Orthoptic exercises: a forgotten art?

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Orthoptic exercises were first described as early as 1855 and are guided training exercises which can be used to treat a number of binocular vision defects. These methods are at risk of becoming a lost art as both orthoptists and optometrists take on extended roles, which are more diagnostic and less therapeutic, leaving less focus on binocular vision. However, many patients present to optometric practice with symptoms and signs of binocular vision anomalies and as such orthoptic exercises can be an area of great interest, but is an area which needs commitment from both practitioner and patient to be successful. The scope of this article is to provide an introduction to the types of binocular vision conditions which are likely to be encountered in a primary care setting.

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Learning objectives
Understand the management of patients with an anomaly of binocular vision (Group 8.1.2)
Investigate and manage adult patients presenting with heterophoria (Group 8.1.3)

About the author
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Who should carry out orthoptic exercises?

Orthoptic exercises have been the realm of orthoptists for many years. Within the UK, hospital eye care services (HES) are well established and referral to such local clinics remains the first course of action for practitioners faced with patients with binocular vision anomalies. For many patients, the first eye care professional they visit will be their local optometrist. If orthoptic exercises are required, patients may prefer to be managed in a primary care setting and, as such, optometrists should be well versed in at least the basics of managing simple binocular vision anomalies. Equally, there will be instances where patients will benefit from specialist orthoptic assessment and management instead, for example due to the complexity of the problem or to enable regular review by the same person. Patient choice has been at the heart of consecutive government initiatives; the coalition government’s approach aims to move away from a system where patients merely receive care to one where they are active participants in their care. The focus of healthcare should be based on outcomes – an area likely to be given much greater focus following the publication of the Francis report. Patients should have their treatment options clearly explained in order to allow them to make an informed choice with regards to their treatment. Part of this should include the option of referral to the local HES clinic for investigation and treatment by an orthoptist to which they are entitled.

Identifying patients who need orthoptic exercises

Patients with convergence or accommodation deficiencies, or binocular instability, typically attend complaining of similar symptoms. Symptoms are often caused by a failure of; or the need for significant effort from, the visual system in maintaining binocular single vision. Symptoms might include general asthenopia such as bilateral frontal headaches or eye strain, typically worsening at the end of the day or following a period of close work. Patients might complain of blurred vision or even intermittent diplopia too. Finding the trigger for the patient’s symptoms can often aid in arriving at a correct diagnosis.

Orthoptic exercises should only be considered if the practitioner is certain of binocular vision potential, thus being able to alleviate symptoms and certainly not exacerbate them. Where there is doubt in the primary care setting, referral to orthoptic secondary care is advisable. Furthermore, the practitioner must be confident that the patient is in good health and that there is no underlying secondary cause of the problem, which requires medical or specialist management. The patient must be motivated and have the ability and cooperation to carry out the exercises, for them to be beneficial. Accordingly, the patient will need to be able to attend regularly for review.

Risks of orthoptic exercises

Unfortunately, it is not unheard of for patients who have undergone vision therapy, specifically those relating to anti-suppression exercises, to develop insuperable diplopia. The likely cause of this is that practitioners have not taken the required precautions when selecting appropriate patients, which should be managed by orthoptic exercises. This is the biggest risk when using orthoptic exercises and it must be avoided. There is also a risk of causing accommodative or convergence spasm by overdoing the exercises or giving exercises to patients who do not need them.
### Table 1: Differential diagnosis of convergence anomalies

<table>
<thead>
<tr>
<th>Problem</th>
<th>Patient type</th>
<th>Likely symptoms</th>
<th>Clinical signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary convergence insufficiency</td>
<td>Any age group  Good health otherwise</td>
<td>Asthenopia Diplopia for near</td>
<td>Exophoria for near Reduced convergence Reduced base out fusional reserves</td>
</tr>
<tr>
<td>Secondary convergence insufficiency</td>
<td>Often elderly patients with significant health problems</td>
<td>Diplopia for near</td>
<td>Exophoria for near Reduced convergence Reduced base out fusional reserves</td>
</tr>
<tr>
<td>Primary convergence paresis or paralysis</td>
<td>Any age group with no significant history</td>
<td>Diplopia for near</td>
<td>Exophoria or exotropia for near Reduced base out fusional reserves</td>
</tr>
<tr>
<td>Secondary convergence paresis or paralysis</td>
<td>Likely underlying neurological deficits May be secondary to head trauma</td>
<td>Diplopia for near</td>
<td>In paresis diplopia occurs at any distance less than infinity</td>
</tr>
<tr>
<td>Convergence spasm</td>
<td>Young patients  More likely to be female patients. May or may not have underlying organic cause</td>
<td>Diplopia and reduced visual acuity</td>
<td>Pseudomyopia Variable deviation exo. to eso. Pupil miosis Variable visual acuity</td>
</tr>
</tbody>
</table>

The exercises or combination of exercises used depends on the extent of the convergence insufficiency. Any exercises carried out should be done with optimum refractive correction.

The mantra used when prescribing these exercises is to do them 'little but often'; classically four to five minutes at a time and three times a day, ensuring relaxation following the period of exercise. Patients should be warned that symptoms are likely to get worse in the short term before they improve. Patients should be reviewed every two weeks if possible on the premise that, if the exercises have been done well, convergence will improve quickly. The exercises need to be modified as convergence and symptoms improve such that they are less intense and perhaps done less frequently; there is a risk of overdoing the exercises therefore close supervision is required.

### Jump convergence

Two targets are required, one at near to be held by the patient and one at distance at least three metres away (Figure 2). The near target should be held close to the break point of convergence. The patient fixates on the near target ensuring binocular single vision then jumps to fixating on the distance target (for example a single letter on a VA chart if performed in the consulting room) ensuring it is single and kept clearly in focus. The patient should then jump back to fixating on the near target, again ensuring it is single and kept clearly in focus. At each distance the patient should maintain fixation with clear single vision for two to three seconds, and this should be repeated several times.

### Simple pen-to-nose convergence

This is also known as pencil push-up, since the tip of a pencil or pen can be used; in practice patients are often asked to use a more detailed target such as a letter on a budgie stick instead. In either case, the patient holds the target at arm's length and while fixating on a certain aspect of this (pen/pencil tip or letter on a budgie stick), the target is steadily brought closer to the eyes, at a consistent speed. The patient must continue to fixate the target and attempt to maintain binocular single vision (Figure 3). If the patient reaches a point where single vision cannot be maintained, even with effort, the target should be slowly moved further away until single vision is achieved and then slowly moved closer once more trying to maintain single vision. At times, convergence will completely fail and the target should be taken back to the original position at arm's length and the process repeated. The patient should repeat this three to five times on average; however the exact instruction is dependent on what other exercises are also prescribed and the magnitude of the convergence insufficiency.
As such, it may be appropriate to advise the patient to do the exercises for one to two minutes, taking a five-second break between each cycle.

**Dot card**
The dot card comprises a slim rectangular piece of card with a single line in the middle; the line carries equally spaced dots at intervals along it. It is held below the patient’s nose in a slightly depressed position (Figure 4). The patient fixates the furthest dot on the card and ensures that it is seen as a single dot. The patient then changes fixation to jump to the next dot along the line and ensures it is kept single. The patient then changes fixation to jump to the next dot along the line and continues in this manner until they get to the nearest dot or until they reach a dot where single vision cannot be maintained. Physiological diplopia will again be perceived.

**Accommodative anomalies**
The classification of accommodative anomalies is shown in Figure 6. The differential diagnosis is perhaps a little trickier as symptoms of the various types are the same and therefore the practitioner must look for other signs and perhaps elicit other information in the history for example recent trauma, as described in Table 2.

As with convergence insufficiency, all patients should have a refraction carried out – cycloplegic refraction being highly recommended – and any significant refractive error should be corrected before orthoptic exercises are considered. In particular, this is important as a further indication for treatment with exercises, since some cases of accommodative anomalies will be as a result of significant latent hyperopia; if a low refractive error is found, it would be appropriate to carry out a cycloplegic assessment before prescribing the low refractive error. However, where symptoms persist despite correction of low refractive error, orthoptic exercises will be beneficial. The mantra used when prescribing these exercises is similar to convergence exercises; four to five minutes at a time, and three times a day, ensuring relaxation following the period of exercise. Patients should be reviewed every two weeks, and the exercises modified as accommodation and symptoms improve.

**Brock string**
This is similar to the dot card exercise. The patient will look at and jump between different coloured beads on a string (Figure 5). The patient begins by fixating on the furthest bead and then changes fixation to jump to the next bead along and continues in this manner until they get to the nearest bead or until they reach a bead where single vision cannot be maintained. Physiological diplopia will again be perceived.

**Treating accommodative insufficiency and fatigue**
Accommodative insufficiency and fatigue are characterised by reduced amplitudes of accommodation in relation to the patient’s age and signs of fatigue (further reduction of amplitude) on repeated testing. If this condition is suspected, it is important for the practitioner to ensure that there is no sign of
To treat accommodative insufficiency or fatigue, the types of orthoptic exercises used are a combination of jump accommodation and accommodative push-ups.

**Jump accommodation**
This exercise is very similar to jump convergence described earlier. Essentially an accommodative target is used to fixate at two distances, one at near and one at distance (Figure 2). The patient is asked to alternately fixate between the two targets, in turn jumping from near to distance and back again. Although the near target should be placed at the closest point of blur to the patient, the exercise can be made more difficult by bringing the near target closer to this.

**Accommodative push-ups**
This exercise is similar to simple pen-to-nose convergence exercises described earlier, but with the use of an accommodative target such as a single word in a book. The target is held at arms-length and gradually brought closer to the eyes as the patient maintains this word in clear focus (Figure 3). This may be done monocularly or binocularly. When the patient reaches a point where the target cannot be kept in clear focus, even with effort, the target should be taken back to the starting position and the exercise repeated.

**Treating accommodative inertia**
Accommodative inertia or infacility is characterised by an inability to quickly change focus from distance to near and vice versa. This may be assessed using +2.00/-2.00 flipper lenses (Figure 7), whereby the patient views a near target through positive lenses, maintaining clarity of the target, and then the lenses are flipped to the negative ones requiring the patient to maintain clarity of the target through these; the number of repetitions/flips which can be performed in one minute is assessed (fewer repetitions are possible with accommodative infacility as more effort is needed for clear focus) and is reported as cycles per minute (cpm) completed. Reported values for norms are 8cpm binocularly and 13cpm monocularly in an adult population, but this can vary in younger patients. If fewer cycles are completed, the flippers can be used in this manner as an exercise to improve accommodative facility. Different lens powers can be given depending on the patient’s ability. Accommodative infacility can also be exercised using jump accommodation, as described earlier.

**Accommodative lag**
It is beyond the scope of this article to describe the identification of accommodative lag, but the primary method for this is dynamic retinoscopy, which has been described in detail previously in Optometry Today.

**Decompensating heterophoria**

**Presentation**
Decompensating heterophoria may present with intermittent diplopia and cover test is likely to show heterophoria at near or distance, dependent on the type of deviation, with a

<table>
<thead>
<tr>
<th>Condition</th>
<th>Likely symptoms</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insufficiency</strong></td>
<td>Asthenopic symptoms</td>
<td>Reduced amplitude of accommodation for age May have esophoria for near Secondary convergence insufficiency</td>
</tr>
<tr>
<td></td>
<td>Blurred near vision</td>
<td></td>
</tr>
<tr>
<td><strong>Fatigue</strong></td>
<td>Asthenopic symptoms</td>
<td>Reduced amplitude of accommodation for age May have esophoria for near Secondary convergence insufficiency</td>
</tr>
<tr>
<td></td>
<td>Blurred near vision especially following prolonged near work</td>
<td></td>
</tr>
<tr>
<td><strong>Innertia</strong></td>
<td>Blurred near and distance vision</td>
<td>Can have normal or reduced amplitude of accommodation Poor accommodative facility</td>
</tr>
<tr>
<td></td>
<td>Can take time for vision to clear when looking from one distance to another</td>
<td></td>
</tr>
<tr>
<td><strong>Paralysis</strong></td>
<td>Blurred vision closer than infinity</td>
<td>Reduced near vision No measurable amplitude of accommodation</td>
</tr>
<tr>
<td></td>
<td>May be caused by trauma or underlying neurological conditions</td>
<td></td>
</tr>
<tr>
<td><strong>Lag</strong></td>
<td>Asthenopic symptoms</td>
<td>Reduced amplitude of accommodation Alleviated by low hyperopic correction</td>
</tr>
<tr>
<td></td>
<td>Blurred near vision</td>
<td></td>
</tr>
<tr>
<td><strong>Spasm</strong></td>
<td>Diplopia</td>
<td>Pseudomyopia</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 2 Differential diagnosis of accommodative anomalies
poor or delayed recovery. Furthermore, poor fusional reserves may be found, with weak levels of stereoacuity. The patient's monocular VA may outstrip their binocular VA and often patients report their vision is better with one eye covered than with both eyes open. Orthoptic exercises are based around increasing either the fusional amplitudes or relative fusional vergence.

When to consider exercises
It is important to understand that it may not always be appropriate or possible to use orthoptic exercises to improve control of heterophoria. In some circumstances, it may ultimately do harm in attempting orthoptic exercises in cases where surgery is required. A general rule would be to only consider orthoptic exercises in those with deviations measuring less than 15Δ.

Fusional amplitudes
Clinically, a patient's fusional amplitudes may be improved using a prism bar. Positive fusional amplitudes may be improved by practicing the prism base out range, whereby the patient slowly increases the base out prism strength, while maintaining binocular single vision on a distance (distance decompensating exophoria) or near (near decompensating exophoria) target. If fusion breaks (diplopia occurs), the patient is told to try to regain single vision. If they are unable to do so, the prism strength is reduced until they are able to regain single vision. This is repeated three to five times in order to exercise and increase the fusional amplitude. For esophoric deviations, negative fusional amplitudes are exercised and increased by using base in prisms.

Relative fusional vergence
The aim of these exercises is to manipulate the amount of convergence exerted relative to the amount of accommodation exerted. This is predetermined by an individual's AC/A ratio, but the amount of convergence may be increased or decreased if the amount of accommodation is constant. This is most often done by the use of stereograms (Figure 8).

For exophoric deviations, the positive relative convergence is exercised and increased. For this, the amount of convergence for a given amount of accommodation is increased. This may be achieved by carrying out near stereograms whereby the patient fixates on a near target while attempting to fuse a stereogram behind it. For esophoric deviations, the negative relative convergence is exercised and increased. For this, the amount of convergence for a given amount of accommodation is decreased. This may be achieved by carrying out distance stereograms whereby the patient fixates at distance while trying to fuse a stereogram held at near.

Summary
In order to be successful with orthoptic exercises a number of criteria need to be met:
1. Correct diagnosis and appropriate selection of patients
2. A motivated patient
3. Management of patient expectations
4. Clear goals and targets
5. Clear and concise instructions
6. Regular review.

Only some of the exercises which can be prescribed have been described in this article, and practitioners need to remember that, where patients do not respond to in-practice treatment, onward referral to HES for orthoptic assessment should be considered. Remember, patients should be allowed to make an informed choice about who treats them and how exercises are to be carried out, as potential for success is based on a patient’s commitment.