Independent and reciprocal accommodation in anisometropic amblyopia

Article

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Independent and Reciprocal Accommodation in Anisometropic Amblyopia:

a case report

Accommodation is considered to be a symmetrical response[1], and in anisometropia, to be driven by the least ametropic and non-amblyopic eye, although a limited capacity for aniso-accommodation has been reported [2-3] and Rook et al [4] have recently reported aniso-accommodation in amblyopia. We report here a case of a child with anisometropic amblyopia who not only accommodates asymmetrically, but who also reliably and repeatedly demonstrates anti-accommodation of the amblyopic eye to near targets, while the non-amblyopic eye accommodates normally. We suggest that a congenital dysinnervation syndrome may result in relaxation of accommodation in relation to near cues, and might be a hitherto unconsidered additional etiological factor in anisometropic amblyopia.

A girl aged 4year 10month old presented to our laboratory as a presumed healthy control for our studies of accommodation development. Past medical history and family history were unremarkable apart from an aunt with anisometropic amblyopia. No visual defect had been suspected. On examination, visual acuity was OD 6/60 (1.0 logMAR); OS 6/7.5 (0.1 logMAR) using the Keeler crowded letters test. Ocular motility and binocular testing showed orthophoria and binocular convergence to 7cm, but absent stereopsis. Subsequent cycloplegic refraction showed anisometropic hyperopia OD +7.0/+0.25x90; OS +2.0/+0.25x90. On the initial visit, abnormal accommodation behaviour of the right eye was noted and has remained largely unchanged over seven subsequent testing sessions undertaken over the course of therapy.

We used a PlusoptixSO4 videorefractor set in a remote haploscopic device to present a detailed picture target at fixation distances between 25cm (4 dioptres (D) and metre angles (MA) demand) and 2m (0.5D and MA demand). Continuous recordings of refraction, eye position and pupil size were collected at 25Hz from both eyes simultaneously. A bespoke macro written in our laboratory used the raw refraction and eye position and inter-pupillary distance (IPD) data produced by the PlusoptiXSO4 to calculate D of accommodation and MA of vergence response at each fixation distance, taking into account a calculated angle lambda and IPD. Our equipment allowed responses to be recorded simultaneously from both eyes while the target could be presented both binocularly and monocularly. Full details of construction, calibration and data processing have been published elsewhere[5].

Figure 1 shows that both eyes converge appropriately to every target distance and pupillary constriction is symmetrical and appropriate. The left eye (filled triangles) accommodates by amounts appropriate for the target distance, while the amblyopic right eye (open squares) accommodates most for the 2m target and then relaxes to close to the cycloplegic refraction for the near targets. Mean right refraction over seven testing sessions at 2m was +3.0D (thus accommodating 4D over baseline +7.0D hyperopic refractive error) and was +5.15D at 33cm demand (thus only accommodating 2D over the hyperopia). In comparison the left eye refraction was +0.5D at 0.5D demand and -1.82D at 3D demand (a stable accommodation lag of ≈1D at both distances). Thus the left eye accommodates an average of 2.32D for 3D increase in accommodation demand, while the right eye simultaneously *anti*-accommodates by 2.12D, with 2.5D of anisometropia at 2m and 6.9D at 33cm (Fig 2a). Adduction of each eye was symmetrical, so excluding off-axis errors of refraction contributing to the difference between the eyes.

Spectacles with the full correction were ordered and worn well. After 4 months of refractive adaptation[6], 6hrs daily total occlusion left eye was prescribed and worn well for 8 months, but with no improvement beyond OD 6/12part (0.35 logMAR) (with crowding and with no improvement with a pinhole, which was used because accommodation was likely to be inaccurate). When tested with spectacles the aniso-accommodation reduces and the binocular response (Fig 2b) shows more anisometropia for distance than near i.e. the hyperopic correction corrects the anisometropia for near but overcorrects the right eye in the distance. When the left eye is occluded, both accommodation responses are flat and the amblyopic right eye refraction rests at ≈-1.25D i.e. over-accommodates in relation to the left (Fig 2c). With the right eye occluded, the fixing LE shows lead of accommodation for near targets and the RE accommodates in the appropriate direction but with a much lower gain (Fig 2d).

To our knowledge this is the first report of such reciprocal accommodation between the eyes and shows that accommodation is not necessarily a consensual response. The greater the accommodation in the least hyperopic eye, the greater the relaxation of accommodation in the amblyopic eye. The effect was reduced after spectacle prescription, possibly because correction of the hyperopia in the non-amblyopic eye reduces accommodation demand overall, but the response slope of the amblyopic eye remains much flatter than in the non-amblyopic eye ($t(6)=3.9, p=0.008$). Correction of the full anisometropia appears to overcorrect the hyperopia for distance, but does equalize refraction for near.

Whether the anisometropia was causal or secondary to the accommodative anomaly is unclear, but the stability of the responses over the course of refractive and occlusion therapy suggests an innervational etiology, possibly due to a dysinnervation syndrome, although since pupil reactions are typical, the anatomical site is unclear. Reverse progressive lenses in the right eye may be a treatment option in the future but aniseikonia and the residual amblyopia may limit their ability to improve binocularity.

We would have been very unlikely to have detected this case if we had been making uniocular measurements (Figs 2c & d) (as is common in clinical practice), as the abnormalities of the responses are less clear, so it may not be as unique as it appears. We only found this case because we used the PlusoptiXSO4 in PowerRefII mode which makes simultaneous recording from both eyes. It is possible that more anisometropic amblyopes may demonstrate similar anomalies if more binocular clinical testing was carried out.

Acknowledgement

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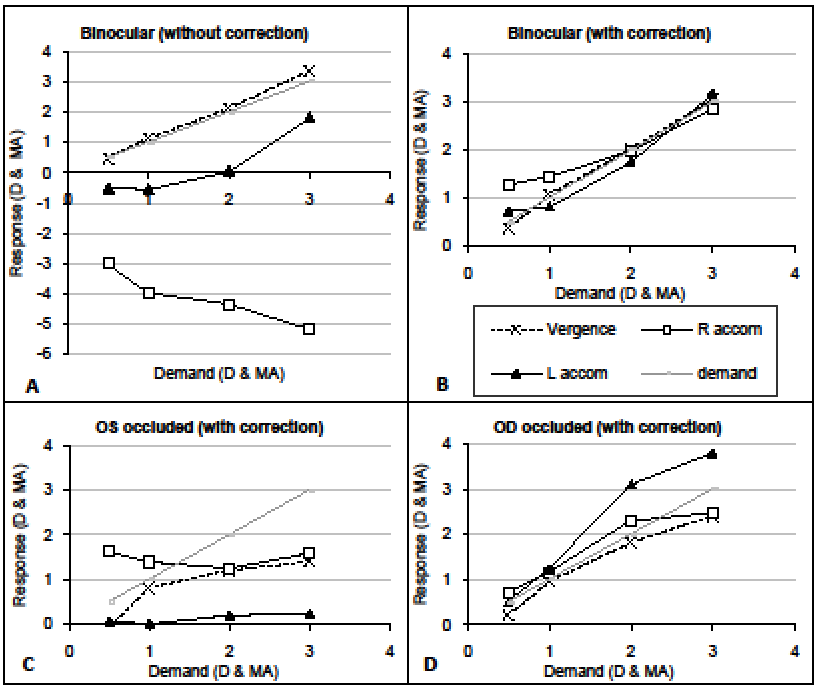
Legends

Figure 1.

Typical recordings from this case of uniocular accommodation and pupil diameter, and binocular vergence made without correction to a binocular target moving between 2m and 25cm. Y-axis: scale in D for accommodation, MA for vergence and mm for pupils. Positive figures denote accommodation(myopic refraction) and convergence, negative figures denote hyperopia and divergence. X-axis: seconds of recorded data.

Figure 2.

2a&b. Response means over 8 visits without and with refractive correction. Target visible to each eye. 2c. Example of occluded OS, fixing amblyopic eye . 2d. Example of occluded OD, fixing non-amblyopic eye. Positive figures denote accommodation (myopic refraction) and convergence, negative figures denote hyperopia and divergence. All recordings were made simultaneously from both eyes although in the occluded conditions the target was only visible to the unoccluded eye



Binocular (without correction)
Response (D & MA)
Demand (D & MA)
A
Binocular (with correction)
Response (D & MA)
Demand (D & MA)
Vergence
R accom
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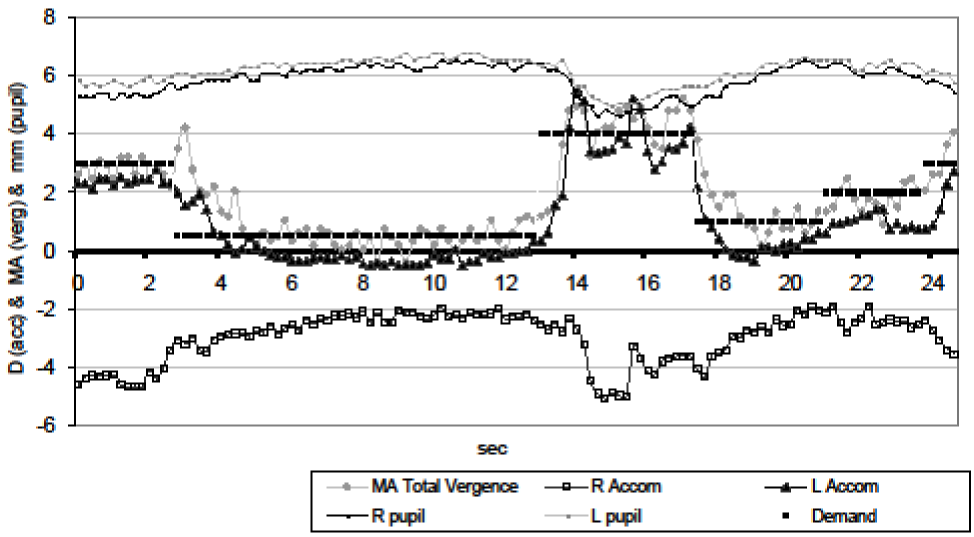
demand
B
OS occluded (with correction)
Response (D & MA)
Demand (D & MA)
C
OD occluded (with correction)
Response (D & MA)
Demand (D & MA)
D


D (acc) & MA (verg) & mm (pupil)
sec
MA Total Vergence
R Accom
L Accom
R pupil
L pupil
Demand