

Independent and reciprocal accommodation in anisometropic amblyopia

Article

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**Independent and Reciprocal Accommodation in Anisometropic Amblyopia:
a case report**

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

12 A girl aged 4year 10month old presented to our laboratory as a presumed healthy control
13 for our studies of accommodation development. Past medical history and family history
14 were unremarkable apart from an aunt with anisometric amblyopia. No visual defect had
15 been suspected. On examination, visual acuity was OD 6/60 (1.0 logMAR); OS 6/7.5 (0.1
16 logMAR) using the Keeler crowded letters test. Ocular motility and binocular testing showed
17 orthophoria and binocular convergence to 7cm, but absent stereopsis. Subsequent
18 cycloplegic refraction showed anisometric hyperopia OD +7.0/+0.25x90; OS
19 +2.0/+0.25x90. On the initial visit, abnormal accommodation behaviour of the right eye was
20 noted and has remained largely unchanged over seven subsequent testing sessions
21 undertaken over the course of therapy.

22 We used a PlusoptixSO4 videorefractor set in a remote haploscopic device to present a
23 detailed picture target at fixation distances between 25cm (4 dioptres (D) and metre angles
24 (MA) demand) and 2m (0.5D and MA demand). Continuous recordings of refraction, eye
25 position and pupil size were collected at 25Hz from both eyes simultaneously. A bespoke

26 macro written in our laboratory used the raw refraction and eye position and inter-pupillary
27 distance (IPD) data produced by the PlusoptiXSO4 to calculate D of accommodation and MA
28 of vergence response at each fixation distance, taking into account a calculated angle
29 lambda and IPD. Our equipment allowed responses to be recorded simultaneously from
30 both eyes while the target could be presented both binocularly and monocularly. Full details
31 of construction, calibration and data processing have been published elsewhere⁽⁵⁾.

32 Figure 1 shows that both eyes converge appropriately to every target distance and pupillary
33 constriction is symmetrical and appropriate. The left eye (filled triangles) accommodates by
34 amounts appropriate for the target distance, while the amblyopic right eye (open squares)
35 accommodates most for the 2m target and then relaxes to close to the cycloplegic
36 refraction for the near targets. Mean right refraction over seven testing sessions at 2m was
37 +3.0D (thus accommodating 4D over baseline +7.0D hyperopic refractive error) and was
38 +5.15D at 33cm demand (thus only accommodating 2D over the hyperopia). In comparison
39 the left eye refraction was +0.5D at 0.5D demand and -1.82D at 3D demand (a stable
40 accommodation lag of ≈ 1 D at both distances). Thus the left eye accommodates an average
41 of 2.32D for 3D increase in accommodation demand, while the right eye simultaneously
42 *anti-accommodates* by 2.12D, with 2.5D of anisometropia at 2m and 6.9D at 33cm (Fig 2a).
43 Adduction of each eye was symmetrical, so excluding off-axis errors of refraction
44 contributing to the difference between the eyes.

45 Spectacles with the full correction were ordered and worn well. After 4 months of refractive
46 adaptation⁽⁶⁾, 6hrs daily total occlusion left eye was prescribed and worn well for 8 months,
47 but with no improvement beyond OD 6/12part (0.35 logMAR) (with crowding and with no
48 improvement with a pinhole, which was used because accommodation was likely to be

49 inaccurate). When tested with spectacles the aniso-accommodation reduces and the
50 binocular response (Fig 2b) shows more anisometropia for distance than near i.e. the
51 hyperopic correction corrects the anisometropia for near but overcorrects the right eye in
52 the distance. When the left eye is occluded, both accommodation responses are flat and the
53 amblyopic right eye refraction rests at $\approx -1.25D$ i.e. over-accommodates in relation to the left
54 (Fig 2c). With the right eye occluded, the fixing LE shows lead of accommodation for near
55 targets and the RE accommodates in the appropriate direction but with a much lower gain
56 (Fig 2d).

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

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

71 We would have been very unlikely to have detected this case if we had been making uniocular
72 measurements (Figs 2c & d) (as is common in clinical practice), as the abnormalities of the responses

73 are less clear, so it may not be as unique as it appears. We only found this case because we used the
74 PlusoptiXSO4 in PowerRefII mode which makes simultaneous recording from both eyes. It is
75 possible that more anisometropic amblyopes may demonstrate similar anomalies if more binocular
76 clinical testing was carried out.

77

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81

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100 Legends**101 Figure 1.**

102 Typical recordings from this case of unocular accommodation and pupil diameter, and
103 binocular vergence made without correction to a binocular target moving between 2m and
104 25cm. Y-axis: scale in D for accommodation, MA for vergence and mm for pupils. Positive
105 figures denote accommodation(myopic refraction) and convergence, negative figures
106 denote hyperopia and divergence. X-axis: seconds of recorded data.

107

108

109 Figure 2.

110 2a&b. Response means over 8 visits without and with refractive correction. Target visible to each
111 eye. 2c. Example of occluded OS, fixing amblyopic eye . 2d. Example of occluded OD, fixing non-
112 amblyopic eye. Positive figures denote accommodation (myopic refraction) and convergence,
113 negative figures denote hyperopia and divergence. All recordings were made simultaneously
114 from both eyes although in the occluded conditions the target was only visible to the
115 unoccluded eye



