The Internet Journal of Allied Health Sciences and Practice
A Peer Reviewed Publication of the College of Health Care Sciences at Nova Southeastern University
Dedicated to allied health professional practice and education
http://ijahsp.nova.edu Vol. 12 No. 4 ISSN 1540-580X

The Current Role of Orthoptists: A Systematic Review

Jessica Stanhope, GCertClinEpid, BPhysio(Hons), AMusA[1]
MaryAnne Gregory, DipOrth[2]
Karen Murphy, BPhty, MAPA, FACHSM, FAICD[3]

1. Research Assistant, International Centre for Allied Health Evidence, University of South Australia, Adelaide, South Australia
2. Senior Orthoptist, ACT Government Health Directorate, Canberra, Australian Capital Territory
3. Chief Allied Health Officer, ACT Government Health Directorate, Canberra, Australian Capital Territory

Australia

CITATION: Stanhope J, Gregory M, Murphy K. The Current Role of Orthoptists: A Systematic Review. *The Internet Journal of Allied Health Sciences and Practice.* Oct 2014. Volume 12 Number 4.

ABSTRACT

Purpose: This review aimed to determine the tasks performed by orthoptists, the types of patients they manage, their work settings, the professionals they work with, and the professionals they receive referrals from and refer to. **Methods:** A systematic search of seven databases was conducted to identify all studies regarding the role of orthoptists that were published in English in peer-reviewed journals from January 2003 to January 2013. Reference lists of all included studies, as well as studies regarding ocular conditions which were excluded as they did not specifically report the role of orthoptists, were screened manually to identify additional relevant studies. Key orthoptic organisations (International Orthoptic Association, British & Irish Orthoptic Society, Orthoptics Australia, the Canadian Orthoptic Society, and the American Association of Certified Orthoptists) were asked to provide any literature relevant to this review. Studies were allocated to the National Health and Medical Research Council hierarchy of evidence. Systematic reviews were appraised using the Centre for Evidence Based Medicine Systematic Review Critical Appraisal Sheet, and level II or III_1 studies appraised with the PEDro scale. Data pertaining to the patient's ocular conditions and co-morbidities, tasks performed, work settings, colleagues/ teams, and referrals were extracted and reported descriptively. **Results:** No relevant studies were identified; hence this is an empty review. **Conclusion:** No studies have been published (January 2003-January 2013) investigating the role of orthoptists. There is, therefore, an urgent need for research into this area to ensure that policy-makers can best utilise orthoptists within their health services and to ensure that the training of orthoptists matches the professional roles in which they are likely to undertake.

INTRODUCTION

Since the first orthoptic private practice opened in 1928, the role of orthoptists has expanded.[1] Initially their role involved working closely alongside ophthalmologists to assist children using exercises to obtain better binocular vision.[1] Over time this role has developed to encompass the assessment, diagnosis, and management of a range of ocular conditions. It is important to determine what the current role of these professionals entails, to enable policy-makers and other health professionals to properly utilise these professionals, and to ensure that training institutions are aware of the role their students may be required to undertake after graduating, rather than limiting roles to more professional duties and work settings.

This systematic review sought to answer the following questions:

1. What patient groups do orthoptists assess and manage?
2. What tasks do orthoptists perform?
3. What work settings do orthoptists work within?
4. Which professionals do orthoptists work with, receive referrals from and refer to?

METHODS

Systematic Search

A systematic search of key library databases (OvidSP Embase, OvidSP Medline, EbscoHost Cumulative Index to Nursing and Allied Health Literature (CINAHL), EbscoHost Health Source, Scopus, Web of Science, ProQuest Nursing and Allied Health Source, Informit Health Collection) was conducted in January 2013. The terms orthoptic OR orthoptics OR orthoptist OR orthoptists were searched in the title, abstract, or keyword fields, and searches were limited to peer-reviewed studies published in English from 2003 to 2013 where permitted by the databases. Studies from the authors' personal collections were also included if they met the inclusion criteria. Furthermore, key orthoptic organisations (International Orthoptic Association, British & Irish Orthoptic Society, Orthoptics Australia, the Canadian Orthoptic Society, and the American Association of Certified Orthoptists) were contacted for additional peer-reviewed literature which may inform this review.

Study Identification

All studies obtained were exported into EndNote X6 where duplicate studies were excluded. The title and abstract of all remaining studies were screened before the full texts were obtained and screened. Studies were excluded if they were not published from January 2003 to January 2013 in English, were not available in full text (e.g. conference abstracts), or were not published in peer-reviewed journals. Studies were also excluded if they did not investigate the role of orthoptists. To widen the search, the reference lists of all included studies were manually screened to identify any studies which investigated the role of orthoptists.

Assigning Levels of Evidence

The study design of included studies were determined and assigned to the National Health and Medical Research Council (NHMRC) hierarchy of evidence.[2]

Critical Appraisal

Critical appraisal was only conducted for studies identified as level III_1 or higher. Systematic reviews were appraised using the Centre for Evidence Based Medicine Systematic Review Critical Appraisal Sheet, and the PEDro scale was used for level II and III_1 studies.[3,4] Lower level studies were not appraised due to the biases inherent in their designs.

Data Extraction

Data regarding the ocular conditions managed, co-morbidities of patients, tasks performed, work settings, colleagues/ teams, and the referrals to and from orthoptists were extracted into a purpose-built Excel Spreadsheet.

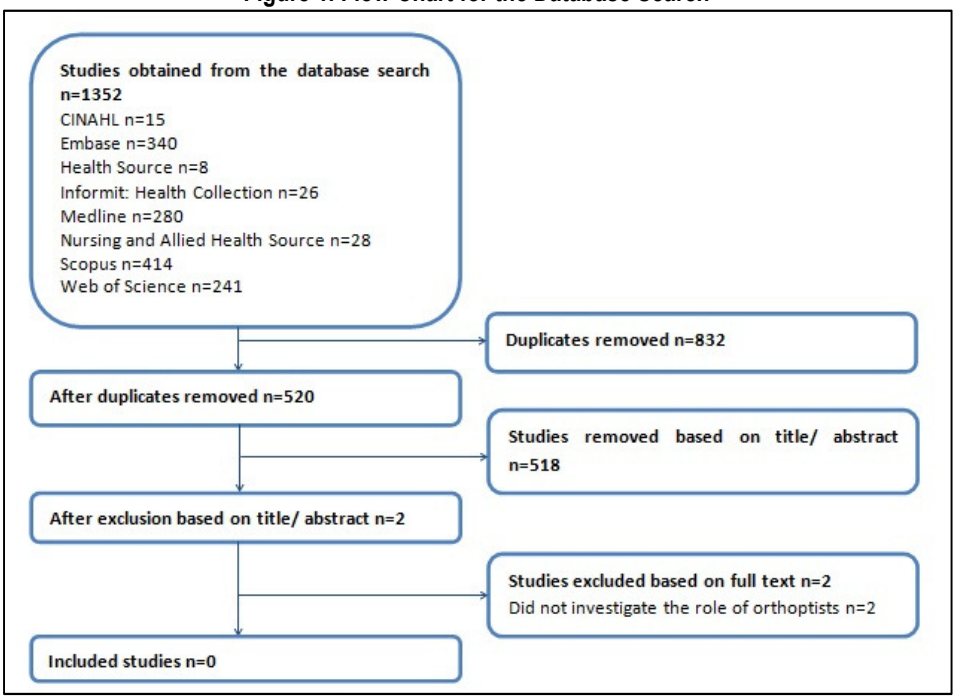
Analysis

Due to the nature of this review, all data were reported descriptively.

RESULTS

One thousand, three hundred fifty two (1352) studies were obtained through the database search, none of which met the inclusion criteria (see Figure 1 for the flow chart). No studies were obtained from the orthoptic organisations.

Figure 1. Flow Chart for the Database Search



CINAHL: Cumulative index to nursing and allied health literature

DISCUSSION

This is the first systematic review to investigate the current role of orthoptists. No studies investigating the role of orthoptists (published January 2003 to January 2013) were identified; hence, this represents an empty review. Proposed reasons for empty reviews include investigating a new research area, having questions that are too specific, or by having inclusion criteria which is too stringent.[5] The nature of the review was broad, and the inclusion criteria appropriate to the review questions; hence, this does not account for the lack of literature identified in this review. Furthermore, while it may be argued that studying the roles in healthcare is new or novel, this is not the case. For example, the roles of radiographers, physiotherapists, occupational therapists, pharmacy technicians, and general healthcare/ rehabilitation assistants have been investigated in primary studies and systematic reviews.[6-16] It was therefore assumed that the roles of orthoptists would have been investigated in the same manner; however, this review indicates that this is not the case.

The Role of Orthoptists

Whilst no studies were identified which specifically investigated the role of orthoptists, a number of exclude studies reported relevant data either as background information to their studies or in the role that orthoptists took in their studies. All excluded studies were screened for this information, which has been used to provide an overview of the role of orthoptists. Although this approach does provide data regarding the roles of orthoptists, it may not reflect the full scope of orthoptists roles. This approach, despite its limitations, does have some value, for the data obtained may be used, along with other methods (e.g. expert consultation, and focus groups), to design appropriate surveys to investigate more widely the role of orthoptists. The following section serves to provide an overview of the role of orthoptists based upon any relevant data reported in studies identified in the systematic search which were excluded only on the basis of not specifically investigating the role of orthoptists (n=123).

Patient Groups Assessed and Managed by Orthoptists

The ocular conditions managed by orthoptists are reported in Table 1.

Table 1. The Conditions Detected and Managed by Orthoptists

Strabismus • Acute acquired concomitant esotropia[17] • Decompensating phoria (eso, exo, hyper)[18] • Fusion disruption[19] • Heterophoria[20] • Heterotropia[20] • Hyperopia[21] • Intermittent exotropia (including distance)[22-26] • Orthophoria[27] • Phoria[24] • Strabismus[1,27-42]	**Vision** • Amblyopia (including strabismic) [1,31,33,36,38,42-61] • Decreased/ poor visual acuity[43,62-64] • Diplopia[17,18,29,42,65-67] • Poor vision[39,56] • Visual fields testing and management[65] • Vision impairment/ pathology[68,69] • Visual neglect[65,67]
Refractive • Ametropia[21] • Anisometropia[21] • Astagmatism[21] • Myopia[21,70] • Refractive error/ symptoms[20,33,62,71,72]	**Extraocular muscles** • Convergence deficiency[65] • Inferior oblique muscle overaction[73] • Inferior rectus underaction[18] • Superior oblique myokymia[18]
Orbital • Orbital cellulitis[18] • Orbital dacryoadenitis[18] • Orbital fracture[18,74] • Orbital metastases[18]	**Retinal** • Flashes or floaters[62] • Macular pathology (including holes)[75,76] • Diabetic retinopathy/ eye disease[77-80]
Anterior segment • Anterior and/or posterior segment injuries[62,81] • Aphasia[71] • Cataracts (including congenital)[39,62,71,82] • Corneal scarring[39] • Dilated pupils[65] • Ectopic lentis[71] • Red eyes[62]	**Neurological** • Chronic progressive external ophthalmoplegia[83] • Compressive optic neuropathy[84] • Internuclear ophthalmoplegia[18] • Nystagmus[31,39] • Near reflex spasm[18] • Ptosis[39] • Vertigo[85]
Syndrome • Asthenopia[65] • Duane retraction syndrome[39] • Dyslexia[86]	**Disease/ condition** • Eye & ocular problems[87] • Glaucoma[62,88,89] • Presbyopia[30]

Patients seen by orthoptists may also present with a range of co-morbidities (see Table 2). Orthoptists are also involved in pre-operative assessments for monovision laser vision correction, refractive surgery, inferior oblique muscle myectomy and recession and surgery for strabismus, as well as pre- and post-operative assessment for macular hole repair.[29,35,73,76,90]

Table 2. The Co-morbidities of Patients Seen by Orthoptists

Conditions:

- Angelman Syndrome[21]
- Blocked VP shunt[18]
- Brain tumours[84]
- Brainstem lesions[18]
- Cochlear implant[98]
- Cranial nerve paralysis[18]
- Deafness[99]
- Demyelination[18]
- Depression[100,101]
- Developmental disorders[37]
- Diabetes[18,79,80]
- Down Syndrome[102]
- Hydrocephalus[38]
- Hypertension[18]
- Infants of opiate dependent mothers[28]
- Intellectual disabilities[103]
- Malignancy[18]
- Migraine[18]
- Miller Fisher syndrome[18]
- Multiple disabilities[69]
- Multiple sclerosis[104]
- Myasthenia gravis[18]
- Myositis[18]
- Neurological conditions[67]
- Neurosarcoid[18]
- Psychomotor retardation[37]
- Sinusitis[18]
- Spina bifida cystica[91]
- Stroke[65,68,92-96]
- Temporomandibular joint dysfunction[97]
- Thyroid conditions[18]
- Trauma[18]

Tasks Performed by Orthoptists

Orthoptists perform a range of assessment and management tasks, as outlined in Tables 3-5.

Table 3. Assessment Tasks Performed by Orthoptists

Assessment tasks performed:

- Assess accommodation[105]
- Assess binocularity using 20 dioptre prism[106]
- Assess lid function[94]/ closing[62]
- Assess colour vision[107]
- Assess contrast sensitivity[107]
- Assess diplopia[84]
- Assess eye dominance[105]
- Assess fixation[108]
- Assess head posture[48,109]
- Assess intraocular pressure (including the use of air tonometer)[90,110]
- Assess isotropia photorefraction[111]
- Assess monocular fixation pattern[51]
- Assess motor fusion (including amplitude in synoptophore)[76,112,113]
- Assess ocular alignment[20,21,33,39,93,94,114]
- Assess extraocular/ocular motility/ movement (including smooth pursuit and saccadic movement, including with a Goldmann telescope) [21-23,27,33,39,41,48,67,68,73,76,83,84,90,93,94,97-99,103,105,107-109,112-118]
- Assess pupils (eg direct and consensual pupil reaction to light)[62,90,94,103,117]
- Assess reference eye[105]
- Assess refraction (including cycloplegic, and autorefraction)[21,23,35,41,62,90,106,113,116,119]
- Assess sensorial status[27,97]
- Assess stereoacuity[39,41,45,47,76,98,99,103,112,113,115,120,121]/ stereopsis[33,68,90,94,105-107]
- Assess stereo function[51]
- Assess strabismus[1,109,116,117,119]
- Assess suppression[73]
- Assess the angle of strabismus (near and far fixation)[34,35,51]
- Assess the AC/A ratio[23]
- Assess the cornea (including corneal light reflex)[39,90]
- Assess the optic nerve head[89]
- Assess the retina (including retinal correspondence)[90,94]
- Assess vergence (convergence/ divergence, fusional vergence, and fusional vergence reserves)[23,33,85,94,97,103-105,108,111,113,114,116,122,123]
- Assess visual acuity (corrected and uncorrected, including Snellen/monocular logMAR acuity)[22,23,27,33,35,39,41,45,47,48,51,54,55,57,61-63,67,73,78,79,84,90,93,98,99,103-107,109,112,113,115,116,118-121,124,125]
- Assess visual fields[63,67,73,93,94,107,126]
- Assess visual neglect/ inattention[67,93]
- Assess in surgery[1]
- Detect amblyopia[119]
- Detect heterophoria decompensation[123]
- Detect hypermetropia[119]
- Inspect the anterior eye[33,109,120]
- Measure phoria[113]

Table 4. Tests Conducted by Orthoptists

Tests conducted:
• Conduct a prism base out test[39,76,108,111,117,118]
• Conduct a mallet unit test[123]
• Conduct a prism reflex test[39]
• Conduct automated refraction test[34]
• Conduct biometry[126,127]
• Conduct perimetry (including computerised)[93]
• Conduct corneal pachymetry[126]
• Conduct corneal topography[90]
• Conduct cover/uncover tests (including prism cover tests, near and distant, unilateral and alternating)[22,23,34,35,39,41,47,48,61,67,73,76,84,85,90,94,97,98,103-106,109,111-113,116,118,119,124]
• Conduct cycloplegic retinoscopy[34]
• Conduct a dilated fundoscopy[23]
• Conduct functional investigations[128]
• Conduct Hirschberg test[47,111]
• Conduct hole in card test[90]
• Conduct ocular dominance testing[90]
• Conduct on-road driving assessments (including eye movement patterns, and identification of vision-based information in the driving environment)[107]
• Conduct optical coherence tomography[75,126]
• Conduct photorefraction test[34]
• Conduct stereo retinal imaging[89]
• Conduct stereotests[45,112,118]
• Conduct the Maddox test[34,85,97,113]
• Conduct tonometry (including applanation)[62,88,103,126]
• Conduct prism tests (near and distant)[112]
• Conduct prism vergence testing[39,61]
• Conduct tests with synoptophore[29]
• Take fundus photographs[77,79,80,110]
• Take video refraction measurements[117]
• Use Hess charts[73]
• Use Plusoptix Vision Screener[129]

Table 5. Treatment Strategies Used by Orthoptists

Treatment tasks:

- Conduct convergence training[42,65]
- Correct refractive error[43]
- Conduct visual training[1]
- Dispense binocular vision corrections[128]
- Educate parents about inserting contact lenses, and hygiene and care of contact lenses[71]
- Educate the family about the use and care of Bangerter foil[61]
- Explain diagnostic findings and/or management options with the patient, parents, teachers and other health and/or medical professionals[53-55,65,69,92]
- Instillation of eye drops, including anaesthetic, dilating and fluorescent drops[62,103,126]
- Perform visual rehabilitative procedures[128]
- Prescribe atropine[43]
- Prescribe and modify glasses/ lenses[38,42,44,65]
- Prescribe occlusion[36,42-45,49,53-58,65,67,130]
- Provide advice regarding head positioning[65,67]
- Provide advice regarding positioning of reading material[104]
- Provide ongoing guidance and counselling[71]
- Provide pre-operative counselling[90]
- Recommend/ prescribe exercises (including for fusion, convergence)[1,24,42]
- Recommend/ prescribe prisms[42,65,67,131]
- Teach scanning to compensate for visual field loss[65]
- Train a nurse to conduct vision screening for children[120]
- Train school teachers in eccentric viewing to assist students[63]
- Trial contact lenses[90]
- Use bar of prisms[85]
- Use synoptophore technique[85]
- Visual neglect training[65]
- Vision rehabilitation[63]

Work Settings for Orthoptists

Orthoptists work in a range of settings including baby clinics, general practice surgeries, hospitals (within general and special eye clinics, strabismus clinics, orthoptic departments, stroke units, ophthalmology departments and centres for visual independence), health facilities, home clinics, low vision clinics, medical centres, ophthalmic/ ophthalmology departments, ophthalmology clinics, orthoptic departments, outpatient orthoptic clinics, primary care facilities, private practice, research clinics, schools/ kindergartens, special schools, stroke services, tertiary referral centres and university eye clinics.[18,23-25,27,28,33,35,36,38,39,41,47,52,54-57,62,63,65,71,72,79,84,86,87,91,93,100-103,106,109,111,116-118,124-126,130,132-135]

Work Colleagues and Referrals

Orthoptists may work within multidisciplinary, stroke or health service provision teams, working alongside other health professionals, neuropsychologists, nurses, ophthalmic nurses, ophthalmologists, optometrists, physiotherapists, rehabilitation workers, special education teachers, and support staff.[28,38,46,63,65,68,87,88,95,100,101,120,126,133]

Very little information was identified relating to the interaction between orthoptists and their colleagues. Macfarlane et al. reported that within a stroke unit, the orthoptist would select and teach the patient convergence exercises, which the patient could then perform independently, or under the supervision of another health professional (eg a physiotherapist).[65] In Fitzmaurice and Clarke's study they reported that the orthoptist taught a special education teacher about eccentric viewing and the EccView program which their students were to use.[63] They also provided support as required.

Orthoptists received referrals from eye casualty departments, general practitioners, neurosurgeons, optometrists, and stroke teams, as well as following surgery or when patients are referred for cochlear implantation.[18,33,37,84,94,98,135] They may refer to other orthoptists, community health centres, optometrists, specialist ophthalmic clinics, eye casualty departments, hospitals, low vision rehabilitation services, specialised institutes for the visually impaired, mental health services, self-help/ support groups, neuro-ophthalmic clinics, ophthalmologists, physicians and to other health professionals.[18,31,39,47,101,102,106,109,116,134,136-138]

CONCLUSION

The main finding of this systematic review is that there has been no peer-reviewed research published within the past 10 years which have investigated the role of orthoptists. This identifies an urgent need for research in this area to ensure that policy-makers and educational institutions have a greater understanding of the role of orthoptists, ensuring that orthoptists are appropriately utilised within health services, and that the training provided to orthoptists matches the professional roles in which orthoptists will be required to partake. Whilst an overview of the roles has been provided from background information reported in the literature, this does not report the full scope of the orthoptists roles, and should therefore be considered with this in mind. This data may, however, be utilised by researchers in guiding protocol development for studies into the roles of orthoptists.

ACKNOWLEDGEMENTS

We would like to acknowledge Prof. Karen Grimmer (Director, iCAHE, University of South Australia) for her assistance in developing the protocol, and providing feedback on the draft manuscript, and Leah Baker (Orthoptist, Indigenous and Rural Eye Health Service (IRIS) – a joint initiative of the Australian Society of Ophthalmologists and the Australian Government) for providing feedback on the draft manuscript.

REFERENCES

1. Helveston EM. Visual training: Current status in ophthalmology. *American Journal of Ophthalmology.* 2005;140(5):903-910.
2. National Health and Medical Research Council. NHMRC additional levels of evidence and grades for recommendations for developers of guidelines: Stage 2 Consultation. *National Health and Medical Research Council, Australian Government, accessed online January 18, 2013 <http://www.nhmrc.gov.au/_files_nhmrc/file/guidelines/stage_2_consultation_levels_and_grades.pdf>.* 2009.
3. University of Oxford. Centre for Evidence Based Medicine Systematic Review Critical Appraisal Sheet. *Centre for Evidence Based Medicine, University of Oxford, accessed online February 25, 2013, <http://www.cebm.net/index.aspx?o=1157>.* 2005.
4. The George Institute for Global Health. PEDro Scale. *PEDro Physiotherapy Evidence Database, accessed only February 25, 2013 <http://www.pedro.org.au/english/downloads/pedro-scale/>.* 1999.
5. Yaffe J, Montgomery P, Hopewell S, Shepard LD. Empty reviews: a description and consideration of Cochrane systematic reviews with no included studies. *PLoS ONE.* 2012;7(5):e36626.
6. Price RC, Le Masurier SB. Longitudinal changes in extended roles in radiography: a new perspective. *Radiography.* 2007;13(1):18-29.
7. Kumar JA. Role of physiotherapists in intensive care units of India: a multicenter survey. *Indian Journal of Critical Care Medicine.* 2007;11(4):198-203.
8. Chaboyer W, Gass W, Foster M. Patterns of chest physiotherapy in Australian Intensive Care Units. *Journal of Critical Care.* 2004;19(3):145-151.
9. Kardos M, White BP. The role of the school-based occupational therapist in secondary education transition planning: a pilot survey study. *The American Journal of Occupational Therapy.* 2005;59(2):173-180.
10. O'Leary. Two national surveys of hospital pharmacy technician activities to support the review of national qualifications. *J Pharm Pract Res.* 2012;42:43-47.
11. Lin I, Goodale B, Vilanueva K, Spitz S. Supporting an emerging workforce: characteristics of rural and remote therapy assistants in Western Australia. *Aust J Rural Health.* 2007;15:334-339.
12. Pullenayegum S, Fielding B, Du Plessis E, Peate I. The value of the role of rehabiltiation assistant. *Br J Nurs.* 2005;14(14):778-784.
13. Stanhope J, Beaton K, Grimmer-Somers K, Morris J. The role of extended scope physiotherapists in managing patients with inflammatory arthropathies: a systematic review. *Open Access Rheumatology: Research and Reviews.* 2012;4:49-55.
14. Stanhope J, Grimmer-Somers K, Milanese S, Kumar S, Morris J. Extended scope physiotherapy roles for orthopedic outpatients: an update systematic review of the literature. *Journal of Multidisciplinary Healthcare.* 2012;5:37-45.
15. Lizarondo L, Kumar S, Hyde L, Skidmore D. Allied health assistants and what they do: a systematic review of the literature. *Journal of Multidisciplinary Healthcare.* 2010;3:143-153.
16. Stanhope J, Pearce C. Role, implementation, and effectivenss of advanced allied health assistants: a systematic review. *Journal of Multidisciplinary Healthcare.* 2013;6:423-434.
17. Firth AY. Heroin and diplopia. *Addiction.* 2005;100(1):46-50.
18. Comer RM, Dawson E, Plant G, Acheson JF, Lee JP. Causes and outcomes for patients presenting with diplopia to an eye casualty department. *Eye.* 2007;21(3):413-418.
19. Digout LG, Awad AH. Restoration of binocular single vision after long-term fusion disruption. *Journal of AAPOS.* 2003;7(3):185-189.

20. Leone J, Cornell E, Morgan IG, et al. Prevalence of heterophoria and associations with refractive error, heterotropia and ethnicity in Australian school children. *Br J Ophthalmol.* 2010;94:542-546.
21. Michieletto P, Bonanni P, Pensiero S. Ophthalmic findings in Angelman syndrome. *Journal of AAPOS.* 2011;15(2):158-161.
22. Le T, Koklanis K, Georgievski Z. The fixation target influences the near deviation and AC/A ration in intermittent exotropia. *Journal of AAPOS.* 2010;14(1):25-30.
23. Asadi R, Ghasemi-Falavarjani K, Sadighi N. Orthoptic treatment in the management of intermittent exotropia. *Iranian Journal of Ophthalmology.* 2009;21(1):35-40.
24. Pejic Z, Wong W, Husain R, Ling Y, Farzavandi S. Fusion exercises for treatment of intermittent exotropia and phoria. *American Orthoptic Journal.* 2006;56:138-146.
25. Buck D, Clarke MP, Powell C, Tiffin P, Drewett RF. Use of the PedsQL in childhood intermittent exotropia: estimates of feasibility, internal consistency reliability and parent-child agreement. *Quality of Life Research : An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation.* 2012;21(4):727-736.
26. Piano M, O'Connor AR. Conservative management of intermittent distance exotropia: A Review. *American Orthoptic Journal.* 2011;61(1):103-116.
27. Chiesi C, Chiesi L, Cavallini GM. Evaluation of refraction in a statistically significant sample: changes according to age and strabismus. *Journal of pediatric ophthalmology and strabismus.* 2009;46(5):266-272.
28. Gill AC, Oei J, Lewis NL, Younan N, Kennedy I, Lui K. Strabismus in infants of opiate-dependent mothers. *Acta Paediatrica, International Journal of Paediatrics.* 2003;92(3):379-385.
29. Kushner BJ, Kowal L. Diplopia after refractive surgery: occurrence and prevention. *Arch Ophthalmol.* 2003;121:315-321.
30. Oystreck DT, Lyons CJ. Presbyopia complicating pre-existing strabismus. *Canadian Journal of Ophthalmology.* 2003;38(4):272-278.
31. Buncic JR. A clinician's approach to infantile nystagmus. *American Orthoptic Journal.* 2004;54(1):88-94.
32. Rychkova SI, Ninio J. Paradoxical fusion of two images and depth perception with a squinting eye. *Vision Research.* 2009;49(5):530-535.
33. Groenewoud JH, Tjiam AM, Lantau VK, et al. Rotterdam AMblyopia Screening Effectiveness Study: Detection and causes of amblyopia in a large birth cohort. *Investigative Ophthalmology & Visual Science.* 2010;51(7):3476-3484.
34. Paff T, Oudesluys-Murphy AM, Wolterbeek R, et al. Screening for refractive errors in children: The plusoptiX S08 and the Retinomax K-plus2 performed by a lay screener compared to cycloplegic retinoscopy. *Journal of AAPOS.* 2010;14(6):478-483.
35. Schutte S, Polling JP, van der Helm FCT, Simonsz HJ. Human error in strabismus surgery: quantification with a sensitivity analysis. *Graefes Archive for Clinical and Experimental Ophthalmology.* Mar 2009;247(3):399-409.
36. Van De Graaf ES, Van Kempen-Du Saar H, Looman CWN, Simonsz HJ. Utility analysis of disability caused by amblyopia and/or strabismus in a population-based, historic cohort. *Graefe's Archive for Clinical and Experimental Ophthalmology.* 2010;248(12):1803-1807.
37. van Rijn LJ, Langenhorst AEL, Krijnen JSM, Bakels AJ, Jansen SM. Predictability of strabismus surgery in children with developmental disorders and/or psychomotor retardation. *Strabismus.* 2009;17(3):117-127.
38. Aring E, Andersson S, Hård AL, et al. Strabismus, binocular functions and ocular motility in children with hydrocephalus. *Strabismus.* 2007;15(2):79-88.
39. Hu VH, Starling A, Baynham SN, Wager H, Shun-Shin GA. Accuracy of referrals from an orthoptic vision screening program for 3- to 4-year-old preschool children. *Journal of AAPOS.* 2012;16(1):49-52.
40. MacEwen CJ, Chakrabarti HS. Why is squint surgery in children in decline? *British Journal of Ophthalmology.* 2004;88(4):509-511.
41. Nassif DS, Piskun NV, Hunter DG. The Pediatric Vision Screener III: Detection of strabismus in children. *Archives of Ophthalmology.* 2006;124(4):509-513.
42. Shainberg MJ. Vision therapy and orthoptics. *American Orthoptic Journal.* 2010;60(1):28-32.
43. Georgievski Z, Koklanis K, Leone J. Orthoptists' management of amblyopia - A case-based survey. *Strabismus.* 2007;15(4):197-203.
44. Tan JHY, Thompson JR, Gottlob I. Differences in the management of amblyopia between European countries. *British Journal of Ophthalmology.* 2003;87(3):291-296.
45. Rees MG, Woo CLH. Pediatric eye disease investigator group amblyopia treatment review. *American Orthoptic Journal.* 2007;57(1):99-103.
46. LaRoche GR. The hidden challenges of mixed amblyopia. *American Orthoptic Journal.* 2009;59(1):67-75.
47. Gandjour A, Schlichtherle S, Neugebauer A, Rüssmann W, Lauterbach KW. A cost-effectiveness model of screening strategies for amblyopia and risk factors and its application in a German setting. *Optometry and Vision Science.* 01 Mar 2003;80(3):259-269.

48. König HH, Barry JC. Cost-utility analysis of orthoptic screening in kindergarten: a Markov model based on data from Germany. *Pediatrics.* 2004;113(2):e95-108.
49. Loudon SE, Polling JR, Simonsz B, Simonsz HJ. Objective survey of the prescription of occlusion therapy for amblyopia. *Graefe's Archive for Clinical and Experimental Ophthalmology.* 2004;242(9):736-740.
50. France TD. Charlie Brown, amblyopia, and me: A (not so short) personal history of the past forty years of diagnosing and treating amblyopia. *American Orthoptic Journal.* 2010;60(1):73-81.
51. Fronius M, Sireteanu R, Zubcov A. Deficits of spatial localization in children with strabismic amblyopia. *Graefe's Archive for Clinical and Experimental Ophthalmology.* 2004;242(10):827-839.
52. Kämpf U, Shamshinova A, Kaschtschenko T, Mascolus W, Pillunat L, Haase W. Long-term application of computer-based pleoptics in home therapy: Selected results of a prospective multicenter study. *Strabismus.* 2008;16(4):149-158.
53. Loudon SE, Fronius M, Looman CW, et al. Predictors and a remedy for noncompliance with amblyopia therapy in children measured with the occlusion dose monitor. *Investigative ophthalmology & visual science.* 2006;47(10):4393-4400.
54. Tjiam AM, Holtslag G, Van Minderhout HM, et al. Randomised comparison of three tools for improving compliance with occlusion therapy: an educational cartoon story, a reward calendar, and an information leaflet for parents. *Graefes Archive for Clinical & Experimental Ophthalmology.* 2013;251(1):321-329.
55. Tjiam AM, Holtslag G, Vukovic E, et al. An educational cartoon accelerates amblyopia therapy and improves compliance, especially among children of immigrants. *Ophthalmology.* 2012;119(11):2393-2401.
56. van de Graaf ES, van der Sterre GW, Kempen-du Saar H, Simonsz B, Looman CWN, Simonsz HJ. Amblyopia and Strabismus Questionnaire (A&SQ): Clinical validation in a historic cohort. *Graefe's Archive for Clinical and Experimental Ophthalmology.* 2007;245(11):1589-1595.
57. Loudon SE, Polling JR, Simonsz HJ. Electronically measured compliance with occlusion therapy for amblyopia is related to visual acuity increase. *Graefe's archive for clinical and experimental ophthalmology* 2003;241(3):176-180.
58. Tjiam AM, Vukovic E, Asjes-Tydeman WL, et al. How Dutch orthoptists deal with noncompliance with occlusion therapy for amblyopia. *Strabismus.* 2010;18(4):146-166.
59. Shah M, ur Rehman H, Khan MT, Khan MD. Clinical profile of amblyopia in Pakistani children age 3 to 14 years. *Journal of the College of Physicians and Surgeons Pakistan.* 2005;15(6):353-357.
60. Newsham D. The effect of recent amblyopia research on current practice in the UK. *British Journal of Ophthalmology.* 2010;94(10):1352-1357.
61. Abrams MS, Duncan CL, McMurtrey R. Development of motor fusion in patients with a history of strabismic amblyopia who are treated part-time with Bangerter foils. *Journal of AAPOS.* 2011;15(2):127-130.
62. Sim I, Jolly N, Pepper K. The verbal skills used by orthoptists during private patient consultations. *Australian Orthoptic Journal.* 2009;41(2).
63. Fitzmaurice K, Clarke L. Training children in eccentric viewing: a case study. *Journal of Visual Impairment & Blindness.* 2008;102(3):160-166.
64. Panton CM. It is not always amblyopia. *American Orthoptic Journal.* 2009;59(1):52-66.
65. Macfarlane A, Jolly N, Thompson K. Orthoptic interventions in stroke patients. *Australian Orthoptic Journal.* 2011;43(1):17-23.
66. Arnoldi K, Reynolds JD. "Was it something I said?": finding retinal pathology without actually examining the retina. *American Orthoptic Journal.* 2008;58(1):70-75.
67. Macfarlane A, Pedamont K. Double trouble: patient satisfaction following non-surgical intervention for diplopia. *Australian Orthoptic Journal.* 2004-2005;38:16-18.
68. Jones SA, Shinton RA. Improving outcome in stroke patients with visual problems. *Age and Ageing.* 2006;35(6):560-565.
69. Wright M. The complicated diagnosis of cortical vision impairment in children with multiple disabilities. *Australian Orthoptic Journal.* 2003;37:2-5.
70. Elderman IE, Vukicevic M. Myopia, near work, atropine and bifocals: critical reflections of the key literature examining the influence of several factors on the progression of myopia. *Australian Orthoptic Journal.* 2009;41(1):7-12.
71. Sendelbeck S, Brennan L. The specialised orthoptic role in management of contact lens use in infants *Australian Orthoptic Journal.* 2008;40(2):16-20.
72. Faal H, Qureshi MB. Training to meet the need for refractive error services. *Community Eye Health Journal.* 2007;20(63):48-51.
73. Shipman T, Burke J. Unilateral inferior oblique muscle myectomy and recession in the treatment of inferior oblique muscle overaction: A longitudinal study. *Eye.* 2003;17(9):1013-1018.
74. Malhotra R, Saleh GM, de Sousa JL, Sneddon K, Selva D. The transcaruncular approach to orbital fracture repair: Ophthalmic sequelae. *Journal of Craniofacial Surgery.* 2007;18(2):420-426.
75. Chan WH, Shilling JS, Michaelides M. Optical coherence tomography: An assessment of current training across all levels of seniority in 8 ophthalmic units in the United Kingdom. *BMC Ophthalmology.* 2006;6(33).

76. Mireskandari K, Garnham L, Sheard R, Ezra E, Gregor ZJ, Sloper J. A prospective study of the effect of a unilateral macular hole on sensory and motor binocular function and recovery following successful surgery. *British Journal of Ophthalmology.* 2004;88(10):1320-1324.
77. Georgievski Z, Koklanis K, Fenton A, Koukouras I. Victorian orthoptists' performance in the photo evaluation of diabetic retinopathy. *Clinical and Experimental Ophthalmology.* 2007;35(8):733-738.
78. Lamoureux EL, Hassell JB, Keeffe JE. The impact of diabetic retinopathy on participation in daily living. *Archives of Ophthalmology.* 2004;122(1):84-88.
79. Massin P, Aubert JP, Erginay A, et al. Screening for diabetic retinopathy: The first telemedical approach in a primary care setting in France. *Diabetes and Metabolism.* 2004;30(5):451-457.
80. Schulze-Döbold C, Erginay A, Robert N, Chabouis A, Massin P. Ophdiat®: Five-year experience of a telemedical screening programme for diabetic retinopathy in Paris and the surrounding area. *Diabetes & Metabolism.* 2012;38(5):450-457.
81. Meier P. Combined anterior and posterior segment injuries in children: A review. *Graefe's Archive for Clinical and Experimental Ophthalmology.* 2010;248(9):1207-1219.
82. Abdi S, Rydberg A. Asthenopia in schoolchildren, orthoptic and ophthalmological findings and treatment. *Documenta Ophthalmologica.* 2005;111(2):65-72.
83. Man CYYW, Smith T, Chinnery PF, Turnbull DM, Griffiths PG. Assessment of visual function in chronic progressive external ophthalmoplegia. *Eye.* 2006;20(5):564-568.
84. Elderman IE, Vukicevic M. Why are males with compressive optic neuropathy predisposed to developing cranial nerve palsy and binocular vision problems? *Australian Orthoptic Journal.* 2009;41(2):12-16.
85. Bucci MP, Kapoula Z, Yang Q, Wiener-Vacher S, Brémond-Gignac D. Abnormality of vergence latency in children with vertigo. *Journal of Neurology.* 2004;251(2):204-213.
86. Kapoula Z, Bucci MP, Jurion F, Ayoun J, Afkhami F, Brémond-Gignac D. Evidence for frequent divergence impairment in French dyslexic children: deficit of convergence relaxation or of divergence per se? *Graefe's archive for clinical and experimental ophthalmology = Albrecht von Graefes Archiv fur klinische und experimentelle Ophthalmologie.* 2007;245(7):931-936.
87. Tosswill V. Child and adolescent health in rural NSW. *Australian Orthoptic Journal.* 2004-2005;38:26-28.
88. Liu L. Australia and New Zealand survey of glaucoma practice patterns. *Clinical and Experimental Ophthalmology.* 2008;36(1):19-25.
89. Asakawa K, Kato S, Shoji N, Morita T, Shimizu K. Evaluation of optic nerve head using a newly developed stereo retinal imaging technique by glaucoma specialist and non-expert-certified orthoptist. *J Glaucoma, DOI: 10.1097/IJG.0b013e318264be18.* In press (published online 2012).
90. Ta SS. Suitability of monovision laser correction in patients with ocular motility disorders. *Australian Orthoptic Journal.* 2008;40(1):27-29.
91. Caines E, Dahl M, Holmström G. Longterm oculomotor and visual function in spina bifida cystica: A population-based study. *Acta Ophthalmologica Scandinavica.* 2007;85(6):662-666.
92. Rowe F, Brand D, Jackson CA, et al. Visual impairment following stroke: do stroke patients require vision assessment? *Age and Ageing.* 2009;38(2):188-193.
93. Rowe FJ. Who sees visual impairment following stroke. *Strabismus.* 2010;18(2):37-40.
94. Rowe FJ, V. I. S. Group. Accuracy of referrals for visual assessment in a stroke population. *Eye.* 2011;25(2):161-167.
95. MacIntosh C. Stroke re-visited: visual problems following stroke and their effect on rehabilitation. *Br Orthopt J.* 2003;60:10-14.
96. Rowe FJ, Noonan CP, Freeman G, DeBell J. Intervention for intermittent distance exotropia with overcorrecting minus lenses. *Eye.* 2009;23(2):320-325.
97. Cuccia AM, Caradonna C. Binocular motility system and temporomandibular joint internal derangement: A study in adults. *American Journal of Orthodontics and Dentofacial Orthopedics.* 2008;133(5):640.e615-640.e620.
98. Falzon K, Guerin M, Fulcher T, Viani L. Ophthalmological screening of a paediatric cochlear implant population: A retrospective analysis and 12-year follow-up. *Eye.* June 2010;24(6):1031-1036.
99. Nikolopoulos TP, Lioumi D, Stamataki S, O'Donoghue GM. Evidence-based overview of ophthalmic disorders in deaf children: A literature update. *Otology & Neurotology.* 2006;27(Suppl. 1):S1-S24.
100. Fenwick EK, Lamoureux EL, Keeffe JE, Mellor D, Rees G. Detection and management of depression in patients with vision impairment. *Optometry and Vision Science.* 2009;86(8):948-954.
101. Rees G, Fenwick EK, Keeffe JE, Mellor D, Lamoureux EL. Detection of depression in patients with low vision. *Optometry and Vision Science.* 2009;86(12):1328-1336.
102. Creavin AL, Brown RD. Ophthalmic assessment of children with down syndrome: Is England doing its bit. *Strabismus.* 2010;18(4):142-145.

103. Hanman K, Suda K, Koklanis K, Geogievski Z. Vision screening of individuals with mild intellectual disability. *Australian Orthoptic Journal.* 2009;41(2):17-19.
104. Fitzpatrick J. A case of triplopia: a case of conversion disorder? *Australian Orthoptic Journal.* 2009;41(1):17-19.
105. Wulff J. The standard of vergence eye movements in children with reading difficulties. *Australian Orthoptic Journal.* 2004-2005;38:5-8.
106. Williams C, Northstone K, Harrad RA, Sparrow JM, Harvey I, ALSPAC Study Team. Amblyopia treatment outcomes after preschool screening v school entry screening: observational data from a prospective cohort study. *British Journal of Ophthalmology.* 2003;87(8):988-993.
107. Silveira S, Jolly N, Heard R, Clunas NJ, Kay L. Current licensing authority standards for peripheral visual field and safe on-road senior aged automobile driving performance. *Clinical and Experimental Ophthalmology.* 2007;35(7):612-620.
108. Horwood A. Neonatal ocular misalignments reflect vergence development but rarely become esotropia. *British Journal of Ophthalmology.* 2003;87(9):1146-1150.
109. Barry JC, König HH. Test characteristics of orthoptic screening examination in 3 year old kindergarten children. *British Journal of Ophthalmology.* 2003;87(7):909-916.
110. Beynat J, Charles A, Astruc K, et al. Screening for diabetic retinopathy in a rural French population with a mobile non-mydriatic camera. *Diabetes and Metabolism.* 2009;35(1):49-56.
111. Atkinson J, Braddick O, Nardini M, Anker S. Infant hyperopia: Detection, distribution, changes and correlates - Outcomes from the Cambridge infant screening programs. *Optometry and Vision Science.* 2007;84(2):84-96.
112. Asaria R, Garnham L, Gregor ZJ, Sloper JJ. A prospective study of binocular visual function before and after successful surgery to remove a unilateral epiretinal membrane. *Ophthalmology.* 2008;115(11):1930-1937.
113. Risovic DJ, Misailovic KR, Eric-Marinkovic JM, Kosanovic-Jakovic NG, Milenkovic SM, Petrovic LZ. Refractive errors and binocular dysfunctions in a population of university students. *European Journal of Ophthalmology.* 2008;18(1):1-6.
114. Horwood A. Too much or too little: Neonatal ocular misalignment frequency can predict later abnormality. *British Journal of Ophthalmology.* 2003;87(9):1142-1145.
115. Koklanis K, Georgievski Z, Brassington K, Bretherton L. The prevalence of specific reading disability in an amblyopic population. A preliminary report. *Binocular Vision and Strabismus Quarterly.* Spring 2006;21(1):27-32.
116. Alexander P, Rahi JS, Hingorani M. Provision and cost of children's and young people's eye services in the UK: findings from a single primary care trust. *The British journal of ophthalmology.* 2009;93(5):645-649.
117. Anker S, Atkinson J, Braddick O, et al. Identification of infants with significant refractive error and strabismus in a population screening program using noncycloplegic videorefraction and orthoptic examination. *Investigative Ophthalmology and Visual Science.* 2003;44(2):497-504.
118. Dahlmann-Noor AH, Vrotsou K, Kostakis V, et al. Vision screening in children by Plusoptix Vision Screener compared with gold-standard orthoptic assessment. *British Journal of Ophthalmology.* 2009;93(3):342-345.
119. Williams C, Northstone K, Howard M, Harvey I, Harrad RA, Sparrow JM. Prevalence and risk factors for common vision problems in children: Data from the ALSPAC study. *British Journal of Ophthalmology.* 2008;92(7):959-964.
120. Chui L, Fraser T, Hoar K, LaRoche GR. Negative predictive value of a vision screening program aimed at children aged 3 to 4 years old. *Journal of AAPOS.* 2004;8(6):566-570.
121. Parkinson J, Tremblay F. Misleading clinical stereoacuity levels in pediatric maculopathy. *Journal of AAPOS.* 2009;13(5):496-498.
122. Raab EL. Questions revisited: Is experience still the best teacher? *American Orthoptic Journal.* 2010;60(1):64-72.
123. Conway ML, Thomas J, Subramanian A. Is the aligning prism measured with the mallett unit correlated with fusional vergence reserves? *PLoS ONE.* 2012;7(8).
124. Horwood J, Waylen A, Herrick D, Williams C, Wolke D, Avon Longitudinal Study Parents and Children Study Team. Common visual defects and peer victimization in children. *Investigative Ophthalmology & Visual Science.* Apr 2005;46(4):1177-1181.
125. Howard C, Firth AY. Is the Cardiff acuity test effective in detecting refractive errors in children? *Optometry and Vision Science.* 2006;83(8):E577-E582.
126. Viney KA, Kehoe PJ, Doyle B, et al. An outbreak of epidemic keratoconjunctivitis in a regional ophthalmology clinic in New South Wales. *Epidemiology and Infection.* 2008;136(9):1197-1206.
127. Gale RP, Saha N, Johnston RL. National biometry audit. *Eye.* 2004;18(1):63-66.
128. Deb N, Thuret G, Estour B, Massin P, Gain P. Screening for diabetic retinopathy in France. *Diabetes and Metabolism.* 2004;30(2):140-145.
129. Dahlmann-Noor AH, Comyn O, Kostakis V, et al. Plusoptix vision screener: the accuracy and repeatability of refractive measurements using a new autorefractor. *British Journal of Ophthalmol.* 2009;93:346-349.
130. Tjiam AM, Akcan H, Ziylan F, et al. Sociocultural and psychological determinants in migrants for noncompliance with occlusion therapy for amblyopia. *Graefe's Archive for Clinical and Experimental Ophthalmology.* 2011;249(12):1893-1899.

131. Wright D, Firth AY, Buckley D. Comparison of the visual effects of Fresnel prisms in normal and amblyopic eyes. *Journal of AAPOS.* 2008;12(5):482-486.
132. Simonsz HJ, Eijkemans MJC. Predictive value of age, angle, and refraction on rate of reoperation and rate of spontaneous resolution in infantile esotropia. *Strabismus.* 2010;18(3):87-97.
133. Robinson K, Georgievski Z, Koklanis K. The use of peer-supported 'case conferencing' to enhance orthoptic students' learning in a clinical school environment. *Australian Orthoptic Journal.* 2009;41(1):13-16.
134. O'Connor P, Mu L, Keeffe J. Access and utilization of a new low-vision rehabilitation service. *Clinical and Experimental Ophthalmology.* 2008;36:547-552.
135. Lim HY, O'Connor PM, Keeffe JE. Low vision services provided by optometrists in Victoria, Australia. *Clinical and Experimental Optometry.* 2008;91(2):177-182.
136. Logan NS, Gilmartin B, Marr FJE, Stevenson MR, Ainsworth JR. Community-based study of the association of high myopia in children with ocular and systemic disease. *Optometry and Vision Science.* 2004;81(1):11-13.
137. Denniston AK, Butler L. Ophthalmic features of Turner's syndrome. *Eye.* 2004;18(7):680-684.
138. van Genderen M, Dekker M, Pilon F, Bals I. Diagnosing cerebral visual impairment in children with good visual acuity. *Strabismus.* 2012;20(2):78-83.

KEY TERMS
Orthoptist, Role, Systematic Review, Ocular