O1 and O2 of the 10–20 electrode placement system. Initial baseline measures were recorded for up to 2 minutes in response to the presentation of a grey screen, which was of equal mean luminance to the reversing checkerboard stimulus. Each stimulus was presented for 10 cycles of 30 s and interspersed with the control baseline grey screen for 30 s.

Results: During visual stimulation, only young participants showed a reliable increase of HbO from baseline (grey screen), and a decrease in its concentration during interstimulus-interval. Hb changes were substantially smaller than those observed for HbO. However, older adults produced more variable result: group data failed to show a significant difference between the on and off periods of visual stimulation. Varying the spatial frequency of the check widths revealed a significant effect in the elderly participants only; HbO responses to 30 minute checks were larger than those elicited by 15 minute checks.

Conclusion: fNIRS is a valid way to distinguish between haemodynamic responses to stimuli with differing characteristics. Future work is required to elaborate on possible reasons why the haemodynamic responses in elderly participants' were so variable.

Changes in phoria are affected by exposure conditions in stereoscopic displays

Pascaline Neveu, Caroline Coulot, Charles-Antoine Salasc, Corinne Roumes and Anne-Emmanuelle Priot

Armed Forces Biomedical Research Institute, France

Purpose: Accommodation/vergence conflict (A-V conflict) has been proposed to be one of the main reasons for discomfort induced by stereoscopic displays.[1–3] We studied the impact on phoria of the dynamic and mean disparities displayed on a stereoscopic device.

Method: For all conditions, accommodative demand was fixed at 2.5 D. In condition 1, vergence demand oscillated in depth from 3.0 to 4.7 MA creating an A-V conflict within the acceptable fusional reserve convergence. In condition 2, vergence demand was at 3.6 MA creating a fixed A-V conflict. In condition 3, amplitude of oscillation of vergence demand was similar to that in condition 1 except that the mean disparity was in the accommodative plan. In condition 4, there was no A-V conflict, the target was fixed at 2.5 MA. Phoria was assessed every minute during a 20-minute exposure followed by 10 minutes with eyes closed for each condition.

Results: The increase in phoria during exposure was fit with a rise-to-max exponential function. Values of maximal amplitude of change in phoria varied significantly across conditions. The highest was observed in condition 1 ($4.38 \pm 1.21\Delta$). The decrease in phoria during the eyes closed period followed an exponential decay curve. The decay in phoria was more pronounced than its increase.

Conclusions: Change in phoria was very similar to those reported during prism adaptation.[4–6] The magnitude of the A-V conflict affected changes in phoria especially when disparities vary dynamically. In the post exposure period, phoria decreased and tended to stabilize closer to dark vergence.

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A validation of iSight app in pre-school vision screening

Nadia Northway[1], *G. Panesar*[1], *Daphne McCulloch*[1,2] *and Rachel McKay*[1]

[1]Glasgow Caledonian University, Glasgow, UK, and [2]University of Waterloo, Waterloo, ON, Canada

Background: Technologies such iPads are being used more and more in health care. There are many apps available that test vision however few have been validated. The aim of this study was to compare visual acuity measured with the Crowded Kay Picture test CKC (a LogMAR based crowded picture test widely used in the UK) and the iSight app (that includes an electronic version of the CKC) in pre-school children.

Method: Monocular acuity was measured using both CKC and the CKC mode on the iSight iPad app in 35 preschool children aged between 3 years 8 months and 4 years and 7 months. Test order was randomised to minimise the effect of fatigue and loss of attention. iSight test was carried out by a student Optometrist and an Orthoptist used the CKC. Both tests were carried out at 3 m. VA was recorded in LogMAR and timing in minutes and seconds was noted. Behaviour during each test was noted as 'good', 'average' or 'poor'. Each participant was tested in one single session. A staircase method was used when testing.

Results: The range of acuities measured varied from −0.100 to 0.400 LogMAR for iSight, with a mean RE value of 0.045 LogMAR and LE 0.059 LogMAR. The range for CKC varied from −0.100 to 0.500 LogMAR, with a mean RE value of 0.073 LogMAR and LE 0.081 LogMAR. Mean visual acuity obtained with each test showed good agreement with correlation values of RE 79.6% and LE 82.6%. There was 100% agreement between the tests in terms of screening pass or fail criteria.

Conclusion: This study would suggest that the iSight app can be considered a reliable tool for visual acuity assessment in pre-school children. Any small differences found were not of clinical significance and the iSight test did not pass any children requiring onward referral making it a useful screening tool. Inter-tester differences may have

influenced results. There was however generally good agreement between the conventional flip booklet method and the iPad and analysis showed that differences in acuity level were found mainly in the less co-operative children suggesting compliance in testing was a factor however fatigue effects were not. The iSight app available on iPad is a reliable alternative way to test crowded visual acuity in preschool children.

Measuring and interpreting the biomechanical properties of the cornea

Daniela Oehring, Christine Purslow, Phillip Buckhurst and Hetal Buckhurst
School of Optometry, Plymouth University, Plymouth, UK

Purpose: The assessment of the biomechanical properties of the cornea is important to refractive and therapeutic corneal treatment, in addition to implications for eye growth and IOP measurement. Studies that have assessed corneal biomechanics with devices such as the Ocular Response Analyser (ORA; Reichtert Inc) and the CorvisST (Oculus Optikgeraete GmbH) highlight questions regarding the validity and reliability of the biomechanical metrics obtained. It is particularly important to establish what is known about the factors which may contribute to the assessment of corneal biomechanics *in vivo*.

Method: A systematic literature review was conducted surrounding measurement principles and calculation of principle outputs, as well as influencing factors. One hundred and thirty-two peer-reviewed articles were appraised.

Results: Corneal biomechanics have been analysed via several measurement principles in the past. Of these, the biomechanical metrics derived during non-contact tonometry are the most studied. The ORA and CorvisST are both based upon the principle of corneal applanation with a defined air puff. However the pressure parabola, with which the biomechanical parameters will be calculated for each measurement, seems to be extrapolated and needs to be investigated. It is likely that differences in the characteristics of the puff of air will affect the loading/unloading behaviour of the cornea providing variation in the principle outputs. Furthermore, consideration needs to be given to uncontrolled biological factors such as surface hydration, tear film stability, corneal thickness and corneal temperature.

Conclusion: The clinical values of accurate and valid measures of corneal biomechanics are currently large. Future investigations are required to determine the influence of uncontrolled factors.

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The character of monocular and binocular perceptual visual distortions in adult amblyopia

Marianne Piano[1], *Anita J. Simmers*[1] *and Peter J. Bex*[2]
[1]Visual Neuroscience Group, Glasgow Caledonian University, UK, and [2]Schepens Eye Research Institute, Boston, USA

Aim: To measure monocular and/or binocular perceptual visual distortions in adults with long-standing treated or untreated amblyopia and identify any relationships between distortion severity and clinical features of amblyopia in the sample.

Methods: Twenty-three amblyopes (strabismic, anisometropic, mixed strabismic/anisometropic and microtropic types) and 11 age-matched controls underwent a standardised orthoptic assessment and were measured for perceptual visual distortions under dichoptic viewing conditions. Testing involved moving a crosshair (viewed by amblyopic eye) to click on a target dot (viewed by fellow eye) that appeared in 16 locations comprising two nested rectangles spanning the central 5° of the visual field. A subset of 15 amblyopes and four controls were measured for perceptual visual distortions under monocular viewing conditions. Testing involved reconstruction of a square from a single reference dot and reference line by positioning eight dots consecutively. Seven amblyopes in this subset also had their contrast sensitivity measured. Global distortion index was calculated in each case as the average vector distance from perceived and veridical dot locations.

Results: Seventeen of the 23 amblyopes had measurable perceptual visual distortions. Amblyopic subjects had a significantly higher global distortion index than age-matched controls (dichoptic: 0.57° vs 0.17°, Mann–Whitney $U = 62$, $p < 0.001$; monocular: 0.25° vs 0.13°, Mann–Whitney $U = 122$, $p = 0.013$). Distortion severity was significantly affected by amblyopia type, with mixed strabismic/anisometropic amblyopes having the highest global distortion index ($F = 3.92$, hypothesis df = 3, error df = 33, $p = 0.017$), followed by strabismic, microtropic and anisometropic types. Amblyopia depth, level of refractive error in the amblyopic eye, contrast sensitivity threshold and level of binocular function (normal, subnormal and absent) did not affect the global distortion index.

Conclusions: Seventy-four percent of our sample of amblyopes had perceptual visual distortions. Mixed strabismic/anisometropic amblyopes had the most severe distortions, followed by strabismic, microtropic and anisometropic amblyopes respectively. Perceptual visual distortions in amblyopic subjects appear independent of amblyopia depth, refractive error, contrast sensitivity threshold, and level of binocular function. Their existence in treated amblyopes suggests that although current amblyopia treatment modalities improve visual acuity and contrast sensitivity, they do not address this additional impact of amblyopia upon veridical perception.

In vitro measurement of light scatter caused by intraocular lens glistenings

Eva Philippaki[1], *Andy Doraiswamy*[2] *and Christopher C. Hull*[1]
[1]Division of Optometry and Visual Science, City University London, UK, and [2]Advanced Vision Science Inc. (AVS), USA

Background: Intraocular lenses (IOLs) can develop inclusions in their polymer matrix known as glistenings, which can potentially increase intraocular light scatter. The purpose of this study was to quantify the light scatter produced by glistenings *in vitro*.

Methods: Seven IOLs with glistenings graded from 0 to 4+ were measured for light scatter at angles from 0° to 17.5° and for pupil sizes of 3, 4 and 5 mm. Digital images of each IOL were recorded with a Nikon FS-2 photo slit-lamp using standardized settings and a Nikon D-90 digital camera. Light scatter was quantified by calculating the scatter index (n), and area under the scatter function (AUSF).

Results: Increased light scatter was demonstrated in IOLs with glistenings compared to clear lenses. The variation in scattered light intensity with angle was not linear for all angles, as predicted by theory, but can be split into small-angle (0–0.5°) and large-angle domains (beyond 0.5°). For a 5 mm pupil size, small-angle scatter with a clear IOL gave $n = 3.11$ and an AUSF = 0.03 while for a grade 3 IOL n was 2.18 and AUSF = 0.12. However, association between AUSF and clinical grade was not statistically significant ($p > 0.7$, all pupil sizes).

Conclusions: Glistenings produced an increase in light scatter when assessed using the scatter index or area under the scatter function that was not associated with the clinical grade. The effect of size, density and distribution of glistenings on light scatter needs to be investigated further as well as the association between glistenings and human visual function, which remains unclear.

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Cell substrates for *ex vivo* cultured human corneal endothelial cells

Kostadin Rolev, Alexandra Chittka and Madhavan Rajan
Department of Life Sciences and Vision and Eye Research Unit, Anglia Ruskin University, Cambridge, UK

Purpose: To review the scientific evidence for the use of cell substrates in *ex vivo* culture of human corneal endothelial cells in relation to cell attachment, migration and proliferation.

Background: There is significant interest in developing a cell based therapy for corneal decompensation, to replace traditional treatments such as DSAEK and DMEK that require donor tissue for successful visual rehabilitation. The main limiting factor is the poor proliferation potential of the corneal endothelial cells (CE) in culture. Cell substrates have been shown to play an important role in cell attachment, migration and proliferation. The human corneal endothelium is naturally supported by the Descemet's membrane whose primary component is collagen type IV with collagen type VIII, fibronectin and sulfated proteoglycans.Therefore, the CE proliferation inducing ability of the following substrates was evaluated: collagens type I and type IV, fibronectin, FNC coating mix, Laminin-5, laminin + chondroitin sulfate, chondroitin sulfate, laminin, gelatin, fibroin and other fibroin mixtures and bovine corneal endothelial cell-derived ECM (BCEC ECM).

Methods: Thirty peer reviewed articles were studied of which nine included cell proliferation assays of cultures grown on different substrates. The cell density change induced by each substrate with respect to the control was compared across the different articles and a mean value ± SD was used to determine the ideal substrate for stimulating human corneal endothelial cell proliferation.

Results: Bovine corneal endothelial cell-derived extracellular matrix (BCEC ECM) followed by laminin-5 appear to to be most efficient in inducing corneal endothelial cell proliferation in *ex vivo* cultures.

Conclusion: The basic composition of cell substrates appear to have varying influence on proliferation and viability of *ex vivo* cultured corneal endothelium, the understanding of which would assist future strategies for cell therapy to cure corneal blindness.

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Obstacle crossing in patients with visual field impairment

Amy C. Scarfe[1], *Matthew A. Timmis*[1,2], *Daryl R. Tabrett*[1], *Rupert R. Bourne*[1] *and Shahina Pardhan*[1]
[1]Vision and Eye Research Unit, Postgraduate Medical Institute, Anglia Ruskin University, Cambridge, UK, and [2]Sport and Exercise Sciences Research Group, Department of Life Sciences, Anglia Ruskin University, Cambridge, UK

Purpose: To assess the adaptive gait of patients with visual field loss.

Background: Approximately 33% of older adults report falling at least once a year.[1] Although the causes of falls are multifactorial, visual impairment is a major risk factor.[2] Using 3D motion analysis, we investigated how patients with either peripheral (PFL) or central (CFL) field loss negotiate a floor-based obstacle, in comparison to normally sighted controls.

Methods: In two separate studies, motion data were collected from 24 PFL (73 ± 8 years), 10 CFL (77 ± 10 years) and 35 control participants (71 ± 7 years), as they walked up to and stepped over a floor-based obstacle. Movement of lead and trail limbs were analysed. LogMAR VA, CS (Pelli Robson), stereopsis and visual field (Humphrey 30-2 SITA) were measured.

Results: Compared to controls, PFL and CFL patients exhibited increased lead (PFL $p < 0.01$, CFL $p = 0.04$) and trail toe clearance (PFL $p = 0.03$, CFL $p = 0.02$) and decreased lead toe horizontal velocity (PFL $p = 0.02$, CFL $p = 0.049$). PFL also patients exhibited greater between-trial variability than controls ($p < 0.05$). Worst-eye mean deviation (MDworst) was significantly correlated with lead toe clearance ($r = -0.536$; $p = 0.007$) and velocity($r = 0.454$; $p = 0.026$) in PFL patients. No other correlations were found between vision and kinematics.

Conclusions: In comparison to controls, visually impaired patients exhibit adaptations in obstacle crossing kinematics; with increased toe clearance and decreased velocity both decreasing the likelihood of tripping.[3] However, despite their more cautious approach, the increased variability in PFL patients has previously been suggested to increase fall risk.[4] This, together with correlation findings, highlights the importance of the peripheral visual field during obstacle crossing.

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A unique insight into the progression of unilateral scotoma to acute homonymous hemianopia

Syed Nadeemullah Shafiullah and Neha Zubair Dar
School of Medicine, University of Liverpool, UK

Purpose: To report a unique case of an elderly patient who presented with unilateral scotoma, but progressed to acute homonymous hemianopia within a few hours.

Background: Isolated homonymous hemianopia,[1,2] residual visual function in the hemianopic field,[3] recovery and rehabilitation[4,5] have been studied extensively leading to conceptualising of the visual fibre projections on to the primary visual cortex. However they were studied in stable patients, post cerebrovascular event. This report captures acute visual field changes presenting as a relative scotoma and progressing to a hemianopic defect in an optometric practice. A timeline of visual field changes that accompany occipital cortex lesions has not been documented previously. This is primarily because of the latency of presentation following a vascular or traumatic event.

Results: In our patient, the initial, unilateral relative scotoma, was beyond the 300 field of vision commonly used in screening for visual field defects in clinical practice. The progression of field loss was also

asymmetric and relative; only becoming absolute and typically neurological in the later stages.

Discussion/Conclusion: A clinician encountering a snapshot of any of the initial field defects in our patient's timeline could easily settle for a less sinister cause of the underlying pathology. The value of a confrontation fields despite a normal initial central visual field and serial field testing in symptomatic patients is emphasised. The significance of the defects along the timeline will interest the anatomist in postulating alternate models for primary visual cortex perfusion and insult.

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Visual acuity loss in patients with AMD, measured using a Vanishing Optotype letter chart

Nilpa Shah[1], *Steven C. Dakin*[1], *Adnan Tufail*[1], *Catherine A. Egan*[1] *and Roger S. Anderson*[1,2]
[1]NIHR Biomedical Research Centre for Ophthalmology, Moorfields Eye Hospital NHS Foundation Trust & UCL Institute of Ophthalmology, London, UK, and [2]Vision Science Research Group, University of Ulster, Coleraine, Northern Ireland, UK

Purpose: Vanishing Optotype (VO) letters have a pseudo high-pass design so that the mean luminance of the target is the same as the background and the letters thus 'vanish' once the resolution threshold is reached in the fovea. We wished to investigate how visual acuity measurements using charts constructed from these letters compared to charts of conventional letter design, in both normal subjects and patients with differing levels of AMD.

Methods: Sixty participants were recruited; 30 with no ocular abnormalities and 30 with AMD and no other significant ocular pathology. Following refractive error correction, each subject underwent monocular (single letter scored) visual acuity measurements using ETDRS charts 1 and 2, and charts of the same layout but constructed using VO letters (VO1 and VO2). All tests were performed in a random sequence. The methods of Bland and Altman were employed with test-retest variability (TRV) expressed as 95% confidence intervals for agreement.

Results: Visual acuity measurements with the VO chart were, on average, approximately 3 logMAR lines 'worse' than those with conventional letter design in subjects with AMD compared to a difference of only 1.5 logMAR lines in normal subjects. This difference between the two groups was statistically significant ($p < 0.05$, unpaired t-test). Similar TRV's of approximately ± 0.10 logMAR were found for both the ETDRS and VO charts in both groups.

Conclusions: AMD patients display a measurably larger visual acuity deficit using VO letter charts compared to conventional ETDRS charts, with no significant difference in test-retest variability.

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Dietary analysis and nutritional behaviour in age-related macular disease affected subjects

Rebekah Stevens, Hannah Bartlett and Richard Cooke
Ophthalmic Research Group, Aston University, Birmingham, UK

Purpose: Age-related macular degeneration (AMD) is the leading cause of visual impairment in adults over the age of 50 years in the UK.[1] The objective of this study was to determine a group of AMD patient's ability to prepare and cook healthy food, and analyse their diets.

Methods: A questionnaire was designed and validated using focus groups. One hundred and fifty-eight participants were recruited via the Macular Society helpline and a telephone interview was conducted by trained workers. The questions covered demographic data, cooking and shopping capabilities, and participants completed a 24 h food diary.

Results: Over half (57%) of participants that felt their vision was poor on the day of the interview. The majority of participants (>60%) can prepare and cook their own food, and primarily get their food from a supermarket. Many participants felt that nothing was preventing them from preparing and cooking food, or from changing their diet should they wish to. The main factor that influenced participant's food choices was preference (44%). Overall, participants were under-consuming the nutrients analysed and the average calorific intake was also lower than recommended for their age-group. The average lutein and zeaxanthin intake was especially low in both genders: there was a significant correlation between low intake and participants who were not able to cook a hot meal.

Conclusions: For an 'informed' population, many participants were under-consuming useful nutrients for their condition. It is essential to design more effective dietary education and dissemination methods for people with, and at risk of, AMD.

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Why does cataract surgery not reduce falls rate as much as you would expect?

Elvira Supuk[1], *Alison Alderson*[1], *Christopher J. Davey*[1], *Andy Scally*[2], *Clare Green*[3], *Norman Litvin*[3] *and David B. Elliott*[1]
[1]Bradford School of Optometry & Vision Science, University of Bradford, UK, [2]School of Health Studies, University of Bradford, Bradford, UK, and [3]Ophthalmology Department, Bradford Teaching Hospitals Foundation Trust, Bradford, UK

Purpose: To determine whether the rate of falls is increased after large changes in spectacle magnification following cataract surgery and updated spectacles.

Background: Falls are a major health problem in the elderly population. Visual impairment has been shown to approximately double falls risk. Despite this the improvement in falls rate due to cataract surgery is limited.

Method: Three hundred older adults (mean age 76.9) undergoing age-related cataract surgery were invited to participate in this study. A questionnaire was issued asking details regarding falls history, activities of daily living and type of spectacles worn. Data regarding falls were collected using monthly falls diaries. Participants' pre-operative and

post-operative habitual refractive correction was obtained from their hospital records.

Results: To date 50 participants have completed the study. Eleven of these participants had a history of falls in the 6 months prior to surgery and eight had a history of falls 6 months after the surgery. This shows a limited improvement in falls rate post-surgery, despite good improvements in mean visual acuity from 0.44 logMAR to 0.18 logMAR. We found those subjects with a myopic prescription prior to cataract surgery were more likely to fall with an odds ratio of 11.25 (95% CI 0.97–130.22).

Conclusion: Falls rate was the greatest in subjects with myopic prescriptions pre-operatively, however further analysis is required to determine whether this could be due to the large myopic shifts that can occur with nuclear cataracts. A larger sample size and both pre and post-op data will be analysed once data collection has been completed.

Funding: The study is funded by the Dunhill Medical Trust. Elvira Supuk was supported from a grant from the Federation of Ophthalmic and Dispensing Opticians.

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Investigating changes in the crosslink components of the accommodation and vergence responses following virtual stereoscopic viewing

Laura Sweeney, Lyle S. Gray, Dirk Seidel and Mhairi Day
Department of Life Sciences, Glasgow Caledonian University, Glasgow, Scotland, UK

Purpose: To determine the effect of viewing stereoscopic displays upon the crosslink interactions.

Methods: Thirteen subjects (mean age 21.4 ± 1.9 years) participated with informed consent. Subjects viewed the stereoscopic stimulus (a high contrast maltese cross) created using a stereoscopic LCD monitor (Zalman, South Korea), for 30 minutes. The stimulus was viewed at 40 cm creating a fixed accommodation stimulus of 2.50D. The vergence stimulus varied sinusoidally at a speed of 0.25 Hz, from 1.63 to 2.5 MA. Stimulus and response AC/A and CA/C ratios were measured prior to, and immediately post-exposure to the stereoscopic stimulus. During both AC/A and CA/C measurement accommodation was measured using the Shin Nippon SRW-5000 infrared optometer (mean of 10 consecutive static readings) and vergence was measured continuously using the Skalar IRIS infrared eyetracker.

Results: A significant decrease was found in both stimulus ($p < 0.05$) and response ($p < 0.05$) AC/A ratios following stereoscopic viewing. A significant negative correlation existed between baseline response AC/A ratio measurements and the change in AC/A ratio ($p < 0.01$). No significant change was demonstrated in stimulus or response CA/C group mean data following stereoscopic viewing. No correlation was found between the response CA/C ratio and the change in CA/C ratio, however considerable inter-subject variability existed, with five subjects showing a decrease, and eight subjects showing an increase in CA/C post exposure.

Conclusions: Stereoscopic displays substantially alter both AC/A and CA/C crosslinks. These effects are observed after relatively short periods of exposure. More work is needed to elucidate the precise nature of changes in individual subjects.

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Methods for measuring accommodation

Nicola Szostek, Hetal Buckhurst, Christine Purslow and Phillip Buckhurst
Optometry Department, School of Health Professions, Plymouth University, UK

Purpose: To review the current methodology for measuring accommodation in research.

Methods: A consideration of the literature.

Results: During the accommodative process the thickness, curvature and equatorial size of the crystalline lens changes in order to increase the dioptric power of the eye. Loss of accommodation begins from birth and continues throughout life, and although some pseudo-accommodation may still remain, accommodative facility is effectively lost after 50 years of age.[1] The purpose of this review was to compare and contrast methods of assessing accommodation that are most often used in clinical and research settings. Subjective methods include: push-up, minus to blur and subjective optometers. The objective methods reviewed were: dynamic retinoscopy, pharmacologically-induced accommodation with a refractometer (or autorefractor), open-field autorefractors, open field aberrometers and power refractors. Subjective methods, most often used in clinical practice, take into account 'true' accommodation plus 'pseudo-accommodation', leading to an over-estimation of the magnitude of accommodation.[2] Objective measurements tend to be more accurate in measuring 'true' accommodation; further accuracy can be achieved by presenting a 'real' target to the subject, so that blur, convergence and proximal cues stimulate accommodation. Open field auto-refractors have led to improvements in measuring the dynamics of accommodation which proves useful in research studies to monitor very small changes in accommodation.

Conclusions: Understanding the limitations that exist for subjective and objective methods is relevant to any research into presbyopia and accommodation, and the open field auto-refractor appears to be the most useful in modern research.

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Mapping visual impairments in macular disease

Venkatesh Varun[1], *Velitchko Manahilov*[1], *Niall Strang*[1], *Gerard McGowan*[2], *David Yorston*[2] *and Tsveta Ivanova*[2]
[1]Department of Life Sciences, Glasgow Caledonian University, Glasgow, UK, and [2]Tennent Institute of Ophthalmology, Gartnavel General Hospital, Glasgow, UK

Purpose: To develop a new test for quantifying visual impairment in macular disease.

Background: Many patients with macular disease e.g. epiretinal membrane (ERM), macular hole (MH) or age-related macular degeneration (AMD) experience metamorphopsia or scotomas in their central vision. However, a reliable mapping of visual impairment in macular disease is not yet available.

Methods: Twenty-three patients with ERM, 23 patients with MH and 10 patients with AMD were tested with D-charts which contain octagon shaped rings of grids, formed by black squares of various densities, at eccentricities in the range of 0.5–11.5° with different dot density and size. Patients looked monocularly at a central fixation disk and indicated the sectors of apparent distortions. Metamorphopsia scores were determined for each ring and sector. Scotomas in AMD patients

were mapped by asking to report if the grid appeared blurred without structure.

Results: Pre-operatively, metamorphopsia were significantly larger than zero at eccentricities of 0.5–3.5° (ERM) and 0.5–7.0° (MH). Following surgery, 12 subjects reported reduced or absent visual distortions. Four patients with AMD reported presence of scotomas, six reported distortions. Long- and short-term correlations for AMD patients were: 0.87 ± 0.23 and 0.98 ± 0.02, respectively.

Conclusions: D-charts allow quantification of metamorphopsia strength and location in ERM and MH in a wide range of visual acuities. The high long and short-term correlations in AMD suggest that D-charts are reliable in quantifying scotomas and distortions. D-charts could be used as a tool for mapping and monitoring central vision impairments in macular disease.

Illusory contour perception in amblyopes

Richard Watson[1], *Robin Legge*[1], *Anita Simmers*[1] *and Peter Bex*[2]

[1]Department of Life Sciences, Glasgow Caledonian University, Glasgow, UK, and [2]Schepens Eye Research Institute, Boston, USA

Purpose: Can Amblyopes integrate information from both eyes to perceive illusory figures?

Background: Low-level deficits in amblyopia are well-known. However illusory contours are believed to be 'high-level' percepts involving occipital brain areas such as MOG.[1] We used illusory figure perception to ask whether high-level percepts are impoverished in amblyopes.

Method: Kanizsa squares were briefly presented (100 ms) to Normals and Amblyopes using shutter glasses. The angle of the inducers' mouths was varied around 90°, producing 'fat' or 'thin' illusory squares. Inducers were presented in three conditions: all to left eye; all to right; two to left, two to right. Task: to judge whether the angle, A, of the inducers' was $90° < A < 90°$. Control: observers performed same task with inducers rotated 180° hence no illusory figure invoked ('Non-Illusory')

Results: Thresholds of Normals and Amblyopes were higher for 'Non-illusory' configurations, confirming that observers were perceiving illusory figures. Normals' thresholds for angle discrimination not significantly different to Amblyopes. Amblyopes showed no significant difference in performance when either eye was presented with all the stimuli, but were significantly worse in the dichoptic condition compared to their Fellow eye alone. Similarly, Normals were significantly worse in the dichoptic condition compared to the non-dominant condition.

Conclusions: Illusory contours were more readily perceived by both groups when all stimuli were presented to a single eye than when the information was split between the eyes. Amblyopes were as capable at integrating stimuli from both eyes to perceive illusory contours as were Normals. Illusory contour perception in Amblyopes is preserved.

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