ESLRR symposium: Evolution of Devices for the Visually Impaired

Chairs: Antonio Filipe Macedo, PhD and Ava K. Bittner, OD, PhD

Dr. Antonio Filipe Macedo, currently teaching at Linnaeus University (Linnéuniversitetet), Department of Optometry and Medicine, Kalmar, Sweden. He has an active research group at University of Minho, department of Physics and Optometry, Braga, Portugal. He has a background in Physics and Optometry (BSc), Biomedical Engineering (MSc) and Ophthalmology (PhD). He has a strong interest visual function assessment, vision rehabilitation and socio-economic problems of vision loss. Apart from Optometry or Ophthalmology his projects involve collaborations with colleagues working in health economics, public health, psychology, mathematics and neurology. In the laboratory, he has interest in oculomotor studies.

Dr. Ava Bittner is a Low Vision Research Diplomate of the American Academy of Optometry and currently an Associate Professor at the Nova Southeastern University, College of Optometry in Ft. Lauderdale. She received her PhD in clinical investigation from Johns Hopkins, where she completed a clinical research post-doctoral fellowship and then joined the faculty as an Assistant Professor. Dr. Bittner has been funded by NIH and private industry sponsors to conduct clinical trials for patients with retinitis pigmentosa, with a particular focus on electro-stimulation therapies. She has published nearly 30 peer-reviewed journal articles, including a Cochrane systematic review on telerehabilitation for low vision, which is a topic that she is continuing to research.

Symposium outline

The spectrum of possibilities for improved visual functioning of persons with visual impairment was enhanced with optical devices, and further expanded with the introduction of electronic devices. The patient outcomes with these devices are anticipated to become more effective in an era of “digital revolution” in which consumer electronic devices can incorporate many of the features of the “classical” electronic devices. This symposium will cover aspects that range from: (i) clinical trials using the “classical” electronic devices, (ii) prototypes that can lead to innovative equipment, (iii) new techniques to be implemented in future prototypes, and (iv) an all-new approach to rehabilitation using the “internet of things”. The symposium aims to foster a productive discussion about the future of electronic devices as telerehabilitation and new technologies for low vision become a reality.

Symposium speakers

Chris Dickinson (UK) - Do individuals with moderate visual impairment who use optical aids benefit from the use of portable electronic magnifiers?

Ricardo Vergaz Benito (Spain) - Electrochromic filters and augmented reality in new technical aids for low vision

Éric Castet (France) - Evaluation of a Gaze-controlled Vision Enhancement System for Reading and Face Identification in Visually Impaired People

Nicole Ross (USA) - Low Vision Patients' and Providers' Satisfaction with Telerehabilitation

Ava Bittner (USA) - Proposed Applications of Internet of Things (IoT) and Machine-to-machine (M2M) Technologies for Remote Monitoring of Low Vision Rehabilitation or Devices

Do individuals with moderate visual impairment who use optical aids benefit from the use of portable electronic magnifiers?

Chris Dickinson

Division of Pharmacy and Optometry, School of Health Sciences, Faculty of Biology, Medicine and Health, University of Manchester, Manchester Academic Health Science Centre

Purpose: To determine the effect of using portable-electronic vision enhancement systems (p-EVES) in addition to optical low vision aids (LVAs), in terms of near vision visual function, quality of life and wellbeing, for individuals with a moderate visual impairment.
Methods: Experienced optical aid users were recruited to a randomised cross-over trial. The trial intervention was the addition of a p-EVES device to the existing optical LVA(s) for 2 months, and the control intervention was optical LVA use only, for 2 months. Results: A total of 82 participants completed the study. Overall, maximum reading speed for high contrast sentences was not statistically significantly different for optical aids and p-EVES, although the critical print size and threshold print size which could be accessed with p-EVES were statistically significantly smaller ($p<0.001$ in both cases). Optical aids were used for a larger number of tasks ($p<0.001$), and used more frequently ($p<0.001$). However p-EVES were preferred for leisure reading by 70% of participants, and allowed longer duration of reading ($p<0.001$). When a p-EVES was available, participants were able to carry out more tasks independently ($p<0.001$), and reported less difficulty with a range of near vision activities ($p<0.001$). However health-related quality of life, wellbeing, and capability showed no significant change, and vision-related quality of life showed only a slight improvement (unadjusted $p = 0.043$). Conclusions: The study provides evidence that p-EVES devices can play a useful role for some individuals in supplementing the range of low vision aids used to reduce activity limitation. When they are used in addition to optical aids, the incremental effect on quality of life is small. Acknowledgement: This publication presents independent research funded by the National Institute of Health Research (NIHR) under its Research for Patient Benefit (RfPB) Programme (Grant Reference Number PB-PG-0211-24105). The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health. The author has no conflict of interest to declare.

Bio sketch: Chris Dickinson is Professor of Clinical Optometry in the Division of Pharmacy and Optometry, Faculty of Biology, Medicine and Health at the University of Manchester, UK, where she founded a Low Vision Clinic in 1986. She is also an Honorary Optometrist Consultant at Manchester Royal Eye Hospital and held the "Queen Victoria Eugenia" British Hispanic Chair at Universidad Complutense Madrid, Spain in 2016. Her main research interests are in design and evaluation of optical devices, particularly those for rehabilitation of visual impairment. Chris has been involved in clinical trials to evaluate prism relocation for macular degeneration, autofocus telescopes, training for eccentric viewing, and portable electronic magnifiers. Chris was Editor-in-Chief of Ophthalmic and Physiological Optics from 2000-2010, and was elected to a Life Fellowship of the College of Optometrists in 2010.

Electrochromic filters and augmented reality in new technical aids for low vision

Ricardo Vergaz Benito, César Vega-Colado, Juan Carlos Torrez-Zafra
GDAF-UC3M, Universidad Carlos III de Madrid, Spain

Electrochromic devices have been used and even marketed as smart windows or as rear-view mirrors in cars. However, its use as optical filters for vision, although it has been tried since the eighties, has never been commercialized. For patients with pathologies that makes them extremely sensitive to sudden changes of light-darkness, there is a need to carry on a series of filters. Nowadays there is only one commercial comfortable solution of similar operation, the photochromatic lenses, which change their coloration when receiving ultraviolet radiation. A new system, integrated in a glasses frame like the current commercial solutions, capable of applying different algorithms and totally configurable through a user interface, was developed using electrochromic devices as active filters. The results of different algorithms applied to different electrochromic crystals were described. Response times, transmittance variation and electrical consumption were analyzed to apply the optimum algorithm in relation to its consumption / switching time. Improvements in speed and custom control were obtained compared to photochromic lenses. On the other hand, an augmented reality system applying image multiplexing has been also clinically tested at IOBA (Univ. Valladolid). Ergonomy, hardware acceleration and information of depth are its main features. Acknowledgement: These two aids have been developed under the Comunidad de Madrid SINFOTON-CM Research Program (S2013/MIT-2790).

Bio sketch: Ricardo Vergaz Benito got MScs in Physics and Electronics Engineer and Ph. D. in Science (Physics) by University of Valladolid in 2001. Since 2001 he works at Universidad Carlos III de Madrid (UC3M), where he is currently Associate Professor at the Dep. Tecnología Electrónica, researching in the Displays and Photonics Applications Group (GDAF-UC3M). His research lines are electrooptic materials and devices characterization, technical aids for visual impairment and other disabilities, and design of novel nanometric devices using scattering directionality. Co-author of 40 JCR-indexed publications and 60 communications in International Conferences. Supervisor of 2 Ph.D theses, and co-supervisor of other 2. He has leaded 4 competitive National Projects in Spain, two of them related with the development of visual technical aids.

Evaluation of a Gaze-controlled Vision Enhancement System for Reading and Face Identification in Visually Impaired People

Eric Castet, Aurélie Calabrèse and Carlos Aguilar
LPC, Aix Marseille Univ, CNRS, Marseille, France

People with low vision, especially those with Central Field Loss (CFL), need magnification to read and to identify faces. The flexibility of Electronic Vision Enhancement Systems (EVES) offers several ways of magnifying an image. Due to the restricted field of view of EVES, the need for magnification is conflicting with the need to navigate through the image. We have developed and implemented a real-time gaze-controlled system whose general goal is to offer the possibility of smartly magnifying a portion of an image (Region Of Interest - ROI) while maintaining global viewing of the rest of the image. We present the results of two proof-of-concept studies. In the first study, we first tested a variant of our system that was specifically designed for text reading: the ROI was a word or a set of words. This condition was contrasted with two other conditions that mimicked commercially available advanced systems known as CCTV (closed-circuit television systems). A gaze-contingent artificial 10° scotoma was used in the three conditions in order to simulate macular degeneration. Healthy subjects with a gaze-contingent scotoma read aloud sentences from a French newspaper. Reading speed was measured for each sentence: it did not show any significant difference between the three systems and learning curves were similar in the three conditions. In the second study, we tested another variant specifically designed for face processing: the ROI was a face. Patients with Age Related Macular Degeneration had to match two faces of the same person displayed on a monitor among distracter faces. Analysis of reaction times and accuracy showed that average performance was higher with our system. Overall, our studies suggest that the principles underlying the gaze-controlled enhanced system might be further developed and fruitfully incorporated in different kinds of EVES. Acknowledgement: Grant support: Essilor International.

Bio sketch: Eric Castet Directeur de Recherche - Co-directeur de l'équipe Perception & Attention Aix-Marseille Université - CNRS - Laboratoire de Psychologie Cognitive - UMR 7290 - Fédération de recherche 3C Site ST CHARLES - 3 Place Victor Hugo - 13003 Marseille

Low Vision Patients' and Providers' Satisfaction with Telerehabilitation

Nicole C. Ross, Pat Yoshinaga, Angie Bowers, Tony Succar, John Shepherd, Ava K. Bittner

Purpose: Providing remotely delivered telerehabilitation services to low vision (LV) patients for follow up evaluations and device training may be helpful to reduce barriers to care, such as lack of available transportation to in-office visits. We explored the feasibility and acceptability of this model by LV patients and providers.

Methods: Three LV providers (1 OT and 2 ODs) conducted telerehabilitation sessions from their office with eight adults in their homes. Subjects had bilateral vision loss due to AMD or diabetic retinopathy, recently received a hand-held magnification device for reading, and self-reported difficulty with returning for follow-up rehabilitation training at their provider's office. Subjects received instructions and loaner devices (i.e., MiFi, tablets) to access a secure videoconference site for telerehabilitation. Subjects and providers completed a post-telerehabilitation survey to rate the session at which training was provided for magnifier use while reading MNread cards.

Results: Using the preferred tablet, providers had no difficulty with evaluating subjects' reading speed with their magnification device for all participants except one for whom there was only a little difficulty. Providers had little to no difficulty with determining reading accuracy. For all subjects except one, the providers reported only a little (n=4) or no difficulty (n=3) with observing the subjects' working distance with their magnifier. All subjects indicated being satisfied with receiving LV telerehabilitation; half of them were very satisfied. All subjects agreed they were comfortable receiving telerehabilitation and being evaluated via videoconferencing; half of them strongly agreed with this statement. All except one subject reported they were very interested in receiving telerehabilitation services again if their visual needs change.

Conclusions: Positive feedback from both the subjects and providers in this pilot study supports the potential value of LV telerehabilitation. A randomized controlled trial is needed to evaluate the efficacy of LV telerehabilitation for improving patient outcomes.

Acknowledgement: Grant support: Envision Research Institute

Proposed Applications of Internet of Things (IoT) and Machine-to-machine (M2M) Technologies for Remote Monitoring of Low Vision Rehabilitation or Devices

Ava K. Bittner, OD, PhD (1) and Andrew Jacobson (2)
(1) Nova Southeastern University; College of Optometry; (2) Black Box Network Services

Background: By the year 2020, the number of devices connected to the Internet is predicted to reach 50 billion. Internet of Things (IoT) is defined as the interconnection of communications devices using Machine-to-Machine (M2M) protocols and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Explosive growth and rapid implementation of IoT is largely attributed to improvements in lower-cost technology, open standards and optimized wireless protocols. By 2030, the number of sensors connected to objects is expected be around 100 trillion. The integration of new technologies involving IoT remote monitoring sensors may be readily applied to low vision (LV) devices.
Content: Telemonitoring strategies may include sensors that are wearable or mounted into LV devices or aids, in conjunction with smart mobile devices that are used as communication gateways. These sensors or devices provide real-time data regarding the usability of LV assistive aids and device abandonment. Specifically, they can help determine the frequency and type of usage (e.g., duration, patterns over time, location, illumination). They may help serve as assessment tools that may be used either in conjunction with telerehabilitation to gauge LV device usage on a continuous basis (i.e., outside of rehabilitation sessions, within the patient's home) or during clinical trials of LV devices and aids. M2M interconnected sensor units may detect motion (accelerometer) or environmental factors (video cameras or pressure), exchange information and assist the patient in daily living challenges, such as fall prevention. The knowledge derived from wearable or LV device mounted sensor-based data may be used to develop personalized and optimized rehabilitation training.
Implications: Opportunities abound for LV researchers and clinicians to integrate these new strategies into their protocols and practice. Future studies should evaluate their feasibility and patients/providers satisfaction with the implementation of these approaches.

Bio sketch: Dr. Ava Bittner is a Low Vision Research Diplomate of the American Academy of Optometry and currently an Associate Professor at the Nova Southeastern University, College of Optometry in Ft. Lauderdale. She received her PhD in clinical investigation from Johns Hopkins, where she completed a clinical research post-doctoral fellowship and then joined the faculty as an Assistant Professor. Dr. Bittner has been funded by NIH and private industry sponsors to conduct clinical trials for patients with retinitis pigmentosa, with a particular focus on electro-stimulation therapies. She has published nearly 30 peer-reviewed journal articles, including a Cochrane systematic review on telerehabilitation for low vision, which is a topic that she is continuing to research.