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Refereed Journal

Orthoptics, Optometry, Vision Therapy

Editors
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The community is bombarded by a large amount of information pertaining to the therapeutic strategies that are available to help with vision function. For example children with learning related vision problems can have vision therapy to enhance their learning skills, people who wear spectacles can have natural therapy to eliminate the need for glasses, people with aesthenopia related to reduced convergence can have therapy to enhance their ocular comfort, people with macular degeneration can have eccentric viewing training, and people can have their health status diagnosed by examination of the iris.

These therapeutic approaches are undertaken by a range of different disciplines, including orthoptists, optometrists, natural vision therapists, iridologists each of whom claim expertise in their field and successful treatment outcomes. The outcome from the treatment procedures is often reported as individual anecdotes with glowing patient testimonies. Unfortunately this area is poorly researched and when the actual outcomes are measured in a controlled scientific study (not necessarily double blind) the evidence does not substantiate the claim. Here is where the disparity lies between scientific and non scientific claims about the validity of the therapy.

The issue for members of the general public is the ability to select from amongst the large number of possibilities the most appropriate treatments. The community deserves to receive care that is valid, effective and delivered by professionals who are up to date and externally regulated. The community is best served when they are provided with information that is accurate, clearly presented, easily understood and allows them to have informed choice about the procedures being offered. Orthoptics in Australia fits this model and as several of the articles in this edition of the AOJ demonstrate therapy is alive, diverse and scientific in its approach.

In a recent guest editorial in Binocular Vision & Strabismus Quarterly, Press[1] alludes to vision therapy being an "outgrowth of orthoptics" which has developed as a distinct area of optometric practice and training in the United States. It is postulated that the evolution of optometric vision therapy is attributed to several events including dwindling numbers of orthoptists, orthoptics becoming "more than most ophthalmologists can manage" and a perceived shift in patient focus by the orthoptists from that of active non surgical management to a passive pre and post operative surgical assessment. There is an acceptance that orthoptics, as an area of treatment, has a valid role in providing enhanced visual function which incorporates the expertise of total patient care, specialised interpersonal skills and the need for a treatment period, not an instantaneous outcome from a short procedure. A question arises as to whether the Australian orthoptic profession will adopt the described American model or continue to develop the expertise and research of evidence based outcomes to be active therapists. Orthoptics has been in existence for over 100 years on the international arena, history attests to its value it is not appropriate to allow orthoptics to be subsumed by another profession.

1. Press. L. J.
The interface between Opthalmology and Optometric Vision therapy.
Binocular Vision B Strabismus Quarterly.
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Microtropia - A challenge to conventional treatment strategies

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ABSTRACT

A sample of members of the Orthoptic Association of Australia, practicing within Sydney was surveyed. The members surveyed were selected at random and represent a cross section of the Sydney metropolitan Orthoptic 'workforce'. The survey pertained to occlusion management of primary microtropia. The survey aimed at examining modes of current Orthoptic practice and pinpointing Orthoptic opinion regarding the outcome of visual acuity standards achieved in primary microtropia. This paper includes reference to both past and present literature sources and documented research. Multiple authors, each with their specifically defined classifications are cited in the literature dating back to the 1950's, as having identified a unique non paralytic strabismus "phenomenon", which is now termed Microtropia. In conclusion, this paper aims at provoking a renewed interest in a well established phenomenon; in addition to providing an altered view of management protocols and treatment outcomes in primary microtropia.

INTRODUCTION

Multiple authors, each with their specifically defined classifications are cited in the literature dating back to the 1950's, as having identified a unique non paralytic strabismus 'phenomenon', which is now termed microtropia.[1,2,3] Indeed, the phenomenon of microtropia has been defined with great diversity over the years and has been referred to with a variety of names over the decades. Small angle deviations characterised by central suppression of the deviating eye and normal or near normal fusion amplitudes were first identified by Pugh in 1936, and were referred to as 'retinal slip.[3,4] Following this time a multitude of names prevailed including among others the terms "fixation disparity, fusion disparity, retinal flicker, monofixational esophoria, monofixational syndrome, strabismus spurius, microtropia unilateralis anomalo-fusionalis, microstrabismus and minisquint".[4] Many authors have grouped 'like' criteria pertaining to the strabismus but have often distinguished, and separated individual characteristics specific to their definition.

Lang coined the term microtropia in 1966 to describe a "monolateral squint of less than five degrees"[5] associated with harmonious abnormal retinal correspondence (ARC) which allows for abnormal binocular single vision (ABSV), fusion and reduced stereopsis.[6] According to Lang's clinical description, a foveal suppression scotoma and amblyopia are frequent findings accompanying microtropia. Eccentric fixation may or may not exist.[5,6] It is also widely recognised that microtropia is associated with the presence of anisometropia.[3] In 1984 Lang distinguished four groups of microtropia according to their fixation and refractive state. These groups consisted of central and eccentric fixation each occurring with either isometropia or anisometropia.[7]

Halveston and von Noorden (1967) originally restricted their definition of microtropia to include very small angle strabismus with eccentric fixation and ARC, with the cover-uncover test revealing no manifest deviation; the uniocular angle of eccentric fixation and the angle of anomaly therefore being coincident.[6,8] Parks (1969) used the term 'monofixation syndrome' to describe the phenomenon of small angle strabismus (a manifest strabismus of eight prism dioptres or less), and was the only author to propose that the patients have normal retinal correspondence (NRC).[6]

In general, the literature points toward an agreement of microtropia having the common characteristics of a central suppression scotoma and the presence of ABSV. Amblyopia and anisometropia are frequently reported findings accompanying the phenomenon.[6] There is however, disagreement amongst authors on what is observed on cover testing, the size of the manifest deviation and the form of retinal correspondence.[6]

The literature reports a consensus that the condition may occur as a primary entity or be secondary to optical or surgical correction of a larger angle strabismus. Secondary microtropia is rarely associated with ocular pathology.[3,4,6] Lang qualifies the use of the term 'secondary' microtropia stating that "since secondary has not only a temporal but also a causative meaning, we prefer now to speak in these cases of 'consecutive' microtropia which means: Microtropia resulting after treatment".[2] Lang believes that the term 'secondary' may be reserved for microtropia when a condition can be attributed to it's cause. For example, secondary microtropia due to anisometropia.[2] Lang reported that in a group of 805 microtropes, 388 (48%) were of the primary form.[2]

The term microtropia 'with identity' is used by most authorities to describe cases with no manifest movement on cover test, the eccentric fixation point coinciding with the angle of ARC. Microtropia 'without identity' describes cases where a small manifest movement is determined on the cover-uncover test, the angle of anomaly exceeding the angle of eccentricity.[9,10] In 1998 Houston, Cleary, Dutton

and McFadzean reported on a series of patients with microtropia. They found microtropia with identity in 30% of the cases and microtropia without identity in 70%.[8]

As previously indicated, there is wide recognition of microtropia being associated with anisometropia. A review of primary microtropia conducted by Lang in 1974 showed that 70% of cases were isometropic; the remaining 30% anisometropic.[3] Amblyopia has been reported to be denser in cases with eccentric fixation and more pronounced with higher anisometropia.[5]

The aetiology of microtropia is not fully understood, although there are several hypotheses documented in the literature.[2,5,11] Typically in strabismus, suppression develops in order to alleviate confusion and diplopia in response to a motor anomaly. However, unlike other forms of strabismus primary microtropia is considered essentially sensorial in nature.[10] A summary of the proposed aetiological factors documented in the literature include "an inherent inability or loss of ability for bifoveal fusion, anisometropia producing a habitually defocused image in one eye and a subsequent foveal scotoma, a 'statistical variant' in the fixation reflex feedback mechanism, and a genetic/hereditary component with a particular familial disposition to ARC".[10] Keiner (1978) proposed an abstract argument that it is a dynamic impediment of uncontrolled accommodation in the amblyopic eye which maintains the microtropia and the amblyopia.[12] Lang (1983) described the aetiology as "a primary sensorial defect, which predisposes to ARC".[2] Lang qualifies that microtropia is "an inherited primary congenital defect, rather than an acquired anomaly".[13] Cleary, Houston, McFadzean and Dutton in 1998, hypothesized an alternative process for a 'subset' of microtropic patients having responded well to occlusion therapy. The process included a period of normal visual development preceding the onset of microtropia, during which the retinocortical 'foundations' for NRC were established. Precise pairing of foveo-foveal receptive fields was not abolished by the presence of amblyopia and a central scotoma, but this relation was "temporarily suspended" and binocular single vision was sustained via the neural substrate of paired receptive fields over a wide retinocoritcal area.[10]

Lang has stated that microtropia is "by no means a rare condition".[2] Lang acknowledges early practitioners Javal, Worth, Duane and Bielschowsky had not mentioned small angle strabismus. However, Maddox in 1898 believed that, "very small angles were extremely rare because the natural tendency to fusion was much too strong as to allow small angles to exist"[2]! Lang estimates that one per cent of the general population has a microstrabismus. With this statistic in mind and with knowledge of the resulting amblyopia described by Everhard-Halm and Maillette de buy Wenniger-Pick as "the most important aspect of microstrabismus",[7] a sample of thirty members of the Orthoptic Association of Australia practicing within Sydney was surveyed.

THE SURVEY

The members surveyed were selected at random, representing a cross section and included approximately 40% of the Sydney metropolitan 'OAA workforce'. The principal author carried out a telephone interview survey of four questions. Each respondent was informed of the purpose of the survey which was to collect information related to the current modes of Orthoptic practice with regard to management of microtropia. The respondents were also informed that anonymity with regard to their name would be observed. Respondents were encouraged to give complete answers and were allowed to make qualifying statements and comments related to each question. The survey questions were designed to provoke clinical comments and pinpoint Orthoptic opinions regarding visual acuity standard outcomes in microtropia. The questions were as follows:

Question 1. In the case of primary microtropia what form of occlusion would you recommend? (i.e. with what would you patch the non-amblyopic eye?)
Question 2. What patching regime would you recommend? (i.e. for how long?)
Question 3. What final standard of visual acuity in the microtropic eye would you aim for?
Question 4. What clinical tests would you use to monitor the primary microtrope during occlusion therapy?

RESULTS & DISCUSSION

The results were collated and summarised. The following table reports the responses for Question 1. of the survey.

TABLE 1
Question 1. In the case of primary microtropia **what form of occlusion** would you recommend? (i.e. with what would you patch the non-amblyopic eye?)

Form of Occlusion Recommended	Frequency
Total to light/ 'Opticlude' direct to the face	4/30
'Micropore' direct to the face	7/30
'Micropore' or 'Opticlude' direct to the face	3/30
'Leucosilk' or 'Leucopore' direct to the face	2/30
'Micropore', 'Leucosilk', "whatever" direct to the face	1/30
Sticky patch direct to the face	1/30
Total to light/ 'Opticlude' direct to the face reducing to, or partial occlusion (filter/ tape) on glasses	6/30
Partial occlusion (filter/ tape) on glasses; if fails total to light/ 'Opticlude' direct to the face	2/30
'Micropore' on glasses reducing to filter occlusion on glasses	1/30
Sticky patch on glasses	1/30
No occlusion at all or 'Opticlude' direct to the face with VA of less than 6/12	1/30
No occlusion at all or 'Micropore' on glasses or direct to the face	1/30

Respondents in clarification made several statements in addition to their answers for Question 1. A number of respondents commented that:

- "The selection of the form of occlusion in microtropia is dependent upon the patient's age, compliance and previous history/ experience with patching. It is also dependent upon the level of visual acuity."
- "An added heterophoria should be considered when selecting the form of occlusion in microtropia".

One individual commented that:

- "The selection of the form of occlusion is important in management of microtropia, as the Orthoptist does not want to interfere with patient's binocularity".

Another respondent added that:

- "Binocular function should be considered prior to selecting the form of occlusion for a patient with microtropia".

Microtropic amblyopia is viewed by Lang as responding well to simple, full time direct occlusion.[3] Furthermore, Lang made reference to the use of partial occlusion with "graduated occlusion of the sound eye with Bangerter filters until the age of 10 years"[5,7]. The initial use of total occlusion followed by partial occlusion once visual acuity improves, is noted by several authors in the literature.[8,11] Houston et al included an initial period of total to light occlusion. When visual acuity failed or ceased to improve, or with waning compliance, the substitution of full time, partial (total to form) 'Blenderm' (tape) occlusion was made.[8] Lithander and Sjostrand made use of atropine penalisation as an alternative when compliance with direct occlusion was unsatisfactory.[14]

The authors mentioned have considered the level of visual acuity and the compliance of the patient as factors in determining the form of occlusion prescribed. The literature makes no apparent reference to the age of the patient being a significant consideration in selection of the form of occlusion. The issue of establishing the stability of binocular function in microtropia prior to occlusion therapy shall be discussed later.

The information gathered from the survey reflects a general assumption that the various forms of occlusion 'tape' and 'patches' available allow for what is referred to as total ('total to light') occlusion. Of the Orthoptists choosing to apply occlusion direct to the face, 39% recommended the option of the use of either 'tape' (usually 'Micropore') or 'Opticlude' occlusion. It was also interesting that 20% of the Orthoptists surveyed made direct reference to the use of either 'Micropore' or 'Leucopore' acting as a form of total occlusion.

Electrophysiology Experiment

With these figures in mind, a preliminary mini-experiment was set-up to observe the difference in retinal activity between eyes patched with 'Opticlude' and those occluded with 'Micropore'. Photopic electroreintogram (ERG) traces were recorded for a series of 7 subjects. The subjects included for the ERG were caucasian adult volunteers with a mean age of 36 years. There was a remarkable consistent finding of the eyes patched with 'Opticlude', providing an approximate 60-85% reduction in the amplitude of the ERG signal with delayed latency noted. Whereas, for eyes patched with 'Micropore' the consistent finding showed virtually no, or an upper limit of 20% reduction in the amplitude of the ERG trace with no delay in the latency noted. These preliminary experimental results showed that under photopic conditions, there was a difference in the amount of visual stimulus received by the retina, when subjects wore the two different forms of occlusion. It appears that neither of the patches totally 'block out' a stimulus and certainly the 'Micropore' does not appear to impede the light source dramatically. This preliminary evidence would suggest that 'Micropore' is not able to provide total, i.e. ('total to light') occlusion. The clinical significance of the result of using various occlusion patches for the treatment of amblyopia requires further study.

It was interesting that a couple of the group surveyed often chose to recommend no occlusion for patients with microtropia. The literature identifies reports of insuperable diplopia having resulted as a consequence of occlusion therapy. We however, along with others, could find no information related specifically to this complication in microtropia, a phenomenon recognised as having normal or near normal fusion amplitudes.[3,4,8]

The following table reports the responses for Question 2. of the survey.

Table 2

Question 2. What patching regime would you recommend? (i.e. For how long?)

Occlusion regime recommended (hours/day)	Frequency
3hrs to full time	6/30
2hrs to 8hrs	4/30
6hrs	1/30
4hrs to 6hrs	3/30
1hr to 6hrs	2/30
4hrs to 5hrs	4/30
2hrs to 4hrs	3/30
3hrs to 4hrs	3/30
2hrs to 3hrs	2/30
1hr	1/30
1hr per line of difference	1/30

Note: When partial occlusion was recommended, it was placed on the glasses for full time wear.

Respondents provided the following points of clarification when providing answers to Question 2.

- 27/30 (90%) of the respondents made direct reference to the degree of amblyopia being a 'key element' in formulating a suitable patching regime.
- 10/30 (33%) of the respondents also stated that the patient's age is an important consideration when recommending an occlusion regime.

A number of respondents stated that:

- "Part time occlusion is best carried out with the child doing close work."

- "Less occlusion time is recommended for younger children, whereas with the older child there is less time to gain an improvement in vision and thus a more vigorous approach is required."

Individuals provided the following statements:

- "With an older child there is little expectation for improvement. A token regime of occlusion is all that is required."
- "It is important to warn parents of an increased size of deviation with the use of occlusion therapy."
- "Limited occlusion time would be recommended should the child have an added heterophoria."

The Orthoptists surveyed have reported diverse 'patching' regimes. A similar variety of opinions for full time versus part-time occlusion therapy is documented in the literature.[3,7]

Lang (1974) found part-time patching to be a non-effective regime and preferred the use of simple, full time direct occlusion followed by partial occlusion until the amblyopia was remedied.[3]

Houston et al (1998) studied the visual acuity outcomes of thirty microtropes managed with a specific occlusion therapy protocol. The regime included an initial period of 6-8 weeks of spectacle wear alone. Total to light occlusion was then introduced for 4-8 hours daily, with a greater number of hours for patients with poor visual acuity. Close work was encouraged during the patching. As the visual acuity improved the occlusion was reduced to a minimum of 2 hours daily. When no improvement was evident or waning compliance occurred, full time, partial (total to form) 'Blenderm' occlusion was substituted.[8]

The following table reports the responses for Question 3. of the survey.

Table 3

Question 3. What final standard of visual acuity in the microtropic eye would you **aim** for?

Final standard of visual acuity (VA) in microtropic eye - The Aim	**Frequency**
6/5part	1/30
6/6	2/30
'Equal VA or close to equal VA'	3/30
'One line difference between the microtropic eye and the "good" eye'	8/30
6/9 to 6/6	2/30
6/9	7/30
6/12 to 6/9	5/30
6/12	1/30
Some improvement	1/30

The above results to survey Question 3 indicate that 50% of Sydney Orthoptists are aiming for a final visual acuity standard of 6/9 or 'one line of difference' in the microtropic eye following occlusion therapy. Respondents in clarification made several statements in addition to their answers for Question 3. Several of the respondents commented that:

- "The final standard of visual acuity is dependent upon several factors, the age of the patient at the time of diagnosis, the level of the visual acuity at the commencement of occlusion therapy, the degree of refractive error and eccentric fixation."
- "VA will never be equal, it will regress once occlusion is ceased."
- "The aim is for stable vision."
- "Patching should be pursued whist improvement is gained."

One respondent made an additional comment that:

- "With microtropia, sometimes it is better to settle for less improvement."

An individual also provided anther statement that:

- "Near VA is a most important factor, aim for N6 to N8."

The literature makes little mention of the achievable visual outcomes in microtropia. Visual acuity is thought to be responsive to occlusion therapy, but the result limited by the presence of eccentric fixation.[10] Like 50% of the Orthoptists surveyed, Lithander and Sjostrand (1991) agree that a residual one line difference in visual acuity to be the best endpoint for treatment in microtropia.[14] Whereas approximately 20% of the group surveyed would agree with Parks and Eustis (1961) who stated "that amblyopia has to be treated by occlusion until equal vision of both eyes has been reached"[7]. Everhard-Halm et al, however, believed that amblyopia treatment in microstrabismus was successful when a visual acuity of 6/12 or better was achieved.[7]

Houston et al (1998) comment that "following occlusion it is generally accepted that levels of visual acuity greater than 6/12 or 6/9 Snellen are rarely achieved, despite the lack of literature evidence to support this view."[8] Houston et al report their findings of equal 6/5 vision being attainable in microtropia, with 43% of the microtropic group studied having achieved this visual acuity outcome.[8] The authors suggest it is the full time use of 'Blenderm' (total to form) occlusion on the glasses, when visual acuity levels reach 6/9 Snellen in the amblyopic eye, which is a major factor in improving the visual outcome.[8]

The literature recognises that the standard of visual acuity may regress once occlusion is ceased and that periods of patching or 'form occlusion' on the glasses, may have to be reinstated to achieve optimal stable vision.[7,8] Parks commented that "intermittent occlusion is the treatment of choice until it is finally terminated at 9 years of age".[3]

It is noteworthy that Houston et al reported that older patients in their study (i.e. 5-7year olds) were often able to achieve 6/5 visual acuity and most often 6/9.[8] Lithander and Sjostrand also found "no crucial age related differences in the final outcome of treatment".[14] Furthermore, these authors and others report that "initial poor visual acuity did not predispose to a poor visual outcome".[7,8] The degree of anisometropia was also reported as having no relationship to the final visual acuity achieved.[8]

Lang recognises near vision as an important factor. Poor reading faculty with the microtropic eye is often demonstrated in spite of seemingly good distant and near vision with optotypes. This discrepancy is referred to as 'reading amblyopia'.[2]

The following table reports the responses for Question 4. of the survey.

Table 4
Question 4. What clinical tests would you use to **monitor** the primary microtrope **during occlusion** therapy?

Clinical tests used for monitoring microtropia during therapy	Frequency
Visual acuity near	12/30
Visual acuity distance	28/30
Refraction	3/30
Cover test near and distance	24/30
Measurement of deviation	10/30
Visuscope	21/30
Sbisa Bar	1/30
4^ Prism Test	3/30
Worth's Lights	2/30
CNP	2/30
Fusion ranges	1/30
Synoptophore assessment	4/30
*Stereoacuity assessment	26/30

*It was of interest that there were a variety of stereoacuity tests selected for use. The following is a breakdown of the tests selected.

Table 5 Stereo Tests

Stereoacuity test(s) selected	Frequency
Titmus	10/30
TNO	5/30
Langs	2/30
Titmus or TNO	4/30
Titmus or Langs	2/30
TNO or Frisby	1/30
Unspecified stereoacuity test	2/30

Respondents in clarification made several statements in addition to their answers for Question 4. Several respondents made mention that:

- "Linear visual acuity testing should be attempted whenever possible in order to highlight the presence of the 'crowding phenomenon'."

One individual commented that:

- "Near visual acuity is most necessary at every visit"

Another responded added that:

- "Measurement of the deviation is of importance, particularly with patients having an added heterophoria."

Many of the respondents included that:

- "The visuscope is used throughout the occlusion therapy, although no change in fixation would be expected"

One respondent stated that:

- "The visuscope is only to be used during therapy when there is a poor result with the occlusion."

Another clarified that:

- "The visuscope is only used at the commencement of treatment in order to establish the effect of occlusion on fixation."

A couple of respondents added that:

- "Stereoacuity would only be attempted as visual acuity improved with treatment."

The Orthoptists surveyed have included a variety of practice protocols. Near visual acuity was included by 40% of the group surveyed. Lang reports that reading difficulties exist in microtropia due to a monocular temporal scotoma, creating a 'crowding phenomenon'. The fixation point scotoma corresponds to the area where in microesotropia the centre of the ARC lies, causing separation difficulties and thus reading amblyopia. This explains why in microtropia of the right eye the final letters of a word seem blurred, whereas in microtropia of the left eye the initial letters seem blurred. In order to monitor this form of amblyopia it is essential that monocular near vision be assessed with text rather than single optotypes when possible.[2,3,5,12]

Houston et al suggest that the "risk of insuperable diplopia can be monitored by measuring fusional reserves".[8] It is also recommended that the stability of the ABSV for older patients having full time occlusion be measured with the Sbisa bar.[8] It is noteworthy that there was very little mention of examination of fusion ranges or the stability of ABSV among Sydney Orthoptists. Several comments were however made with regard to the importance of measuring the size of the total deviation throughout occlusion therapy. The underlying heterophoria determined by alternate cover test is ultimately compensated by fusion.[4 cited in 15] Thus emphasizing the importance of continued assessment of fusional reserves during occlusion therapy.

The literature documents the importance of monitoring stereopsis throughout occlusion therapy.[8] Houston et al state that after patching, all of the microtropic patients in their series showed improved stereoacuity, with a third of patients achieving better than 60" of arc. It was of clinical significance that for half of these patients the improved stereopsis preceded the improvement in visual acuity.[8] The results to the survey indicate that 87% of the Sydney Orthoptists would routinely assess stereoacuity. The specific choice of stereoacuity test does however, vary amongst the group. It is interesting to note that Hahn, Cadera and Orton reported no relationship being found between the presence or absence of anisometropia and the level of stereoacuity attained.[6] Two studies cited in the literature comment that microtropes with identity achieve better stereoacuity levels.[6,8]

The results to the survey indicate that 70% of the Sydney Orthoptists would monitor fixation during occlusion therapy. The qualifying statements however, made in reference to the use of visuscopy would suggest many Orthoptists are not predicting a change in fixation to occur. Everhard-Halm et al (1989) had a similar impression "that the fixation pattern was not greatly influenced by therapy".[7] The literature however, reports that primary microtropia is not a static condition.[8] Houston et al (1998) detected an alteration in the point of fixation in 50% of the microtropes studied following their protocol of occlusion therapy. The authors qualify that one third of the subjects acquired foveal fixation.[8]

As discussed, 87% of the Sydney Orthoptists surveyed indicated they would monitor stereoacuity. Lang acknowledges that binocular function spontaneously improves as a result of 'end stage' partial occlusion therapy.[3] To achieve stereopsis better than 60" of arc, bifoveal fixation must exist.[16] The literature includes evidence of recovery in microtropia. The amblyopia is documented as having resolved, with equal 6/5 Snellen vision resulting, central fixation and stereoacuity of 60"of arc or better.[8]

Von Norden and Cantolino like Houston et al acknowledged the potential for recovery in microtropia following occlusion therapy.[1,8,13] Indeed if microtropia has the potential to be 'cured', it refutes the concept of it being an underlying primary congenital defect of retinal correspondence as proposed by Holland, Richter and Lang.[4] Cleary et al (1998) hypothesise that "the perceived change from ARC to NRC support a plasticity in the retinocortical relation and the existence of ARC on the basis of normally existing retinocortical connections, facilitated by flexibility of paring of receptive fields over a relatively wide cortical area"[10]. The authors state it is likely that high grade stereoacuity and bifoveal fixation are restored in response to occlusion therapy only in patients when "a period of normal retinocortical architecture development preceded the onset of microtropia".[10]

SUMMARY

The survey of Sydney metropolitan Orthoptists has provided insight to the current modes of Orthoptic practice and pinpointed Orthoptic opinion regarding the outcome of visual acuity standards achieved in primary microtropia. In part the literature would suggest that microtropia is a dynamic rather than a static condition, in which it is possible to gain a substantial improvement in visual acuity and stereoacuity. With the included use of full time partial ('total to form') occlusion at the end stage of treatment, equal visual acuities rather than 'one line of difference' or '6/9' should be the aim of therapy. During treatment monitoring patients with microtropia should include the assessment of stereoacuity and fixation, as positive changes in these may precede an improvement in vision.[8] Near reading visual acuity should also be monitored to elicit the 'crowding phenomenon' associated with microtropic 'reading amblyopia' which as discussed may persist in the presence of 'normal' distance visual acuity.[2,3,5,12]

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The effect of eccentric viewing on the visual function of persons with age-related macular degeneration

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ABSTRACT

Eccentric viewing is a strategy which has been shown to ameliorate the impact of sight loss due to Macular Degeneration. In this study two different methods of eccentric viewing training are compared. A pre/post test design was used to determine if eccentric viewing training had an effect on ability to perform activities of daily living and ability to see print. Results indicated improvement in near vision and activity of daily living scores with no significant difference between methods of eccentric viewing training used.

Key words: eccentric viewing, age-related macular degeneration, rehabilitation, activities of daily living.

INTRODUCTION

Age-related Macular Degeneration (AMD) is the leading cause of blindness for people aged over 65.[1] As AMD results in the loss of macular vision, visual function is severely compromised and this can have a major impact on ability to perform everyday tasks such as reading, seeing faces and driving.[2-5] The impact of AMD can be reduced with the use of appropriate rehabilitation strategies. Whilst the centre field of vision in patients with AMD is lost, the peripheral vision is usually preserved, therefore individuals affected by the disease can learn to use their remaining vision for reading and activities of daily living. The technique of using peripheral vision instead of central is called eccentric viewing.[5-8] The technique has been shown to be effective in decreasing the size of print a person is able to read but the impact of eccentric viewing on the performance of tasks of daily living has not been assessed. The aims of this study are to compare two methods of eccentric viewing training, the 'ECCVUE'[9] computer program and the 'Eccentric Viewing Home Kit'[10] the measures used to indicate change in visual function were ability to read print (near vision) and the ability to perform daily living tasks. In addition a subjective measure of improvement was used as an indication of the participants perception of the impact of training.

MATERIALS AND METHODS

Participants

There were ten participants, two male and eight female. They were aged between 75 and 94, with an average age of 82.5 years (SD = 6.13). All the participants were clients of the Low Vision Clinic, Vision Australia Foundation and legally blind as a result of longstanding wet AMD. No other ocular pathology was diagnosed. They had all undergone conventional intervention from the Low Vision Clinic which included the use of magnification aids. The participants had not previously had any form of eccentric viewing training, nor had they developed any mechanisms to use it on their own.

Procedures

Participants were randomly allocated to one of two groups. Group 1 was trained using the 'Eccentric Viewing Home Kit' and group 2 with the 'ECCVUE' computer training program. Both groups were pre-tested for near visual acuity using the near 'Logmar' visual acuity chart. In addition, the participants skills in activities of daily living (ADL) were assessed using the 'Melbourne Low Vision Activities of Daily Living Index'.[11] These skills included tasks such as reading newspaper headlines, dialing a telephone, pouring a glass of water, writing a cheque etc. These outcome measures (near vision and a functional assessment of ADL) were re-assessed once training was complete.

All participants were trained in their own homes apart from two who were trained in a clinic setting. The 'ECCVUE' computer program was presented by laptop where subjects were trained in their own homes. The participants in group 1 used a focal light during training while those in group 2 used only ambient lighting. Participants used prescription reading glasses during training, but no low vision aids. The number of training sessions for each participant ranged from 6 to 9 sessions, the average being 7.7 (SD = 2.0). The duration of each training session was approximately 45 minutes. The sessions were conducted twice a week for a minimum of four to a maximum of six weeks. In order to determine best peripheral macular area to be used for eccentric fixation, a 'Bjerrum' or 'Amsler' visual field was performed prior to training. All participants were asked to state a goal prior to commencement of training and this was evaluated once the training was complete. Participant details are recorded in Table 1.

Table 1.Participant details

Participant number	Gender	Age	Number of training sessions	Program type
1	Female	80	7	Home Kit
2	Male	77	7	Home Kit
3	Male	86	6	Home Kit
4	Female	77	12	Home Kit
5	Female	84	9	Home Kit
6	Female	89	8	EccVue
7	Female	75	8	EccVue
8	Female	78	6	EccVue
9	Female	85	5	EccVue
10	Female	94	9	EccVue
		82.5	7.7	
		SD = 6.13	SD = 2.00	

RESULTS AND DISCUSSION

Figure 1 demonstrates participant near acuity before and after training. Pre eccentric viewing training the near acuity of the participants ranged from n32 to n96.5 (mean = n64.4, SD = 16.04). Post training near visual acuity ranged from n12 to n96.5 (mean = n35.2, SD = 20.81). Eight participants had an improvement in near vision, one had a slight improvement and one did not improve at all. The improvement in near vision was significant ($t = 4.668$ $p = 0.001$).

Figure 1

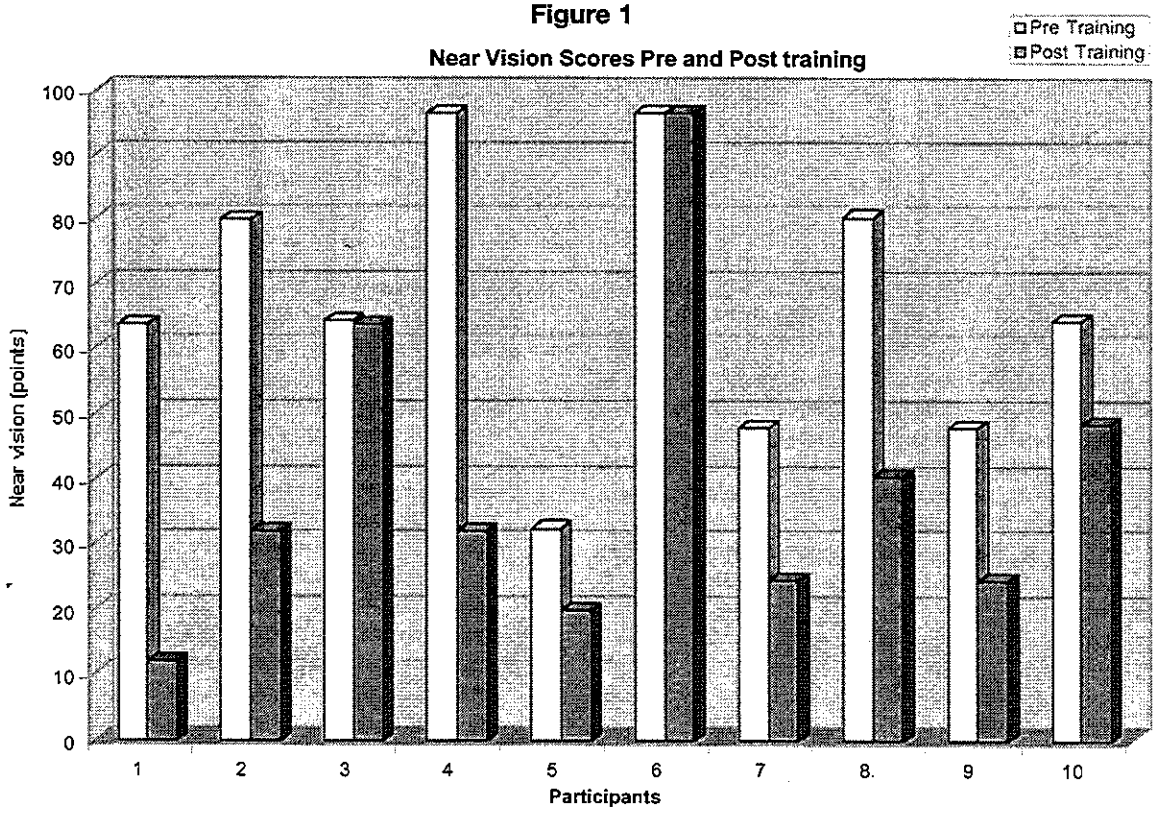


Figure 2 demonstrates pre and post training ADL scores for all participants. The ADL tasks were given a score between one and one hundred. Increased ability is indicated by a higher number. ADL scores prior to training ranged from 36 to 74 (mean = 57, SD = 12.79). After eccentric viewing training the ADL scores of the participants ranged from 39 to 77 (mean = 63.3, SD = 11.8). Analysis indicated that eccentric viewing improved the ADL score of the participants ($t = 5.645$, $p = 0.001$)

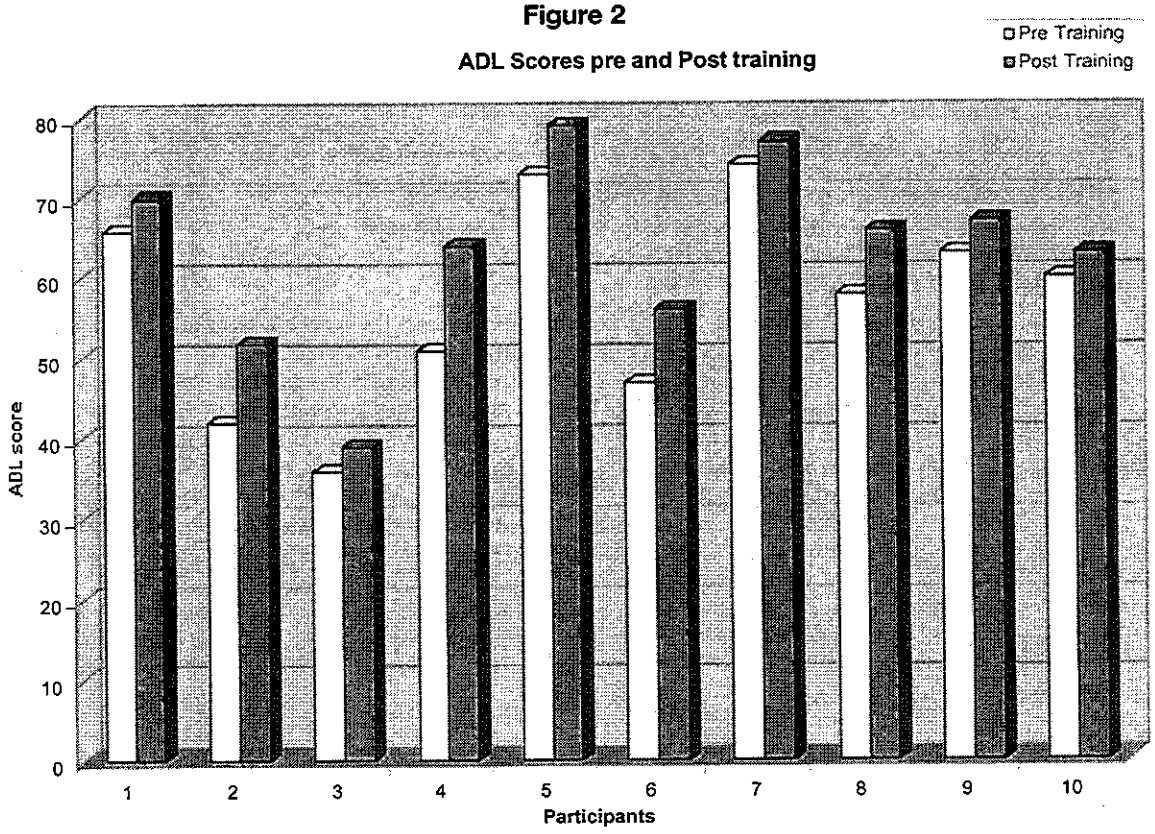
The pre and post near acuity and ADL scores for each group are outlined in Table 2. The variance between the two groups was analysed with a t-test. Results indicated no significant difference between

Table 2. Pre And Post Near Acuity and ADL Scores

	Near Vision pre Training	Near Vision post Training	ADL pre Training	ADL post Training
Home Kit	64.8 (SD = 17.97)	32 (SD = 19.79	53.6 (SD = 15.66)	60.8 (15.64)
EccVue	64 (SD = 16)	38.4 (SD = 23.59)	57 (SD = 12.79)	63.3 (11.88)

Near vision is expressed in points, as on the near acuity 'Logmar' chart.

Figure 2



the two groups. Analysis of pre-post acuity is significant as is the case with pre-post ADL skills. Therefore eccentric viewing probably ameliorated the effect of sight loss caused by AMD in relation to near acuity and ADL tasks.

During the course of the study, the researcher kept a diary of each client's responses and vision changes during training sessions. Diary recordings indicated that eccentric viewing training appeared to increase the participants' confidence to use their remaining vision. Evaluation of each individuals pre training goals also indicated their ability to more efficiently use remaining vision on a daily basis. For example, participant 4 stated her pre training objective was to "see faces more clearly and to be able to read a little bit". Post training she stated that she was "able to see print more clearly" especially her own personal notes such as telephone numbers and shopping lists. Participant 2 stated her goal as "to be able to read more easily". Once training was complete she was able to read more easily, especially newsletters from the hostel where she lives claiming this task was "very important" to her. Observation also indicated that motivation was a better indicator than age of a successful outcome to eccentric viewing training. This is supported by the average age of the participants being 82.5 years. The researcher found that time was also an important factor when training eccentric viewing. The participant must be committed to at least one training session per week for at least six weeks. Participant 4 had the greatest improvement in both near vision and ADL score. This participant also had the greatest number of training sessions. All participants demonstrated an initial decrease in print size of the eccentric viewing target at each session however at sessions four or five this progress ceased for several clients. In each case, persistence beyond this point resulted in further improvement. The research did not indicate any particular reason for this observation, however clinicians need to be aware of such fluctuations in training and must motivate the client to continue beyond this static stage for a more significant improvement to take effect. Participant 6 had no improvement in near vision yet significant improvement in ADL score, thus vision alone cannot be used a sole measure of the success of eccentric

viewing training. Participant progress is outlined in Table 3. Based on this research one or two training sessions do not provide sufficient training for a client to learn to efficiently use an eccentric viewing point. The eccentric viewing point had to be constantly reinforced and each participant was instructed to practice alone between sessions.

Observation indicated that providing motivation was important in supporting the client's confidence to continue training and to practice alone. Introduction of difficult tasks too early can diminish confidence.

Table 3. Participant Progress

	Training Weeks											
Participant	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	96	36	24	24	36	24	12					
2	96	96	48	36	36	36	36					
3	96	48	48	36	36	36						
4	96	48	36	72	48	36	24	24	24	24	24	24
5	96	36	24	24	36	24	24	24	24			
6	96	96	36	36	36	36	36	24				
7	36	36	24	36	36	24	24	16				
8	36	24	24	36	18	18						
9	36	24	24	14	14							
10	96	36	36	24	36	24	24					

The number indicates "Times New Roman" point size used during training.

CONCLUSION

This research supports the hypothesis that eccentric viewing can ameliorate the functional deficits resulting from central visual field loss. In addition observations made during the research training periods indicated the need for the clinician to be able to predict the clients responses and assess stamina at each session to ensure that the appropriate tasks are given. The length of training should be such that the client feels some achievement at the end of each session and the client can feel confidence with the technique and realise their set goals. This study supports eccentric viewing training as a valuable and important rehabilitation tool.

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Patterns of abnormal binocular fixation in a symptom free subject with a well controlled exophoria

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ABSTRACT

A case history is presented that illustrates six different patterns of binocular fixation in a symptom free subject with a moderate exophoria or convergence weakness type, following a vergence eye movement. This 19 year old student showed normal vergence resulting in binocular fixation, but also showed an insufficient vergence response, two types of saccadic responses, an unequal vergence response, and a response where one eye converged for near fixation while the other eye remained fixing for distance. Similar responses to these have been described by others in apparently normal subjects, who may represent a symptom free group able to make ready sensory adaptations to abnormal binocular fixation. Alternatively, the lack of diplopia in the presence of significant retinal disparity may be the result of a normal form of visual suppression that occurs briefly during, and just following a vergence eye movement, similar to that which occurs during a saccade.

INTRODUCTION

If a person has a well controlled heterophoria, normal ocular movements, full convergence and good stereoacuity and has never complained of symptoms, the expectation of most clinicians is that such a person would make normal convergence and divergence eye movements that result in bifoveal fixation. Any deviation from this would result in symptoms such as diplopia, blurred vision or general asthenopia. A case is presented of such a subject who shows a range of abnormal vergence movements without any diplopia or symptoms.

SR is a 19 year old university student, who presented as a volunteer for a study on normal vergence eye movements. She had visual acuity of 6/6 in each eye, a well controlled exophoria of 10^{Δ} for near and 4^{Δ} for distance, normal ocular movements, and stereoacuity to 40" on the Titmus Test. Her left eye failed on convergence at 6 cms, with diplopia. Her base out prism fusion amplitudes held at 45^{Δ} for near and distance, and her base in ranges were to 8^{Δ} for distance and 20^{Δ} for near, with diplopia noticed when fusion failed. She was not aware of her heterophoria, having never experienced symptoms of eyestrain or diplopia . She presented during a university Summer School, an intense six week study period, having just completed one year of her university course.

METHODS

A computer based video eye movement system was used to measure the subjectís eyes as she made convergence and divergence changes of 5°, 10° and 15° along the midline. The 'far' target was 2m from the eyes, the closer targets were at 52 cms, 30 cms and 21 cms from the eyes. The head was stabilised with a bite bar.

The measurement device consisted of an IBM compatible PC and a video on which two monochrome infra-red sensitive CCTV video surveillance were mounted. Two ìhot mirrorsî reflected the infra-red image of the eye to the cameras

The video images of each eye were adjusted to give maximum contrast that clearly identified each pupil. Horizontal and vertical eye positions could then be calculated by tracking the center of mass of the largest black object (the pupil) in each binary video image and converting its position into gaze angles using geometric transformations and calibration procedures. During recording sessions the video images tracked by the system could be viewed by the examiner, who noted the unusual responses described opposite.

RESULTS

SR had at least six different types of response to a vergence stimulus, these are illustrated in figures 1-6.

Figure 1 shows a normal response to a 10° stimulus. In this example the slight separation of the traces for distance fixation represents a small error of complete divergence, but this is within normal limits.

In all figures, the lower solid circles represent movements of the right eye, the upper open circles represent movements of the left eye.

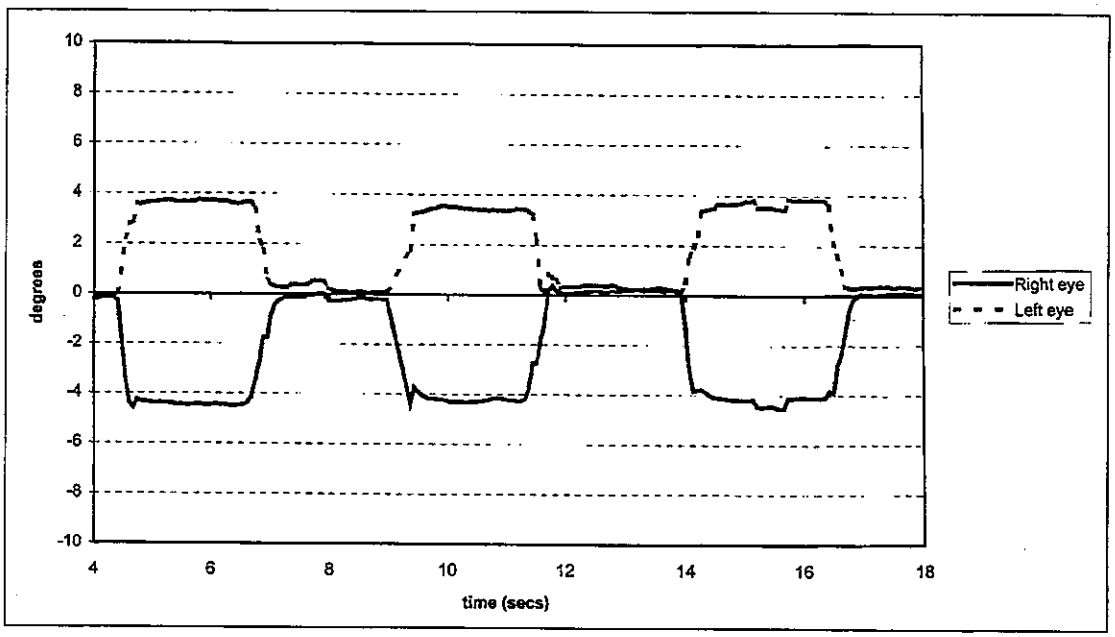

Figure 1. *Response of each eye to a 10° vergence stimulus. This represents a normal response. The traces separate during convergence movements for near fixation and come together for distance fixation. The small failure to diverge fully is within normal limits.*

Figure 2 shows a response to a 5° stimulus. The left eye shows a deficient and inconsistent response to both convergence and divergence. The right eye seems to be the 'fixing' eye but the response is slow and not always accurate. This pattern is probably familiar to most clinicians.

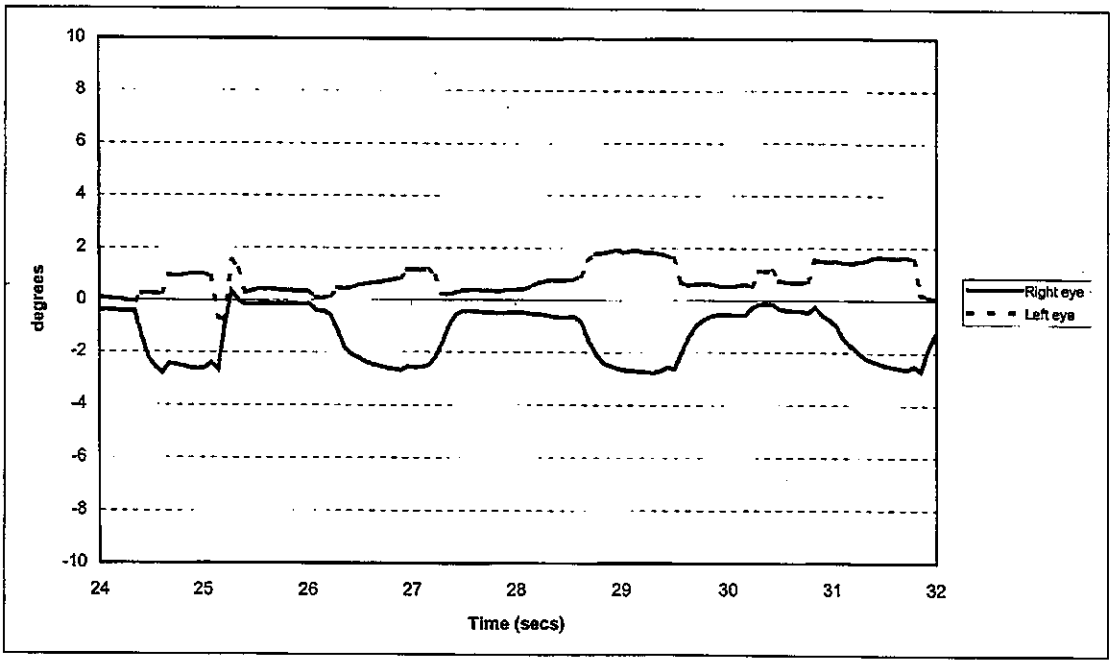

Figure 2. *Response of each eye to a 5° vergence stimulus. The left eye shows reduced, and variable convergence responses, the right eye shows slow but mostly accurate convergence responses. There is a reduced divergence response in each eye.*

Figure 3, again a response to a 5° stimulus, shows one near normal movement, otherwise there is a conjugate response, with the right eye adducting and the left eye abducting for near fixation, and the reverse for far fixation. Again, this response, whilst being abnormal, is likely to be familiar to clinicians.

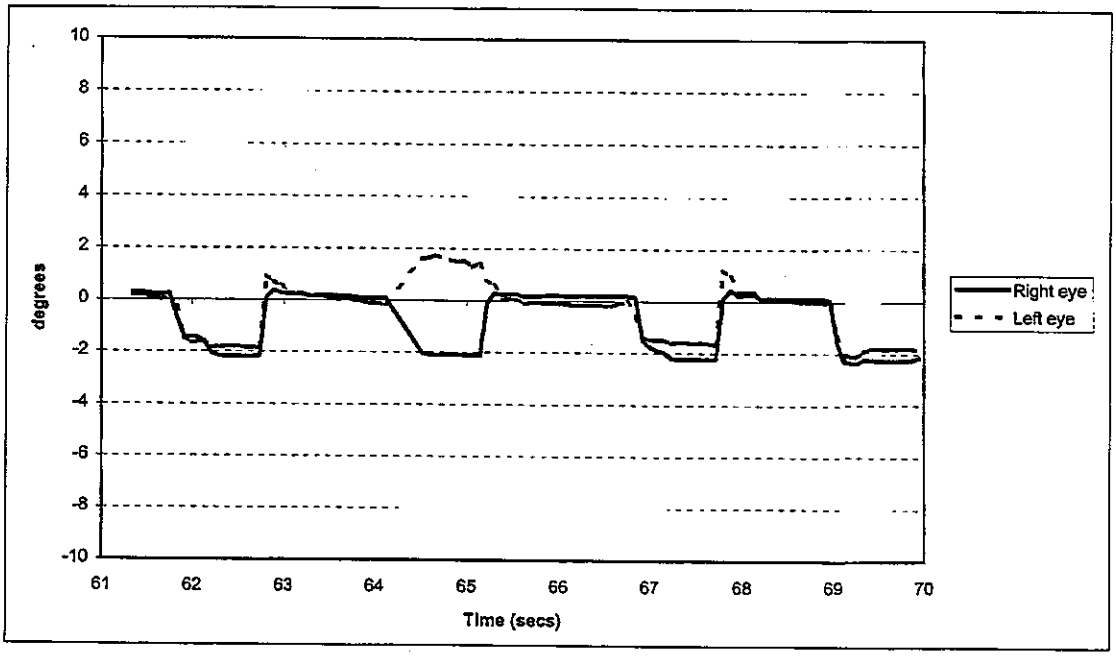

Figure 3. *Response of each eye to a 5° vergence stimulus. On one occasion there is an attempt of the left eye to converge. Otherwise there is an equal conjugate response, with the right eye fixing.*

Figure 4, a response to â 10° stimulus, shows relatively normal fixation of the right eye, with a much smaller conjugate movement in the left eye. In this case the right eye was making a full adducting movement to fixate for near, whilst the left eye was making a consistent, but much smaller abducting movement.

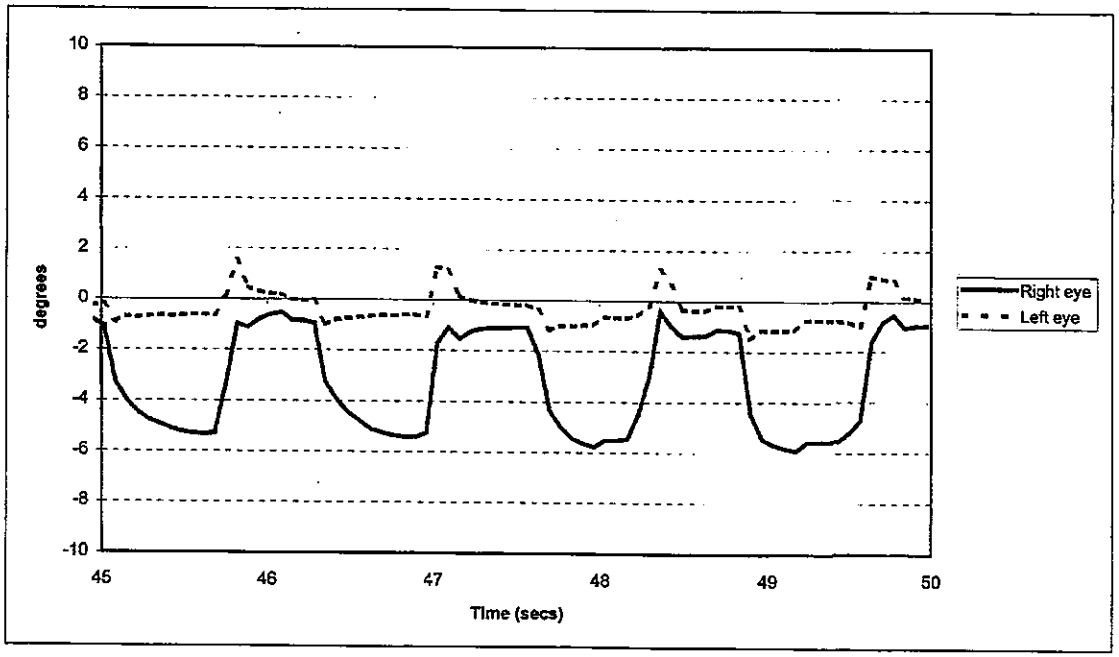

Figure 4. *Response of each eye to a 10° vergence stimulus. There is an unequal conjugate movement of the eyes, with the right eye fixing, and the left eye making a much smaller conjugate movement.*

Figure 5, a response to a 15° stimulus, shows consistent, but very asymmetrical vergence. The right eye is making an accurate movement, whilst the left eye is making a consistent but hypometric vergence movement.

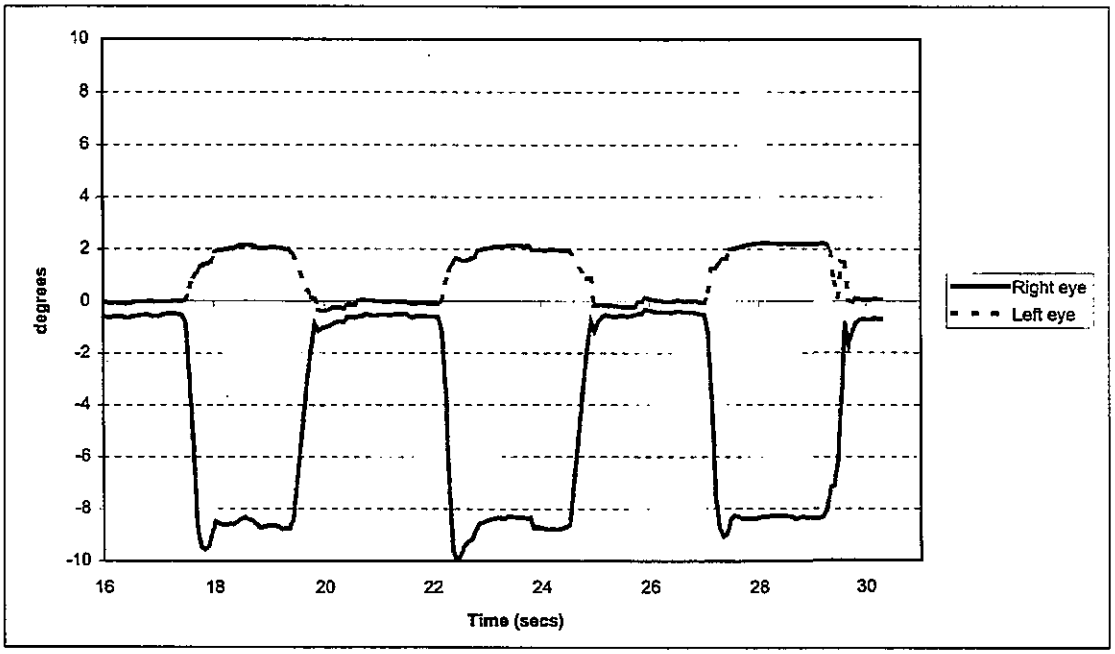

Figure 5. *Response of each eye to a 15° vergence stimulus. There is an unequal vergence movement. The right eye converges fully, the left eye makes a much smaller vergence movement. There is insufficient divergence of the eyes.*

Figure 6, again a response to a 15° stimulus, shows normal convergence of the right eye, however the left eye remains fixing for distance. This seems to be a very unusual movement to a target on the midline, not normally observed in orthoptic practice.

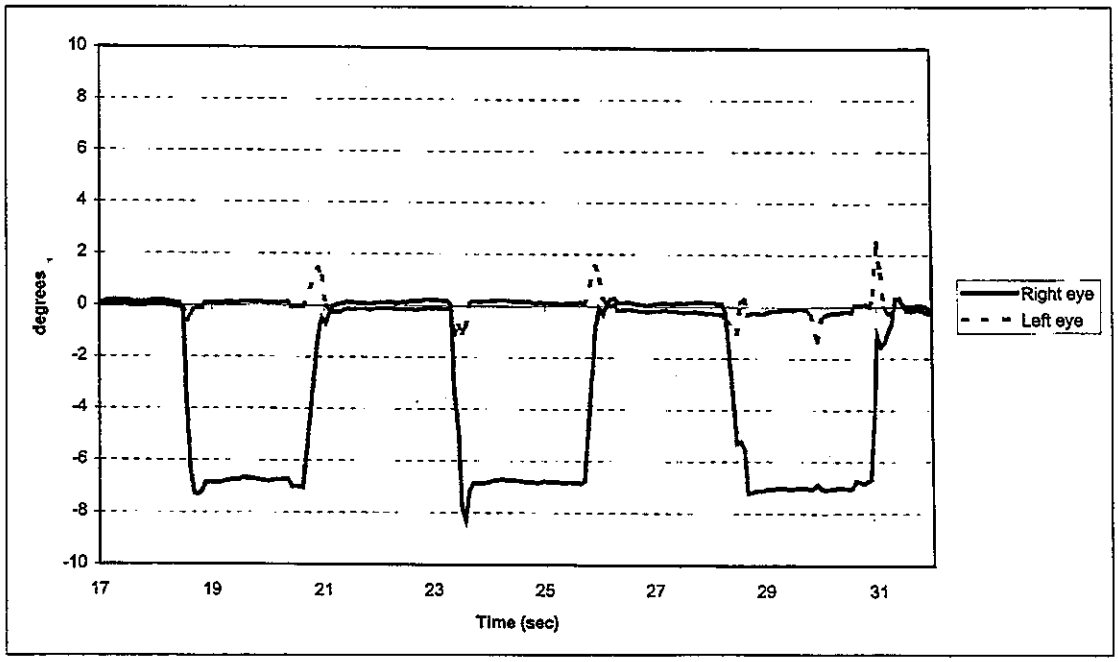

Figure 6. *Response of each eye to a 15° vergence stimulus. The right eye makes an accurate convergence and divergence movement, however the left eye does not move, but remains fixing for distance.*

DISCUSSION

Although SR had moderate exophoria, she was not aware of it, and it appeared to be fully compensated. She showed several abnormal vergence and conjugate movements, some of which did not obey Hering's Law, yet she did not notice diplopia, and had no history of symptoms, despite undertaking a lot of close work. Although she obviously had some sensory mechanisms to cope with these abnormal eye movements, they must have varied with each type of response, and did not result in ongoing reduced stereoacuity or decompensation of her heterophoria.

Similar abnormal vergence movements in normal subjects have been reported by others. Van Leeuwen et al[1] reported on the eye movements of ten normal subjects and five subjects with convergence insufficiency. They differentiated their subjects into two groups, 'vergence responders' who made correct vergence shifts, sometimes associated with small saccades, and 'saccadic responders' who fixated the far targets with both eyes, but made a conjugate movement to the near target, fixating with only one eye. Of the six saccadic responders in their study, three were from the "normal" group and three were from the CI group. They comment that *"binocular motor control is not as binocular as assumed in subjects without complaints."*

Collewijn et al[2] made an incidental observation from a study of the dynamics of version and vergence eye movements in a group of normal subjects. Some were observed to make 'ambiguous' vergence movements, *"some vergence shifts had only half the required size: one eye shifted to the nearer or further target, whilst the other eye continued to fixate the (first) target".*

Malinov et al[3] in a study on eye movements towards targets within arm's reach reported that subjects 'under-verged' by 25-35% during these tasks. Steinman[4], reporting a similar experiment from the same laboratory commented that *"vergence was set and held such that the lines-of sight intersected in space well beyond arms' reach (80 - 110 cm) despite the fact that all targets were well within arms' reach (nearer than 50 cm)".*

These observations question the cause of symptoms in the patients we see with decompensating heterophoria or convergence insufficiency. Van Leeuwen et al[1] comment that the symptomatic subjects in their study were those who did not have a strong monocular preference that would allow suppression to occur. They report that none of the convergence insufficiency subjects used one eye consistently for fixation. Certainly SR showed a strong preference for the right eye, however this monocular preference would also appear to be the pattern in many convergence insufficiency patients seen in orthoptic practice. It could be that those people who can make ready sensory adaptations to abnormal vergence movements remain symptom free, those who cannot do so resort to clinically diagnosed suppression or experience the common symptoms of convergence insufficiency or decompensating heterophoria.

It is interesting that although SR noticed diplopia on failure of convergence and base in prism fusional amplitudes, she did not notice it during the eye movement recording sessions. During these sessions pauses in fixation were no longer than two seconds duration. It is possible that there is a normal form of 'vergence suppression' that occurs during and just after a vergence eye movement, similar to 'saccadic suppression' (suppression of vision during a saccade). Manning and Riggs[5] have described a form of visual suppression in normal subjects who were less sensitive to a stimulus when it was presented at the beginning of a 2-3° convergent or divergent eye movement, than when it was presented during steady fixation.

Patients who report diplopia normally describe it as something that persists for a definite period of time, rather than as a brief phenomenon. Although some heterophoric patients notice fleeting diplopia during the cover/uncover test immediately after the cover has been removed, in these cases the eye may have been covered for longer than this hypothesised suppression period. Therefore, as Manning and Riggs[5] suggest, the concept of saccadic suppression should be broadened to include visual suppression that also accompanies non saccadic eye movements.

CONCLUSIONS

Abnormal patterns of binocular fixation, without diplopia, can occur in subjects with normal binocular vision and in those with well-controlled heterophoria. It is proposed that this phenomenon may be a consequence of visual suppression occurring during, and immediately following a binocular eye movement, similar to that which occurs during a saccadic eye movement.

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ADD/ADHD and Ocular Conditions

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ABSTRACT

It has been reported that children with ADHD are three times more likely to have convergence insufficiency than other children. Additionally, it is widely regarded that a child with ADHD often has learning difficulties. This paper reviews 50 children seen in the Orthoptic Department at The Royal Far West Children's Health Scheme who had been diagnosed with ADHD. Each child underwent an orthoptic screening prior to commencing prescribed stimulant medication. Visual acuity, cover-test, ocular movements, binocular single vision, convergence and the notation of an ocular history were all undertaken during screening. In some cases, accommodation, pupil reactions and colour vision were also assessed. Results show that 22% of children screened had convergence insufficiency, indicating that this ocular condition is quite prevalent amongst the paediatric ADHD population.

Key Words: Attention Deficit Disorder/Attention Deficit Hyperactivity Disorder, Royal Far West Children's Health Scheme, Convergence Insufficiency, Learning Difficulties

INTRODUCTION

Attention Deficit Disorder (ADD) may be defined as 'a persistent and frequent pattern of developmentally inappropriate inattention and impulsivity, with or without hyperactivity'.[1] The National Institute of Mental Health refers to Attention Deficit Hyperactivity Disorder (ADHD) as a family of related chronic neurobiological disorders that interfere with an individual's capacity to regulate activity level (hyperactivity), inhibit behaviour (impulsivity), and attend to tasks (inattention) in developmentally appropriate ways.[2] At the Royal Far West Children's Health Scheme (RFWCHS), located in Manly, Sydney, a vast number of children with ADD/ADHD are seen each year by a multidisciplinary team comprising orthoptics, occupational therapy, social work, physiotherapy, psychology, speech therapy, dietetics and a paediatrician.

The aetiology of ADD/ADHD is extremely varied. Some believe that it is hereditary or genetic,[3,4,5] whilst others feel that it is due to a disorder of the brainstem, thalamus, frontal lobe[3] or a shift in cerebral dominance to the right brain.[6] Neuropsychological deficits, pre- and post-natal hazards, disruption to a behavioural inhibition system[3] and inadequate amounts of certain fatty acids[7] have also been cited as potential aetiologies of ADD/ADHD. Whatever the cause, ADHD is dimensional, not categorical. However, there are those who still believe that ADHD is just a myth or label for exuberant children faced with intolerant or inadequate caregivers. Commonly, children with ADHD have inappropriate language skills and find it difficult to take other people into account. Communication should comprise listening and understanding, which the child with ADHD cannot do adequately. This then leads to socialisation and relationship problems and subsequent behaviour problems, all of which are multifactorial, dependent on environment,[8] genetics and personality. Children with ADHD are highly visual rather than auditory - they are very easily distracted and therefore do not learn properly.

At RFWCHS, diagnosis of ADHD is made from a combination of observation and a core number of checklist areas being present. Formal questionnaires (DSM-IV/ADHD Rating Scale IV-Home Version (University of Massachusetts Medical Centre),[9] detailed objective testing, a carefully taken history, presentation and outside reports all contribute to the paediatrician's diagnosis of the condition. If appropriate, either Dexamphetamine or Ritalin (stimulant medication) is prescribed by the paediatrician. It is thought that these medications stimulate neurotransmitters and bio-chemicals in the under-aroused areas of the brain that involve planning, foresight, weighing of alternative responses and inhibiting actions when alternative solutions might be considered.[2] Stimulants do not cure ADHD – they help the child to make the best of their abilities with regards to education, relationships and behaviour until some resolution comes with maturity.[5]

The Australian National Health Strategy Report (2000)[10] stated that ADHD was the most common developmental variation affecting 1.2% of Australian children.[6] Though a number of children will 'grow out of it', 60% will carry some degree of ADHD with them into adulthood.[5] In the USA, ADHD is the most commonly diagnosed disorder of childhood, estimated to affect 3 to 5% of school-aged children, and occurring three times more often in boys than girls.[2] Similarly, in New Zealand, it is estimated that 6.7% of children and 2 to 3% of teenagers suffer from ADHD.[11] Working groups concerned with ADD/ADHD are becoming more and more prominent in the community. The Orthoptic Association of Australia has addressed this with their Learning Difficulties Committee and the Central Sydney Area

Health Service has developed a best practice model for assessment and management of ADHD for children, adolescents and family health services.[12]

The diagnostic features of excess in ADHD are impulsivity, hyperactivity, distractibility, drivenness, insatiability and attentional bias.[6] It presents as a complex developmental impairment and co-morbidity of other disorders is recognised.[4,5,11,13] Children with ADHD have been found to commonly have learning difficulties (25-50% of children), Oppositional Defiant Disorder (40-67%), Conduct Disorder (20-56%), Anxiety Disorders (25%) and major depression (0-30%).[11]

Few specific ocular disorders have been reported in conjunction with ADD/ADHD. It is known that side-effects of Ritalin are headache,[1,14,15] blurred vision, dizziness, hypersensitivity reaction with conjunctivitis, rash and hives,[14] and nervous habits such as tics.[15] Poor dark adaptation,[7] an inability to voluntarily inhibit saccades,[16] and poor performance on tasks involving sustained attention variables in both visual and auditory domains[17] have all been reported. Studies have also shown that children with unmedicated ADHD make more errors on spatial working memory tests.[16] Evian[18] reports seeing very jerky midline movements with motor overflow of the head, overshooting and undershooting of the saccadic and pursuit movements, and reduced depth perception.

A study reported in 2000 from the Shiley Eye Centre at the University of California, San Diego (UCSD),[19] found that convergence insufficiency (CI) was also often co-morbid with ADHD. Convergence Insufficiency (CI) was defined as 'a physical eye problem that makes it hard to keep both eyes pointed and focused at a near target, making it difficult to maintain concentration when reading'.[19] Similarly, Lyle and Jackson[20] describe CI as 'the inability to obtain and/or maintain adequate convergence, without undue effort'. Additionally, CI may be considered as reduced convergence in the presence of orthophoria or a heterophoria, generally producing aesthenopic symptoms, and may be accompanied by reduced accommodation or near vision. Dr David Granet, et al,[19] at the Shiley Eye Centre, reported that children with ADHD were three times more likely to have CI than other children. When looking at the ADHD population, they found an incidence of convergence insufficiency of almost 16%. In the USA, convergence weakness has been found to be a disorder that generally affects less than 5% of children.[19] In Australia, it has been reported to affect about 5% of children and up to 10% of adults.[21] In view of Granet's findings, a study was undertaken at RFWCHS of 50 children, known to have ADHD, to determine if CI is indeed a common finding amongst the paediatric ADHD population.

METHOD

Written consent for any screening or medical procedure undertaken at RFWCHS is obtained as part of the client registration procedure, and verbal consent is implied at the time of screening. Each of the 50 RFWCHS children underwent an orthoptic screening in the Orthoptic Department prior to commencement of either Ritalin or Dexamphetamine. Some children have since undergone a follow-up assessment, at least six months after starting medication. For each child, a cover-test was performed at both near and distance (1/3 metre and 6 metres respectively). Visual acuity was also measured at both distances, using the Snellen Linear Chart, with some children needing to match the letters on a board held on their lap. Near vision was tested by either matching Snellen linear or single letters or reading Curpax text type.

Ocular movements were performed using the standard "H" pattern at near and convergence was measured with either the RAF Rule or in free space if the child could converge to closer than 5 centimetres. Binocular Single Vision (BSV) was measured using either the TNO Stereo Test or the Titmus Stereo Test. Glasses were worn for all tests when appropriate. Standard overhead fluorescent lighting was used, with an additional overhead 60 watt lamp for near tests.

Additional ocular signs and symptoms reported by the family were also noted, along with the child's age, date of birth and the type of stimulant medication prescribed. As this was a retrospective study, it was found that the measurement of accommodation had not always been recorded as part of routine orthoptic assessment. Additionally, accommodation cannot accurately be measured with the RAF Rule on children under the age of eight years, which discounted an extra group of children. The assessment of pupils and colour vision (using the Ishihara Colour Vision Test) were also undertaken on the majority of children.

RESULTS

The age range of children seen was from 2 years 11 months to 15 years 2 months, with the average age being 8 years 7 months. The majority of children were placed on Dexamphetamine (88%) with only 6 children being prescribed Ritalin (12%).

Cover-testing at near revealed 44% of children were orthophoric or exophoric, 8% esophoric, one had an intermittent esotropia (2%) and one had a constant exotropia (2%). Distance cover-test results were slightly different, with 90% being orthophoric, 4% exophoric or exotropic and one had an intermittent exotropia (2%). Overall, 46 of the 50 children (92%) had no manifest or intermittent squint for near or distance.

Colour vision was assessed in 29 children, with 26 showing no obvious abnormality and 3 having a red/green colour defect. Of the 12 children who had their accommodation measured, 66.7% had age appropriate results, 8.3% were over age-appropriate levels and 25% were under accommodating. These 12 children had accommodation measured if they had previously been prescribed reading glasses, other test results were reduced, such as near vision or convergence, or if the family had reported ocular signs/symptoms, such as excessive blinking or headaches. Of those 41 children who had their pupils tested, all were found to have normal direct and consensual responses to a bright torchlight.

The results of ocular movement assessment were such that 92% showed no apparent defect, 6% had a "V exo" pattern (increase in exo deviation in elevation) and one child (2%) had a bilateral inferior oblique over-action. Results of visual acuity testing showed that the majority of children (76%) had vision right and left eyes that was 6/6 or better and N6 or better. A further 14% had 6/9, N6 or better right and left eyes. Two children had vision of 6/36, N18 in one eye and at least 6/12 N8 in the other. One of these children had hypermetropic astigmatism with refractive amblyopia and, with appropriate glasses and occlusion, vision improved to 6/9 N5 either eye. The other child had a constant exotropia and subsequent strabismic amblyopia in that eye.

Titmus Stereo and TNO Stereo testing found that the majority of children (70%) had BSV of 60" of arc or better. Two children did not have a level of BSV recorded – one child was unco-operative and the other had a manifest exotropia at both near and distance.

Apart from this same child with the constant exotropia who did not demonstrate any convergence ability (2%), convergence near point results ranged from 15cms to full convergence. A significantly large group (46%) of the children could converge fully into their nose, 24% had convergence of 5cms or better and 20% were between 5 and 8cms. A further 2% had a convergence break point between 8 and 10cms and the remaining 6% between 10 and 15cms.

Amongst the 50 children screened, the 4 with an intermittent or constant squint were not included when considering the presence of a CI. Results showed that 35 children (70%) had a near point that was between 5cms and full convergence (Table 1). The remaining 11 children were considered to have a CI, 10 of whom (20%) received treatment at RFWCHS and additional orthoptic exercises for home use. Initial convergence near points of those treated ranged from greater than 5cm to 15cm, although one child did had full convergence but poor accommodation. The remaining one child with reduced convergence (2%) did not receive treatment due to poor co-operation. Overall, children in this RFWCHS study were considered to have a CI (22%) if they were struggling to reach at least 5cm, had aesthenopic signs/symptoms, their accommodation was reduced for their age, had orthophoria or heterophoria for near and distance, or a combination of any of these.

CONVERGENCE NEAR POINT	NUMBER OF CHILDREN	
Children with a manifest or intermittent squint	4	(8 %))
Between Full to Nose and 5cms	35	(70 %)
Between 5cm and 15cms	11	(22 %)
TOTAL NUMBER OF CHILDREN	50	(100%)

TABLE 1: Convergence Near Points of Children Without Manifest or Intermittent Squint.

It is interesting to note that, prior to being seen at RFWCHS, 2 children had been prescribed reading glasses by their local eye care practitioner. After orthoptic screening, they were both found to not need their glasses. Particularly, one of these children had been given reading glasses with prisms – without the glasses, this child had 6/5 N5 vision either eye, a tiny esophoria for near, orthophoria for distance, almost full convergence, age appropriate accommodation and BSV of 60" of arc. Additionally, he was asymptomatic.

DISCUSSION

The Shiley Eye Centre found an increase of convergence insufficiency (approximately 16%) in children with attention disorders.[19] This has also been the finding in this current study, with 22% of children considered to have a CI and, overall, 20% receiving treatment. Of course, dependent on the definition of 'convergence insufficiency', others may find differing results to these two studies.

Unlike Evian,[18] however, abnormalities of the pursuit system were not observed, although perhaps the standard procedure used was not detailed enough to show such defects. Additionally, Evian also noted that reduced depth perception was a common finding amongst children with ADHD. Depth perception results of this study do not mirror those of Evian, with the majority of children (70.8%) having BSV of at least 60" of arc. In fact, one child had an improvement of BSV from 120" to 30" of arc after commencing Dexamphetamine. In the case of this same child, the family also reported that since medication, he was now mixing better with his peers, had more appropriate language and socialisation skills and performance at school had much improved.

An area that was not addressed in this current study was the measurement of a fusion range for each child. It is well known that one can have straight eyes, good convergence and age appropriate accommodation, yet still be symptomatic. Often such cases are found to have poor fusional ability - this is an area that could be addressed in further studies. Additionally, further study should include treatment, and continued effect of this, whilst still on medication.

It has been shown that CI is more prevalent amongst a paediatric population with ADHD. Convergence insufficiency is known to make it difficult to perform prolonged near work and maintain interest in such tasks. The ADHD child is widely recognised as having learning difficulties, with weaknesses in reading, writing, spelling and maths – perhaps the convergence system should be investigated more fully in these children to assist them in learning and achieving to their full potential.

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Testing VA: Do symmetrical charts make a difference?

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ABSTRACT

Data on 117 subjects over seven years of age were obtained to determine whether there is a difference in the results obtained from visual acuity charts that use only letters with lateral symmetry and those that use a combination of letters with and without this symmetry. Subjects with acuities of 6/9 or better were used to overcome the problems associated with difference in letters on the 6/60 to 6/18 lines, such as the number of letters, their spacing on a line, and the spacing between lines.

The results showed a highly significant statistical difference (p=0.0001) between the two charts, with the charts that use only letters with lateral symmetry giving a better result of on average, 0.49 letters. This means that on approximately every second test, an eye tested on a chart with lateral symmetry would read one more letter than one tested on a chart with letters with and without symmetry. It is unlikely that clinical decisions would be based on this small difference. These findings should only be generalised to subjects with good visual acuity.

INTRODUCTION

In most eye examinations, an assessment of visual acuity is made with a standard visual acuity chart based on Snellen's principles. Several factors can influence results from a visual acuity test, such as the illumination of the chart itself, room illumination and the overall design of the chart.[1,2,3,4] Another factor could also be the choice of letters that are used on the chart. Although the logMAR chart has been designed to overcome most of the identified problems of the standard Snellen's chart, many clinics still use the traditional charts in their standard testing procedures.

Vision charts usually display different letters of the alphabet. Some use symmetrical letters such as A,O,H,V,T, a feature of the Sheridan Gardiner charts, whilst others (for this project referred to as Snellens charts) use a variety of letters, some with lateral symmetry others without, such as L, C, N. As recognition of a letter often involves detecting certain cues, symmetrical letters may be easier to detect as such features are present on both sides of the letter, so that the cues of line, or space, are doubled for that particular letter.

On many vision testing boxes, charts of each type may be used, so that a Sheridan Gardiner chart is used for testing one eye, and Snellens chart is used for testing the other eye. A difference in test results may be interpreted as a true difference in visual acuity, whereas it may simply represent a difference in the ability to recognise letters with (or without) symmetry.

This study was designed to determine whether there is a difference in the legibility of letters on these charts give that could be explained by the above factors. If this is so, then a change in visual acuity between assessments may be attributed to improvement or reduction in acuity, rather than an artifact caused by the type of chart used.

METHOD

Twenty five third year orthoptic students gathered data on subjects over seven years of age who were not familiar with the standard charts.

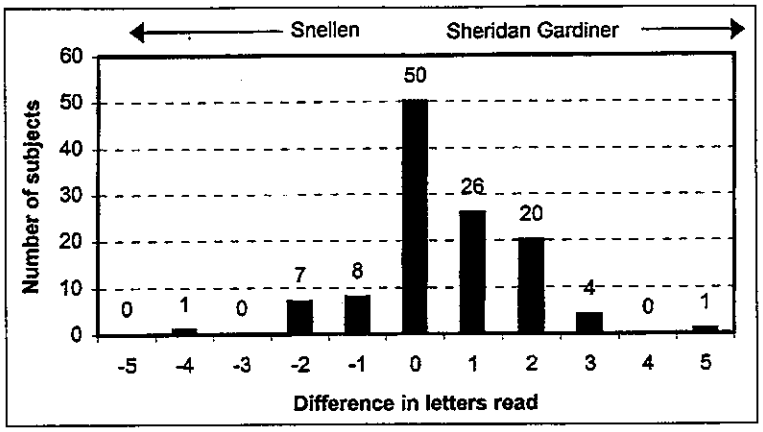
As there are different numbers of letters on each line of the charts, different spacing between the lines and between the letters on different lines, a study such as this is best carried out at a level of acuity that minimises these effects. Therefore, subjects were included only if they could read all the 6/9 letters on the first chart tested, as the number of letters on each line (from 6/9 to 6/5) is fairly consistent. The charts used were identical in all features apart from the type of letters used.

For each subject, visual acuity was measured with the same eye on each type of chart. The order of testing was varied. The difference in the number of letters read was recorded as positive if there were more letters read on the Sheridan Gardiner chart and negative if there were fewer read on this type of chart. If there was no difference, the score was zero. The results from all students were pooled and analysed. As differences of over 5 letters are unlikely, given the above criteria, the few scores at this level were probably due to error on the part of the students and were not included in the analysis.

RESULTS

Data from 117 subjects were obtained and are shown in Figure 1. A Wilcoxon signed rank test was performed to determine whether the difference in letters read varied significantly from zero. A mean difference of (positive) 0.49 was found which indicates that the Sheridan Gardiner letters were easier to detect. The p value was 0.0001 (ie, highly statistically significant).

Figure 1



Results from 117 subjects aged 7 years and over tested on the Snellens and the Sheridan Gardiner visual acuity charts. Positive values show the additional number of letters read on the Sheridan Gardiner chart, negative values show the additional number of letters read on the Snellens chart. Zero values indicate no difference in the results from each chart.

DISCUSSION AND CONCLUSIONS

Although there is a statistical highly significant difference between the results obtained on each chart, the actual difference was equivalent to only 'half a letter'. This means that on one out of two tests there may be a difference found of one letter that was due to the type of letters on the chart. It is unlikely that clinical decisions would be based on this small difference. This illustrates the difference between 'statistical' and 'clinical' significance.

Nevertheless, as some subjects in this study showed differences of several letters with each chart, it would be advisable to ensure that the same type of chart is used to compare each eye, and to measure the progress of treatment.

These results can only be generalised to testing subjects with good visual acuity. As the 6/60 – 6/18 letters on standard charts vary considerably in the number of letters on a line, and the spacing between letters and the lines, the effect of the cues of symmetrical letters discussed above may be more significant.

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The non-surgical management of accommodative esotropia – a personal reflection

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This paper will be a personal reflection on the current methods of diagnosis and management of accommodative esotropia and a brief look into the future and how refractive surgery may affect the condition.

INTRODUCTION

Accommodative esotropia generally occurs between the age of 1 and 4 years although it may present at either an earlier or later age. It is diagnosed when correction of a hypermetropic refractive error or use of hypermetropic lenses in the near position results in a decrease in the esotropia , the convergent deviation being affected by the state of the accommodation, which is a significant factor in the aetiology of the condition. There are essentially three different types of accommodative esotropia. *Partially accommodative esotropia or esotropia with an accommodative element,* where correction of the hypermetropia results in a reduction in the esotropia but does not result in binocular single vision (BSV); *Convergence excess esotropia* where there is binocular single vision on distance fixation and esotropia for near and *Fully accommodative,* where the correction of the refractive error results in binocular single vision with the spectacle correction in situ. Unfortunately the terminology is not universally accepted which can lead to difficulties when reviewing the literature where there seems to be a wide variation as to what constitutes accommodative esotropia. This has resulted in lengthy discussions on the ethics of surgical intervention, whilst ignoring the important role of orthoptic or non-surgical management.

The management of accommodative esotropia is dependant from the outset on accurate cycloplegic refraction and early and full correction of hypermetropia and astigmatism. The presence of any amblyopia requires occlusion therapy regardless of the possibility of provoking decompensation of the binocular single vision. However, it must be recognised that each case is different and needs to be approached individually as the child may respond to therapy in a variety of ways.

PARTIALLY ACCOMMODATIVE ESOTROPIA

This common type of accommodative esotropia has a multi-factorial aetiology. It is imperative that the cause is established from the outset as this will have an important effect on the prognosis. The more common causes are:

1. Superimposed accommodative squint on
   i) pre-existing microtropia
   ii) previously operated infantile esotropia[1]
   iii) hypermetropic anisometropic amblyopia[2]
2. Accommodative esotropia secondary to anomalies of the oblique muscles ('A' and 'V' patterns)[3]
3. Inherited absence of or defective binocular vision
4. Decompensated fully accommodative or convergence excess esotropia[4]

Therapeutic modalities

As a general rule these children are not expected to achieve normal BSV after treatment. Most patients with partially accommodative esotropia will demonstrate some type of anomalous BV with a variable amount of fusion and stereoacuity. Cases which initially appear to have a fully accommodative and convergence excess esotropia but later present with a constant esotropia frequently turn out to have an underlying microtropia or poor fusion potential. However, in these cases, it is important to establish that there is no uncorrected hypermetropia after the initial refraction so a repeat cycloplegic refraction should be carried out after about 3 month's glasses wear. Occasionally more hypermetropia may be unreeled and its correction may result in the establishment of BSV at times with the glasses.[5] Either part-time or partial occlusion may be necessary to maintain equal visual acuity.

The use of ***anti-suppression and/or fusion treatment for*** partially accommodative esotropias has long been questioned. Synoptophore exercises are very much a treatment of the past. However, it is likely that aggressive occlusion therapy has a beneficial effect on any amblyopia rather than the binocular potential.[6] A weekly visit to the orthoptist is an excellent way of ensuring compliance with occlusion.

Fresnel prisms are frequently suggested as an ideal method of determining binocular potential and as a predictor for the amount of surgery needed to realign the visual axes.[7] However, they are poorly tolerated in most children and as Kulnig[8] has shown, a 20 PD Fresnel prism can significantly reduce the acuity by as much as 4 Snellen lines and may give rise to the development of meridional amblyopia. If prisms are to be used, then, in the presence of equal visual acuity, it is probably preferable to divide the required prismatic correction between the two eyes. If there is any amblyopia, then the prism should be attached to the lens of the fixing eye in order to discourage any further suppression and amblyopia in the strabismic eye.

The majority of children with partially accommodative esotropia will need surgery. When deciding on the extent of operative correction consideration must be given to the amount of hypermetropia present and whether it is possible that the child will be wearing a reduced correction following the surgery or whether the glasses may be discarded at some future time. It is unfair to condemn a child to constant use of a low hypermetropic correction for the rest of his/ her life simply because a tolerable cosmesis with glasses becomes unacceptable without the glasses. However surgery designed to dispense with a moderate to high hypermetropic correction may well result in complications. For instance a consecutive exotropia may occur which may not be reversible by reduction in the hypermetropic correction post-operatively[9] or when the glasses become necessary for vision at the onset of presbyopia, which may be in their early 20's in hypermetropes. The presence of alphabet patterns and the role of the oblique muscles will also need to be considered when planning surgery.[3]

CONVERGENCE EXCESS ESOTROPIA

The most common type of convergence excess esotropia is that associated with a *high AC/A* ratio where an anomaly in the ratio between accommodative convergence and accommodation results in an esotropia for near fixation. The addition of a convex lens of +3 DS for near results in a marked decrease in the esodevation and may result in BSV.

Patients may also be identified as having convergence excess esotropia with a *low or normal AC/A ratio.* The addition of a +3 DS for near may result in a small decrease in the deviation but not in binocularity. It should be noted that some authors may include patients in this category who have a distance deviation of < 10PD but not BSV.[10] The aetiology of the condition is thought to be hyper-innervation of the medial recti. Children with convergence excess esotropia who do not have a high AC/A ratio will not respond to non-surgical treatment and early operation to weaken both medial recti is indicated.

Convergence excess esotropia has been described in association with emmetropia[11] in bright hyper-active children, and associated with myopia.[12,13] It is possible though that both these latter types may fall into the category of *hypo-accommodative convergence excess esotropia* originally hypothesised by Costenbader[14] and later expanded by von Noorden[15] and Muhlendyck.[16] These children appear to have a pre-existing hypo-accommodative state and are unable to exert the necessary accommodation needed to see clearly at near. The existence of this condition underlines the importance of testing not only the AC/A ratio in children with convergence excess esotropia but also estimating either objectively or subjectively the monocular and binocular accommodation.[17]

Opinion with regard to the management of high AC/A ratio convergence excess esotropia is firmly divided between the exponents of surgery as an initial and sometimes only treatment and those who use it as a last resort.[17] In general surgery is probably contra-indicated in infancy[10] and as true convergence excess esotropia is rarely seen in adults, should anything be done except eliminating the amblyopia, repeating the refraction, correcting all the hypermetropia, and waiting for normalisation of the AC/A ratio and the resolution of the esodeviation?

Therapeutic modalities

1 ***Bifocals*** with an addition of up to +3 DS for near frequently result in stable binocularity for near fixation. It is important that the glasses are properly fitted and every effort should be made to effect a reduction in the correction every six months. Some authors[18] suggest that they should be worn until the age of 10 years and then discarded, others suggest that long-term use may cause defective accommodation.[15,19] The point at which further reduction in the near addition is no longer possible may be the stimulus to attempt another form of therapy. Careful monitoring of the monocular and binocular accommodation is advisable during bifocal use. As a general rule it is probably advisable to limit bifocal use to a period of no more than 3 years.

2 ***Contact lenses*** form a viable alternative to bifocals[20] particularly with the advent of daily wear disposable lenses, and may obviate the necessity for surgery. In moderate to high hypermetropia there would be less peripheral blur with contact lenses and therefore more binocular cues with larger corresponding retinal areas stimulated, so improved peripheral as well as central fusion. At the beginning it may be helpful to use a small overcorrection of the hypermetropia although the visual acuity should not be reduced to <6/9. It is necessary to use a large diameter soft lens and helpful to have a contact lens wearer in the family. Careful patient selection is indicated with girls tolerating the lenses better than boys, although a talent for sport may provide the stimulus to contact lens wear in both sexes. Progressive reduction in the hypermetropic correction should be attempted once the condition is stabilised.

3 ***Fresnel prisms*** are an acceptable alternative to bifocals although rarely used. They have the advantage of not interfering with accommodation and convergence but do produce a decrease in visual acuity[8] even if the prisms are divided between the two eyes. There may be a slight risk of causing bilateral amblyopia if the prisms are used for long periods.

4 ***Miotics*** such as Phospholine Iodide are rarely used and may not be available except on a named patient basis. Miotics are sometimes helpful as a short term treatment for recent onset smaller decompensating near deviations.[21]

5 ***Botox***[22] injected into both medial recti simultaneously can result in the resolution of high AC/A ratio convergence excess esotropia.

6 ***Surgery*** Children with low or normal AC/A ratio convergence excess esotropia need early surgical realignment, but for those with a high AC/A ratio

it can be safely postponed until all other treatment has been tried. It is worth remembering that there is a risk to surgery, however slight, and some parents may not wish for operative treatment for their children as the near esotropia may not be noticeable under normal conditions.

Non-surgical management is not simply postponing the inevitable operation but maintaining BSV in an unstable condition whilst normalisation of the AC/A ratio takes place. Whilst it may be suggested that the distance BSV is sufficient to maintain the development of normal binocularity, fusing comfortably for near as well, ensures that suppression and amblyopia do not erode the fragile binocular reflexes.

The condition of hypo-accommodative convergence excess esotropia is uncommon. It tends to occur at a later age with the diagnosis reliant on the detailed assessment of the monocular and binocular accommodation.[14, 15 16, 19] The identification of this condition is important as these children are unable to accommodate sufficiently to see for near and will therefore have to use bifocal or multifocal glasses for the whole of their life.

FULLY ACCOMMODATIVE ESOTROPIA

Whatever happened to orthoptic treatment?
Patients with fully accommodative esotropia were always identified as the perfect orthoptic patient. However, it is unusual in the 21st Century to witness children being taught to control the esodeviation without their glasses. It seems to be accepted that if there is good and stable BSV with the refractive correction in place then the fact that there is an esotropia without the glasses is irrelevant. However, it should not be forgotten that this situation is a problem for the parents who will inevitably see the child without glasses albeit only for brief periods, and may be a problem for the child in later years, if spontaneous control does not ensue.

Children who will benefit from orthoptic therapy may be easily identified by measurement of the AC/A ratio.[17] Most patients with fully accommodative esotropia will have an AC/A ratio within normal limits but those with a high AC/A ratio are those who are likely to decompensate in the long term. Fully accommodative esotropia which deteriorate into an esotropia whilst wearing their glasses are an unusual condition which may be related as much to the state of the binocular reflexes as the AC/A ratio. They usually respond well to surgery. Occasionally though an infant may present with an apparently fully accommodative esotropia within the first eighteen months of life, which later decompensates for near and results in a diagnosis of convergence excess esotropia. Careful observation of babies with fully accommodative esotropia will identify these cases.

Therapeutic modalities
The classical teaching has always been:

1 Eliminate suppression
2 Teach diplopia when squinting
3 Show control of diplopia by relaxation of accommodation
4 Teach dissociation of accommodation and convergence
5 Bar reading
6 Progressive reduction of glasses
7 Patient discharged with comfortable BSV with glasses and with –3 DS added to theoretical hypermetropic correction.

Experience indicates that most children, who have been shown how to appreciate diplopia when squinting, have little difficulty in establishing control of the esotropia without glasses. Lengthy courses of exercises are rarely necessary although periods of bar reading at home are helpful from both an orthoptic and educational standpoint.

Contact lenses may be used as an alternative to glasses in the management of fully accommodative esotropia.[5, 20, 23] They are especially useful in patients who are poorly tolerant of spectacles, children with high hypermetropic errors and in cases where glasses wear is problematic such as for gymnastics, ballet and some contact sports.

The rationale for attempting to reduce the hypermetropic correction progressively in fully accommodative esotropia has always been that the non squinting hypermetrope rarely tolerates full correction of the error. Current theories suggest that full correction of hypermetropia into teenage years may affect the normal process of emmetropisation and result in the patient being a glasses wearer in adult life. This should be the stimulus to resuming active therapy for fully acommodative esotropia. In fact Lambert[24] has shown that progressive reduction of the hypermetropic correction may stimulate emmetropisation, although others would suggest that hypermetropic esotropic children may be predestined to remain hypermetropic.[25]

SUMMARY

In *partially acommodative esotropia* the prognosis for the restitution of normal BSV is rarely good. The best that most of these patients can achieve is satisfactory cosmesis with some fusional ability with anomalous correspondence. It is probably fair to say that those who do achieve BSV after treatment may well have had a wrong diagnosis initially. Early surgical alignment may well constitute their best chance of satisfactory treatment so the use of therapy other than pre-operative occlusion may well have a detrimental effect.

Children with *convergence excess esotropia* frequently do require surgery at some stage, but properly directed treatment to stabilise the deviation, and stimulate normal binocular function for near by the use of contact lenses or bifocals in the early stages results in a much improved response to surgery. No patient should require more than one procedure on the medial recti in order to re-establish full binocularity if stability is obtained prior to operation.

It has to be accepted that there is a group of children with hypo accommodation who will require long term use of bifocal or multifocal glasses in order to use BSV for near.

Cases of *fully accommodative esotropia* with normal or near normal AC/A ratio should be treated aggressively in order to establish control without glasses and every effort should be made to reduce their spectacle correction in order to stimulate emmetropisation. However we must accept that there are a group of children who may need surgery in order to produce constant BSV.

THE PRESENT AND FUTURE

Early results in adults with accommodative esotropia who have had laser surgery to reduce or eliminate their hypermetropic error suggest that there is a significant reduction in the esodeviation following the procedure.[26] This is unlikely to cause serious problems in those with normal BSV, although a change from esophoria to exophoria may be symptom producing in the short term. However there is a diplopia risk in the group of treated partially accommodative esotropes, as many may have been subjected to intensive anti-suppression and 'fusion' treatment over long periods during childhood and need complex investigation and counselling prior to consideration of laser refractive surgery.[27] It is important that there is careful selection of strabismic cases and close monitoring before and after treatment so that a protocol can be established. It is unlikely that laser refractive surgery will become an established treatment modality in children in the immediate future.

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Vision and Sport: The Past Present and Future Role of Orthoptics

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ABSTRACT

In 1970 Air Vice Marshal Daley addressed the graduating Orthoptists in Melbourne. Extracts from his speech were published in the 1970 Australian Orthoptic Journal. In his speech he outlined the significant role of Orthoptics in training pilots during World War 2. He also stated the important role of Orthoptics in sport and gave an example of the "Hawthorn footballer who, following some ailment lost his ability to mark the ball overhead. After orthoptics he recovered his skill, and retained his place in the league".

During this decade and in the 1980's Optometristís mainly in the United States started to develop ~ and propose theories for vision and sports performance. Limited Orthoptic literature in this area led to the development of optometric sports vision training programs. These years produced much anecdotal evidence and to date the sports medicine community largely continues to ignore the claims of vision training and sports performance.

The development of the Orthoptic profession in Australia over the last 50 years has highlighted the flexibility in applying our theoretical and practical knowledge to benefit special communities. This has occurred in low vision rehabilitation, CVA and head injury rehabilitation and driver rehabilitation. The role of orthoptics in sport is purely an extension of these specialty areas.

Sport brings together the celebration of human kind and the endeavors to perform and participate at the highest levels. Orthoptics is a celebration of a profession that continues to expand, thrive and offer opportunities to all those who are willing to participate.

The challenge of re-establishing the role of orthoptics in sport has only just begun. This presentation will highlight the past, present and future role the Orthoptist in sport.

INTRODUCTION

I would like to thank the Australian Orthoptic Association for this nomination. I would like to extend a warm welcome to overseas orthoptists who have joined us for another stimulating national conference. I hope this presentation will be educational, thought provoking and entertaining as I attempt to take you on a journey into the research ideas relating to vision and sport.

By 1939 Sir Philip Livingston an ophthalmologist had concluded the importance of binocular single vision in flying and with the outbreak of World War 2 developed standards for visual requirements for pilots. Orthoptic treatment was extensively used in treating pilots with visual problems related to heterophoria and convergence problems.

In 1970 Air vice Marshal Daley in an address to graduating orthoptists in Melbourne highlighted the significant role of orthoptics in training pilots during World War 2. In his speech he also suggested the importance of orthoptics in sport. Unfortunately the challenge to develop this area was not taken up by orthoptists at that time. Thirty years later I am able to present a scientific basis for othoptics in sport.

The search for excellence through physical performance is unceasing. Researchers, coaches, and athletes continue to explore the limits of human action potential. In this regard, the visual system and its contributions to sport performance success has been investigated for a number of years. These investigations have included the neurophysiology of the eye and brain as well as visual, perceptual and motor parameters.

The plethora of anecdotal evidence and lack of scientific research are frequently cited as the reasons for scepticism amongst critics of practitioners of sports vision. Whilst no-one would deny the importance of good visual acuity to almost all forms of sport, the relevance of binocular single vision is rarely appreciated by those outside ophthalmology. It may be possible to quantify improvement in visual performance in the clinic however the task of equating this with increased skills on the sports field is difficult. Practitioners of sports vision are generally involved in 4 different areas:

1. Vision screening
2. Vision training to improve performance
3. Prescription of protective eyewear and sunglasses
4. Treatment of sports related eye injuries

This presentation will mainly focus on the controversial area of vision training to improve athletic performance.

The relationship of vision and skilled movement

Skilled movement is not a spontaneous muscular response but represents a sequence of complicated processes within the central nervous system. An athlete absorbs information from the surrounding sporting environment and processes this information. The final output produces a movement response. This model of humans as information processing systems is commonly used to explain the role of vision in producing and controlling skilled movement. The human performance model was originally presented by Welford[1]. The model assumes that perceptual-motor

performance occurs when sensory input information is converted into a purposeful output action. In between the input and output actions information passes through three hypothetical central processing mechanisms.

Perceptual mechanism

This mechanism receives information from receptors such as the retina for visual information and the inner ear for balance information. The perceptual mechanism reorganises and interprets the information. The selection of information can be influenced by the athlete's previous experiences.

Decision mechanism

Information from the perceptual mechanism is passed through to the decision mechanism which decides the appropriate action. This mechanism is concerned with response selection and strategy formation. This can also be influenced by the athlete's previous experience.

Effector mechanism

If the decision mechanism selects a motor response, the relevant information is passed onto the effector mechanism which controls and organises the sequence of the desired movement. Neural commands pass from the central nervous system to muscle groups required for the movement. Through feedback this mechanism can control a movement during its execution and evaluate the final result in a way which allows changes to be made in the future.

The perceptual mechanism is made up of 2 different levels of visual information.

1. **Hardware**

The first type of processing involves the reception of visual information, this is affected by the ocular characteristics of the athlete's visual system. The hardware components of the visual system can be measured using orthoptic or optometric tests and forms the basis for a sports vision eye examination.

2. **Software**

The second type of processing involves the perception of visual information this is influenced by the strategies an athlete develops through experience that result in processing the incoming information more efficiently. Software aspects of sports vision include information processing strategies, encoding and retrieving perceptual information from memory, extracting relevant information from both advance cues and ball flight cues and the use of anticipatory skills.

Sports vision testing

A sports vision assessment as conducted by an orthoptist should include:

1 Static and dynamic visual acuity for both near and distance with and without glasses, if worn.
2 Cover test in all positions of gaze to determine the nature and size of any heterophoria or heterotropia
3 Examination of the smooth pursuit and saccadic systems of ocular movements
4 Measurement by prism cover test of the heterophoria or heterotropia
5 Measurement of the near point of convergence
6 Assessment of the range and amplitude of accommodation
7 Assessment of motor fusion ranges of convergence and divergence for near and distance
8 Measurement of stereoacuity for both near and distance
9 Determination of the dominant eye
10 Assessment of the monocular and binocular visual field

In addition to testing the hardware aspects of the visual-perceptual system a sports vision examination may include tests for visual-motor performance. This includes:

Eye hand coordination.

Eye-hand coordination is defined as a perceptual-motor skill involving the integration of visual and tactile information so that a purposeful movement may occur. Eye-hand coordination is often divided into two components, proaction and reaction as tested on the Acuvision 1000. Proaction refers to action which is initiated or controlled by the athlete e.g. the motion of passing a ball. Reaction refers to movement that occurs in response to another action e.g. a player catching a ball

Peripheral awareness reaction time

Peripheral awareness reaction time measures how quickly an athlete is aware of an object in his peripheral vision. In team sports peripheral awareness is a crucial skill.

Total reaction time

This represents the measurement of reaction time plus movement time based on responses from the visual, auditory and motor systems. First step explosiveness and the ability to get off the mark quickly is an important component of visual-motor performance.

Eye / foot coordination

Eye/foot coordination is the ability of the feet to respond in a smooth and coordinated manner as a result of information provided by the visual system.

Coincidence anticipation

Coincidence anticipation is the ability to make a motor response coincident with the arrival of an object at a designated point e.g. predicting the arrival of a pitched ball in baseball.

Concerns about Optometric based sports vision training

In the 1970's and 1980's US optometrists gained increasing attention for their claims that all athletes could benefit from vision training programs. In the majority of the health sciences evidence-based practice forms the major nexus between science and clinical/professional intervention. To this day vision training is increasingly advocated and utilised in clinical and behavioural optometry as a basis for improvements in sports performance yet the evidence-base to support such an intervention is far from compelling. The evidence surrounds three key assumptions to the efficacy of sports vision training:
Assumption 1: The visual attributes being trained are limiting factors to sports performance.

Assumption 2: Functional aspects of limiting visual attributes can be improved through visual training
Assumption 3: Improvements in the functional aspects of key visual attributes translate to enduring improvements in sports performance.

Consideration of the evidence-base relevant to each of these assumptions highlights the need for considerable caution in making strong claims as to the likely benefits to sports performance of existing approaches to visual training.[2]

Abernathy and Wood report the outcome of a controlled study on the impact of visual training on sports performance. The study was conducted over a four week period with 30 subjects allocated to training, placebo and non treatment groups. Results of this study indicated that visual training did not improve either visual or motor performance, however, there was a learning effect. It is important to note that subjects undertaking the vision training had no visual problems. As has been shown, any exercise regimen should be based entirely on the individual athlete's requirements. It is a misconception that a standard set of eye exercises can be given to anyone, as claimed by many sports vision optometrist. Before prescribing a treatment regime, a complex study of the subject's binocular status is necessary.

The Orthoptic approach to sports vision

To the orthoptist the present sports vision training programs present several problems. Firstly they are based on adaptations of treatment modalities utilized by optometrists in the management of children with specific learning disabilities, an area in which there is a great deal of controversy. Secondly it is suggested that all athletes undergoing a similar vision training program regardless of their sporting discipline or binocular status can obtain a beneficial effect. Finally it is not just a lack of situation specificity that is missing but far more importantly a lack of subject specificity, as the exercise regime is not tailored to individual needs.[3]

The orthoptic therapies used are proven methods based on sound scientific principles. The fact that 'the patients' originate from the general population rather than from the sporting fraternity is irrelevant. The skill of the eye care practitioner testing athletes is in identifying those with defects or deficiencies that will benefit from treatment. Orthoptists interested in conducting sports vision testing and training may wish to implement the following guidelines in clinical practice:

1. Conduct an eye examination to establish an athlete's ocular status
2. Ocular motility and binocular vision deficiencies should be identified and linked to asthenopic symptoms.
3. Classical Orthoptic vision training can be introduced with the aim of restoring binocular function and relieving symptoms
4. Athletes who pass the eye examination do not require classical vision training intervention. However the use of warm up eye exercises is a possibility. The focus should switch to visual motor performance, visual awareness coaching and perhaps training the perception of visual information.

Vision training is therefore classified into 4 categories: (this classification is based on guidelines developed at the Sports Vision Clinic, School of Applied Vision Sciences)

1. Classical Orthoptic exercises
2. Visual-motor performance
3. Visual awareness training on the field and warm up eye exercise
4. Perceptual - visual search strategies, decision making

At the Sports Vision Clinic, School of Applied Vision Sciences I currently offer athletes Orthoptic exercises and visual-motor performance training. The ongoing challenge is to identify and develop programs for developing visual awareness programs and perceptual training which is currently limited.

CONCLUSION

An elite or talented junior athlete will dedicate themselves to achieving physical perfection in order to perform at the highest possible level. The fact that the sportsman involved in ball games may not even have a routine eye test, in activities which are wholly dependant on visual skills is surprising.

A sports vision assessment, which should be undertaken by an orthoptist will evaluate the binocular status and visual motor function of each individual in order to ensure that any areas of weakness are identified and treated. Vision therapy will help the athlete to use his entire monocular and binocular system at optimal levels and may well result in improved performance on the sports field if conducted in a proper scientific manner.

Over the years sports physiotherapist have become an integral part of the sports science team dedicated to maximising the athlete's performance. The Orthoptist is ideally suited to join the sports science team and manage the athlete's visual system.

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Named Lectures, Prizes and Awards of the Orthoptic Association of Australia Inc.

The Patricia Lance Lecture

Elaine Cornell (Inaugral)
Alison Pitt
Anne Fitzgerald
Carolyn Calcutt
Associate Professor Judy Seaber
Dr David Mackey
Robin Wilkinson
Kerry Fitzmaurice
Pierre Elmurr

The Emmie Russell Prize

1957	Margaret Kirkland	Aspects of vertical deviation
1959	Marion Carroll	Monocular stimulation in the treatment of amblyopia exanopsia
1960	Ann Macfarlane	A study of patients at the Children's Hospital
1961	Ann Macfarlane	Case history "V" Syndrome
1962	Adrienne Rona	A survey of patients at the Far West Children's Health Scheme, Manly
1963	Madeleine McNess	Case history: right convergence strabismus
1965	Margaret Doyle	Diagnostic pleoptic methods and problems encountered
1966	Gwen Wood	Miotics in practice
1967	Sandra Hudson Shaw	Orthoptics in Genoa
1968	Leslie Stock	Divergent squints with abnormal retinal correspondence
1969	Sandra Kelly	The prognosis in the treatment of eccentric fixation
1970	Barbara Denison	A summary of pleoptic treatment and results
1971	Elaine Cornell	Paradoxical innervation
1972	Neryla Jolly	Reading difficulties
1973	Shayne Brown	Uses of fresnel prisms
1974	Francis Merrick	The use of concave lenses in the management of intermittent divergent squint
1975	Vicki Elliott	Orthoptics and cerebral palsy
1976	Shayne Brown	The challenge of the present
1977	Melinda Binovec	Orthoptic management of the cerebral palsied child
1978	Anne Pettigrew	
1979	Susan Cort	Nystagmus blocking syndrome
1980	Sandra Tait	Foveal abnormalities in ametropic amblyopia
1981	Anne Fitzgerald	Assessment of visual field anomalies using the visually evoked response.
1982	Anne Fitzgerald	Evidence of abnormal optic nerve fibre projection in patients with Dissociated Vertical Deviation: A preliminary report
1983	Cathie Searle	Acquired Brown's syndrome: A case report
	Susan Horne	Acquired Brown's syndrome: A case report
1984	Helen Goodacre	Minus overcorrection: Conservative treatment of intermittent exotropia in the young child
1985	Cathie Searle	The newborn follow up clinic: A preliminary report of ocular anomalies
1988	Katrina Bourne	Current concepts in restrictive eye movements: Duane's retraction syndrome and Brown's syndrome
1989	Lee Adams	An update in genetics for the orthoptist: a brief review of gene mapping
1990	Michelle Galaher	Dynamic Visual Acuity versus Static Visual Acuity: compensatory effect of the VOR
1991	Robert Sparkes	Retinal photographic grading: the orthoptic picture
1992	Rosa Cingiloglu	Visual agnosia: An update on disorders of visual recognition
1993	Zoran Georgievski	The effects of central and peripheral binocular visual field masking on fusional disparity vergence
1994	Rebecca Duyshart	Visual acuity: Area of retinal stimulation
1995 – 1997		Not awarded
1998	Nathan Clunas	Quantitive analysis of the inner nuclear layer in the retina of the common marmoset callithrix
1999	Anthony Sullivan	The effects of age on saccadis mode to visual, auditory and tactile stimuli
2001	Monica Wright	The complicated diagnosis of cortical vision impairment in children with multiple disabilities

The Mary Wesson Award

Diana Craig (Inaugral)
Neryla Jolly
Not awarded
Kerry Fitzmaurice
Margaret Doyle
1997 Not Awarded
Heather Pettigrew

Paediatric Orthoptic Award

Valerie Tosswill
Melinda Symniak
Monica Wright

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