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An Unexpected Role for Normal Accommodative Vergence in Strabismus and Amblyopia

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Abstract

Accommodative vergence was measured using the Müller experimental paradigm in which target movement along the line of sight of the viewing eye results in large movement of the fellow (covered) eye. Our paper demonstrates an unexpected predominance of accommodative vergence over disparity vergence in patients with constant strabismus amblyopia, intermittent strabismus, and amblyopia without strabismus. Comparison of accommodative vergence responses in these patients with responses from normal subjects using symmetrical and asymmetrical targets under binocular and monocular conditions established the normal character of the patients' accommodative vergence and the absence of disparity vergence in most of them. The intermittent absence of disparity vergence in certain of our patients—some with surgically corrected strabismus, some with moderate amblyopia, and some with amblyopia treated with orthoptics—raises questions of clinical and neurophysiological interest. Preliminary results on the effects of amblyopia on accommodative responses are also presented.

Key Words: accommodative vergence, disparity vergence, fusional vergence, strabismus, amblyopia

In 1826, Müller[1] observed that if one eye was covered and a fixation target was changed from far to near along the line of sight of the viewing eye, the covered eye converged. Since Müller's[1] discovery of the synkinetic relation between accommodation and vergence, many investigators have confirmed the large vergence movement in the covered eye, and this has become the experimental paradigm in the laboratory and clinic for defining accommodative vergence.[2-9] Monocular presentation of the stimulus and the large movement in the covered eye emphasized the uniocular aspects of accommodative vergence.

Recently, we[10] found that accommodative vergence is a binocular response (Fig. 1); both eyes converge synchronously in the Müller experiment. However, the size of the vergence movement in the viewing eye equals only 12% of that in the covered eye. For this reason it is easy to understand why

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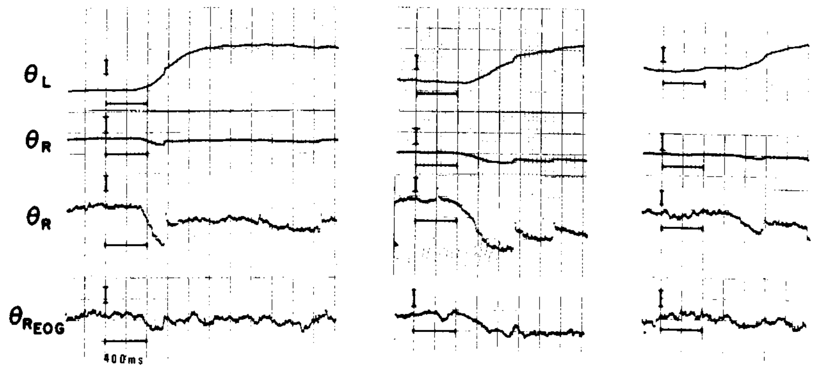

FIG. 1. Binocular accommodative vergence in the Müller experimental paradigm. Binocular eye movements are shown for a normal subject with the dominant right eye viewing a target during divergence. The viewing eye was monitored simultaneously with both photocell and EOG methods; the covered left eye was monitored photoelectrically only. Shown are the position of the covered left eye, the viewing right eye (gain approximately equal to left eye), the viewing right eye (gain four times greater than left eye), and the viewing right eye (EOG method), respectively, from top to bottom as functions of time. Calibration bars represent 0.25 deg for the viewing right eye (lower two traces), 1 deg for upper two traces, and 400 msec. Leftward movements are represented by upward deflections. Note clearly observable vergence movement in the viewing right eye monitored with the photoelectric method but only noise and drift in the viewing eye during the same time with EOG recording, thus demonstrating ineffectiveness of EOG technique for detecting small ocular rotations.

Müller and other investigators using either subjective or insensitive electrooculographic (EOG) methods observed only the large movement of the covered eye. Use of a high-resolution infrared photocell method with a noise level of 1-min arc, a bandwidth of 150 Hz, and a range of ±7 deg permitted recordings that demonstrated a small vergence in the viewing eye (Fig. 1). To compare these two techniques, Fig. 1 includes simultaneous use of the EOG and photocell methods to record eye movements in the viewing eye; detecting the signal amid the noise in the EOG trace is difficult without aid from the photocell trace.

In addition to these step responses, other studies have emphasized the transient binocular nature of accommodative vergence.[11] Fig. 2 displays the pulse response of accommodative vergence to illustrate the unequal amplitudes and dynamics of this binocular response. Dynamics of only the covered eye have also been investigated by both frequency and transient techniques.[12, 13] This recent concept of accommodative vergence as a binocular, not uniocular, response still leaves open important questions about the large inequality of the vergence responses in the two eyes. Such questions concern the role of Hering's law of equal innervation with respect to the unequal vergence. Others address the role of other eye movement systems to counteract the vergence of the viewing eye so as to maintain foveal fixation. Candidates for this interaction include the smooth pursuit and saccadic systems.

UNEXPECTED PREDOMINANCE OF ACCOMMODATIVE VERGENCE

When a normal subject is instructed to follow near and far symmetrical stimuli presented binocularly, disparity vergence responses result (Fig. 3). As Fig. 3a shows, normal disparity vergence consists in a smooth, equal, disjunctive movement of the eyes in response to the equal retinal disparity produced by midline targets.[14-18] However, when patients with strabismus and/or amblyopia are presented with such binocular stimuli, responses differ greatly from those of normal subjects.[19] For example, in Fig. 3b, instead of equal vergence amplitudes, the dominant eye verges only a fraction of the vergence amplitude found in the nondominant eye, a characteristic that resembles normal accommodative vergence. In this disparity vergence paradigm, the amplitude of the vergence in the dominant eye measures about 12% that of the non-

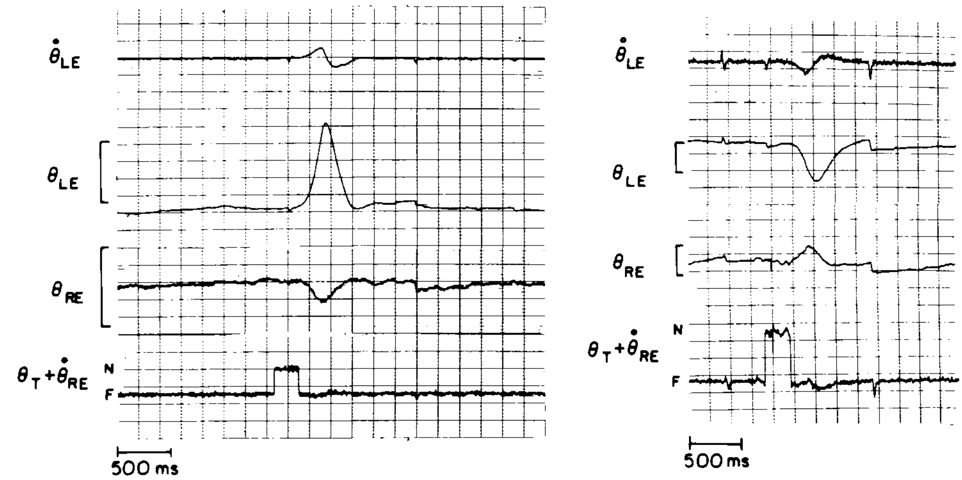

FIG. 2. Transient binocular accommodative vergence response to a *pulse* of accommodative stimulus with right eye as viewing eye. Inequality of vergence amplitudes in the two eyes is obvious even in these transient responses. The following notations for this and subsequent figures apply unless otherwise noted: $\dot{\theta}_{LE}$ = left eye velocity, $\dot{\theta}_{RE}$ = right eye velocity, θ_{LE}= left eye position, θ_{RE} = right eye position, $\theta_T + \theta_{RE}$ = target position summed with right eye velocity. (Using this summation, five functions can be displayed in four channels.) The time marker is 500 msec; leftward movement is an upward deflection. N and F refer to near and far target positions at 25 and 50 cm, respectively.

dominant eye, similar to the viewing eye vergence amplitude found in the accommodative vergence paradigm.

In addition to accommodative vergence, a binocular saccade is used to foveate the target with the dominant eye. The combination of this saccade and accommodative vergence movement maintains fixation of the dominant eye on the target.

NORMAL ACCOMMODATIVE VERGENCE IN STRABISMIC/AMBLYOPIC PATIENTS

First, we can show that if the patient's nondominant eye is covered and a target is displaced along the line of sight of the viewing dominant eye, we obtain normal accommodative vergence. The patient's accommodative vergence responses in Fig. 4a are similar to the normal's accommodative vergence responses in Fig. 4b. Characteristic corrective movements in the viewing eye can be seen in each case.[10] Thus, these patients have normal accommodative vergence with the dominant eye viewing. Second, we can compare our patient's responses with and without the nondominant eye covered when target displacements occur along the midline. Comparing Fig. 5b, with both eyes viewing, and Fig. 5a, with only the dominant eye viewing, reveals similar responses. Uncovering the patient's nondominant (and presumably suppressed) eye does not alter the nature of the response. Third, the response of a patient viewing with two eyes (Fig. 6a) is similar to the response of a normal subject viewing with one eye (Fig. 6b) in the symmetric target condition. Both responses contain unequal vergence amplitudes and binocular saccades. Again, patients respond as if only their dominant eye saw the targets. Fourth, a quantitative comparison of the response asymmetry in normals and in patients with strabismus and/or amblyopia showed similar characteristics in the two groups. Under Müller's[1] condition, the viewing eye shows about 12% of the amplitude found in the covered eye's vergence response. A similar percentage is obtained in patients with strabismus and/or amblyopia.

One mechanism that might act to block binocular vision in these patients is suppression, commonly found in the nondominant eye of such patients under binocular conditions.[20-24] The "monocular" vision that results from this suppression would leave only accommodation to drive vergence. Hence, the predominance of accommodative vergence when both eyes view

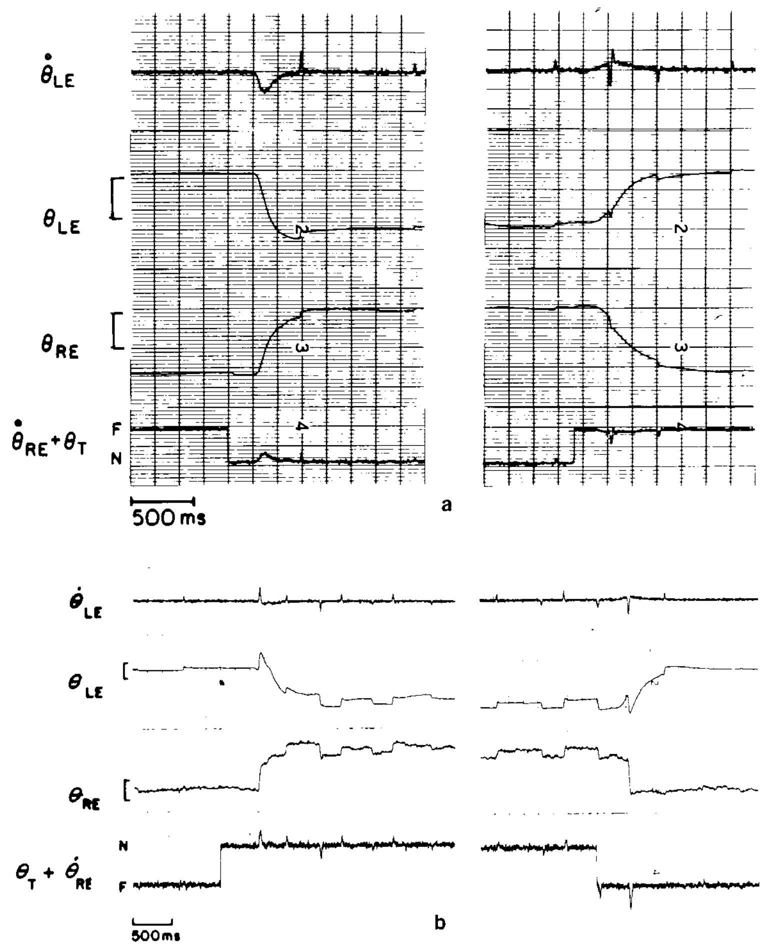

FIG. 3. Symmetric vergence in a normal subject compared with a patient with intermittent strabismus. Eye movement responses are shown to near and far targets placed symmetrically between the two eyes. Under binocular viewing conditions; a, shows the normal control subject used disparity information from the stimuli to produce smooth, equal disjunctive movements, and b, shows the responses of a patient with both eyes viewing the symmetric targets. Instead of producing smooth, equal vergence movements, the response of this subject contains unequal vergence with smaller amplitude vergence in the dominant right eye. A binocular saccade places the dominant eye's fovea on the new target each time.

the targets is probably due to the lack of usable binocular input.

Regardless of the precise nature of the disparity-blocking mechanism in these patients, accommodative vergence is the dominant response in the absence of disparity vergence. This does not imply that the accommodative vergence (with the dominant eye) is abnormal—only that its normal occurrence is revealed because disparity vergence is absent.

INTERMITTENCY

Not all patients showed this unexpected predominance of accommodative vergence under binocular conditions. Patients who showed counterexamples to this phenomenon included some having amblyopia without strabismus and some who had had surgical correction as children and no longer had strabismus. In Fig. 7a, an amblyopic patient with 6/12 (20/40) visual acuity in the left eye shows a predominance of accommodative vergence as well as intermittent episodes of normal disparity vergence, especially during convergence (95% of the time). These episodes of normal vergence were not predictable from one response to the next. This intermittent vergence was also found in a patient who had had surgical correction at age 3 for an esotropia and now has an esophoria. In Fig. 7c this patient's responses show both normal and abnormal disparity vergence. Here, too, the occurrence of normal responses was not predictable; but, again, they occurred more frequently during convergence. However, a patient who had been successfully treated for amblyopia [6/33 (20/110)] and eccentric fixation in the left eye as an adult and who had 6/6 (20/20) visual acuity and no eccentric fixation at the time of examination[25] showed an absence of normal disparity vergence eye movements (Fig. 7b). The orthoptics therapy had no demonstrable effect on this patient's ability to perform normal disparity vergence.

This intermittent absence of disparity vergence in certain of our patients raises interesting questions on what neurophysiological mechanisms might underlie the pathology of their binocular visual motor loss.

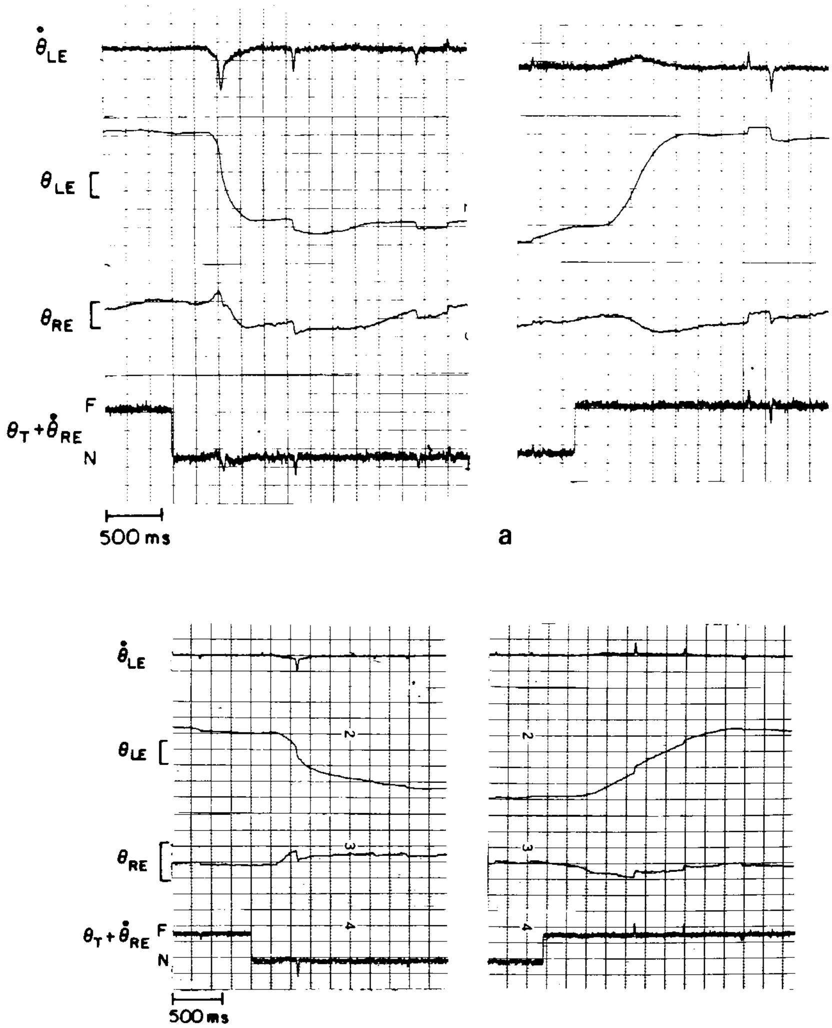

FIG. 4. Accommodative vergence in a patient is similar to accommodative vergence in a normal subject: monocular viewing of visual axis targets. a, Shows recordings of a patient with constant strabismus and amblyopia in the left eye (VA = 6/36.6 (20/122), 10^{Δ} ET). Accommodative vergence response characteristics are normal; note the large movements occurring during vergence in the viewing dominant eye. b, Shows characteristic accommodative vergence response of a normal subject with vergence movements in viewing right eye less than 0.5 deg in amplitude and large vergence in occluded, nondominant left eye.

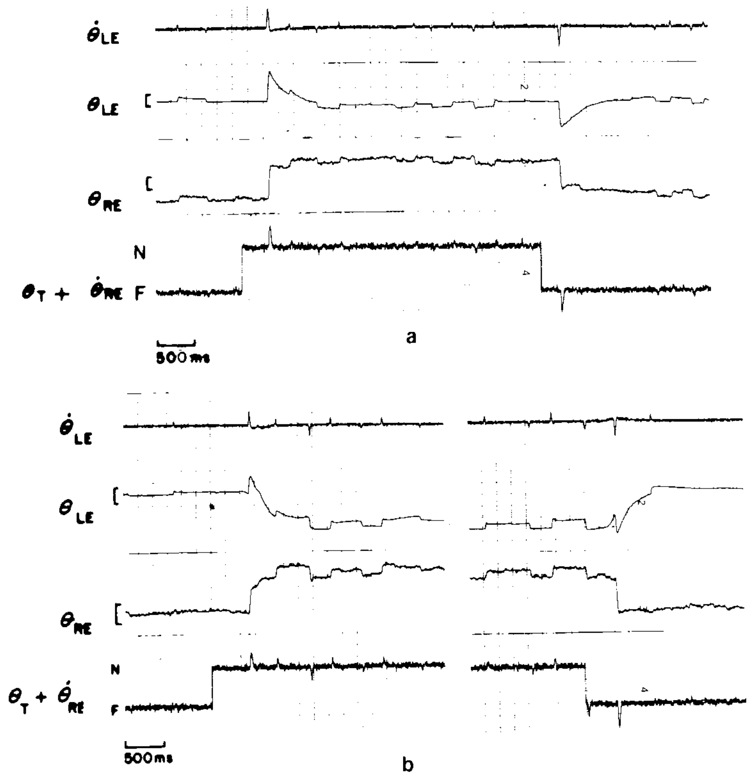

FIG. 5. A patient's vergence responses to symmetric targets are similar with and without the nondominant eye covered. An intermittent left exotrope without amblyopia shows similar responses with the nondominant left eye covered (a) and with both eyes viewing (b). Each response contains an accommodative vergence, characterized by unequal vergence amplitudes, and a saccade to fixate the viewing eye in a and the dominant eye in b. Notice that covering of the nondominant eye does not change the basic response found under binocular viewing conditions. This similarity would be expected if only accommodative vergence were active under binocular conditions.

Neurophysiological experiments on animals with induced strabismus have shown that strabismus has strong effects on the population of binocular cells in the visual cortex.[26-31] These binocular cells presumably perform the sensory disparity processing for both psychophysical processes and may perform the sensory disparity processing for motor binocular visual processes, that is, stereopsis and disparity vergence. When binocular vision is restored, for instance, in the former strabismus patient whose eye movements are shown in Fig. 6c, the psychophysical function may recover. However, recovery is not complete, in that disparity vergence is intermittently absent. The same is true for the patient in Fig. 7b. Here, orthoptics treatment resulted in a marked improvement of stereoacuity from 1000 to 60 sec arc, yet the patient exhibited absence of normal disparity vergence response.[25] Either there has been a differential recovery of psychophysical and motor disparity units, or some separate motor control process has been disrupted and not fully recovered. In our amblyopic patients, the intermittent presence of disparity vergence (Fig. 7a) again suggests differential effects of the deprivation mechanism postulated for the amblyopia on the psychophysical and motor disparity sensory processing. These intriguing findings call for replication in animal experiments in which assessment of binocular cortical single units can be carried out.

EFFECT OF AMBLYOPIA ON ACCOMMODATIVE VERGENCE

Although strabismus has a more disruptive effect on disparity vergence than am-

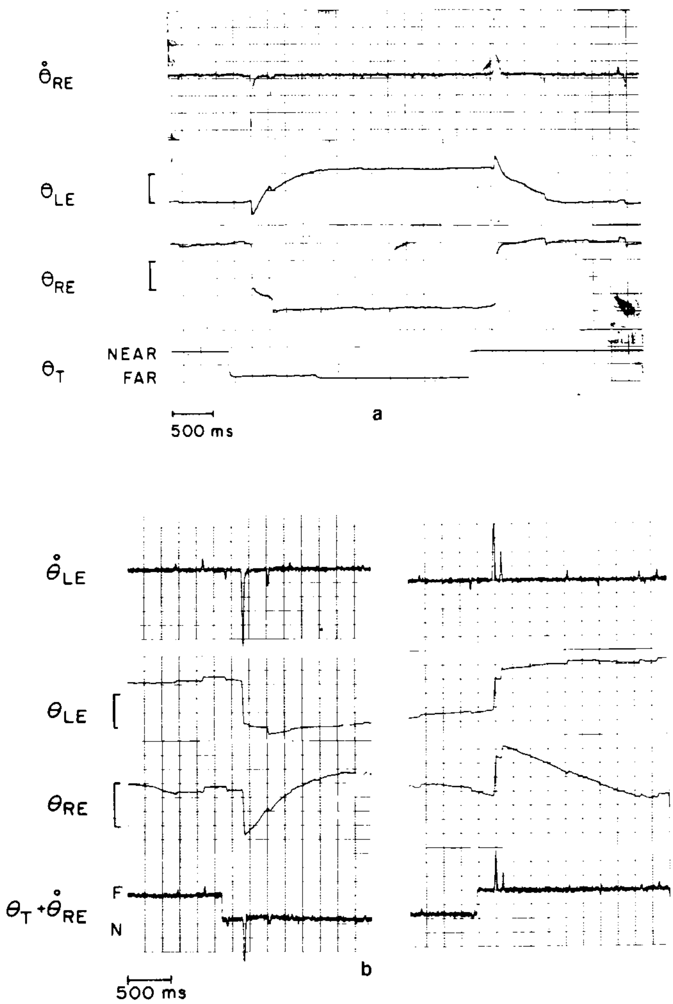

FIG. 6. A patient's responses under binocular viewing conditions are similar to monocular viewing responses in a normal subject (symmetric target conditions). The symmetric vergence response of this constant strabismus (4^{Δ} ET) patient with mild amblyopia [6/9 (20/30)] shows an accommodative vergence response under binocular viewing conditions (a). When the normal subject has the nondominant right eye covered, the accommodative vergence responses to the monocularly viewed symmetric targets show the same response as does the patient in a. In both a and b the response contains an unequal vergence and a fixating saccade.

blyopia does,[32] amblyopia has a more marked effect on accommodative vergence than strabismus does. With targets along the line of sight of a patient's dominant eye and the fellow eye covered, the resulting accommodative vergence responses show normal characteristics, as shown in Fig. 3. If targets are now placed along the line of sight of the patient's nondominant eye and the dominant eye is covered, accommodative vergence amplitudes in the covered eye are related to the depth of amblyopia. In Fig. 8a, responses from an intermittent exotrope without amblyopia show normal accommodative vergence amplitudes in the covered, dominant right eye while viewing with the nondominant left eye. However, this patient had longer response duration here than when the dominant eye was used. In Fig. 8c, an amblyopic patient with 6/12 (20/40) visual acuity in the left eye shows an accommodative vergence amplitude in the left eye which shows little if any reduction from the accommodative vergence response of the dominant right eye. In Fig. 8b, a strabismus patient with 6/36.6 (20/

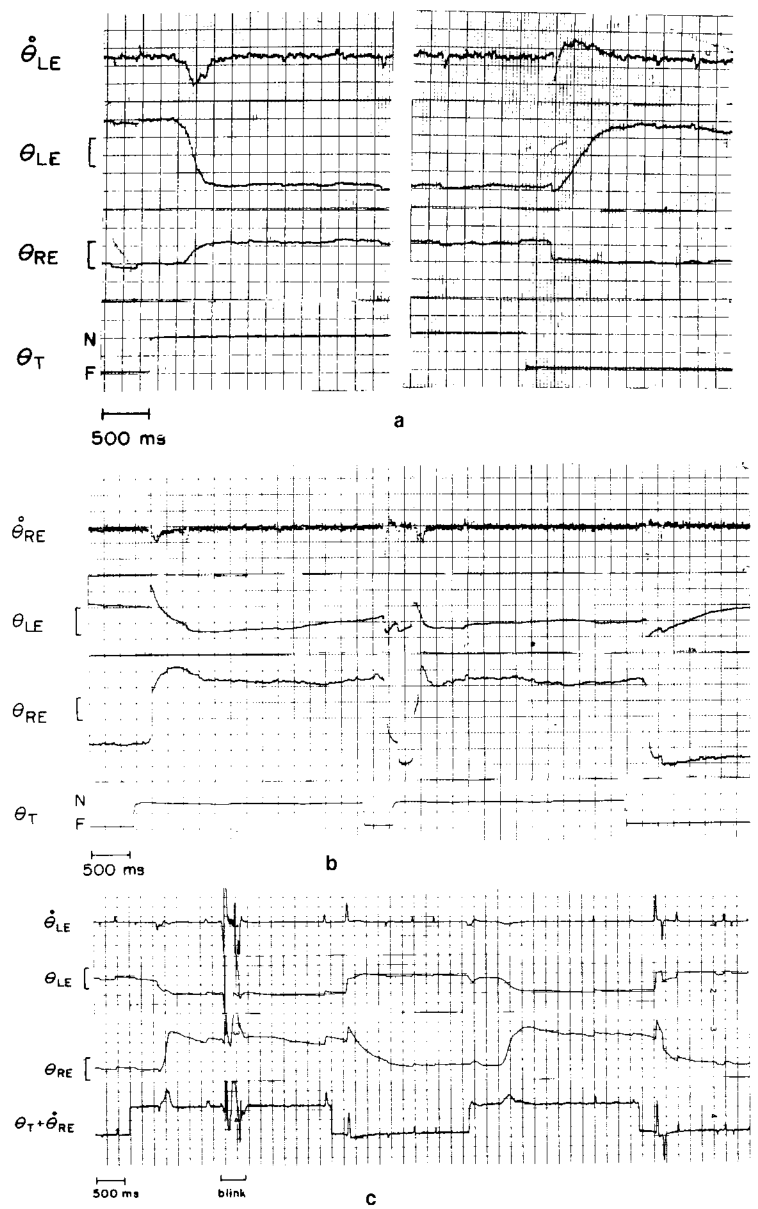

FIG. 7. Intermittent normal disparity vergence in an untreated amblyope (a), a treated amblyope (b), and a former strabismic patient (c) under binocular viewing conditions (symmetric targets). a: Patient SH has amblyopia without strabismus. This record shows both the normal and the abnormal vergence responses, which occurred unpredictably in this patient. b: Another patient having 6/6 (20/20) visual acuity, at time of eye movement testing, in a formerly amblyopic [6/33 (20/110)] left eye. This adult patient had just completed 2 yr of extensive orthoptics therapy. Again, as found in all patients with strabismus and in some patients with amblyopia only, characteristic abnormal vergence responses are clearly seen. c: Shows recordings of patient JW, who had an esotropia but was surgically corrected at age 3. This record shows episodes of normal vergence but only to convergence stimuli.

122) visual acuity in the left eye also responds with little if any reduction in amplitude of accommodative vergence. However, when visual acuity is 6/120 (20/400) or worse, response amplitudes are dramatically decreased. In Fig. 9, b and c, a patient with such deep amblyopia shows little or no accommodative vergence in the domi-

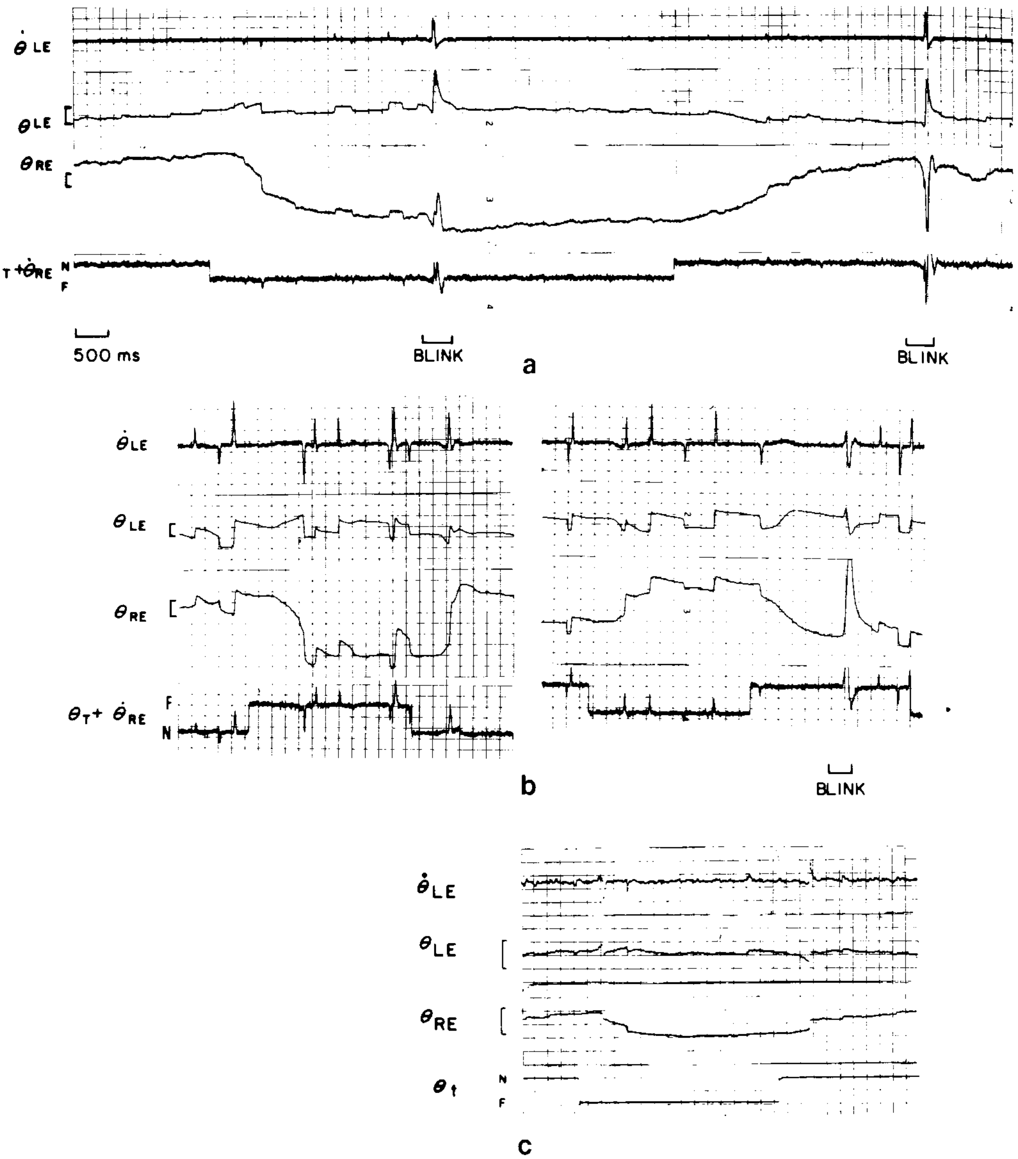

FIG. 8. Accommodative vergence to targets aligned along the visual axis of the nondominant eye in patients with low and moderate depths of amblyopia. The effects of different degrees of amblyopia on accommodative vergence are shown here and in Fig. 9. a: The accommodative vergence responses of patient having intermittent strabismus and no amblyopia shows normal amplitude accommodative vergence in the covered eye. In addition, the viewing eye performs compensatory movements found in normal subjects. The viewing eye's vergence equals 15% of that in the covered eye. However, note that the duration of the accommodative vergence is in excess of 1.5 sec. b: Responses of patient who has strabismus and 6/36.6 (20/122) visual acuity in the left eye. The accommodative vergence responses show normal durations. However, there is a tendency to saccade with the covered eye, as if the patient is using the covered eye to view the target; such responses may be learned responses to accommodative stimuli. c: Response from a patient with only amblyopia [6/12 (20/40)] in the left eye. The response shows no reduction of the vergence amplitude in the covered eye compared to those along the visual axis of the normal eye. Notice that the compensatory movements in the viewing eye are similar to those of normal patients.

nant eye. Interestingly, the response in Fig. 9c is similar to the divergence response seen in Fig. 9b, but there was no actual change in the stimulus to accommodation, which indicates that this is a purely anticipatory response. This anticipation suggests that the responses in Fig. 9b may also be preprogrammed movements, not stimulus

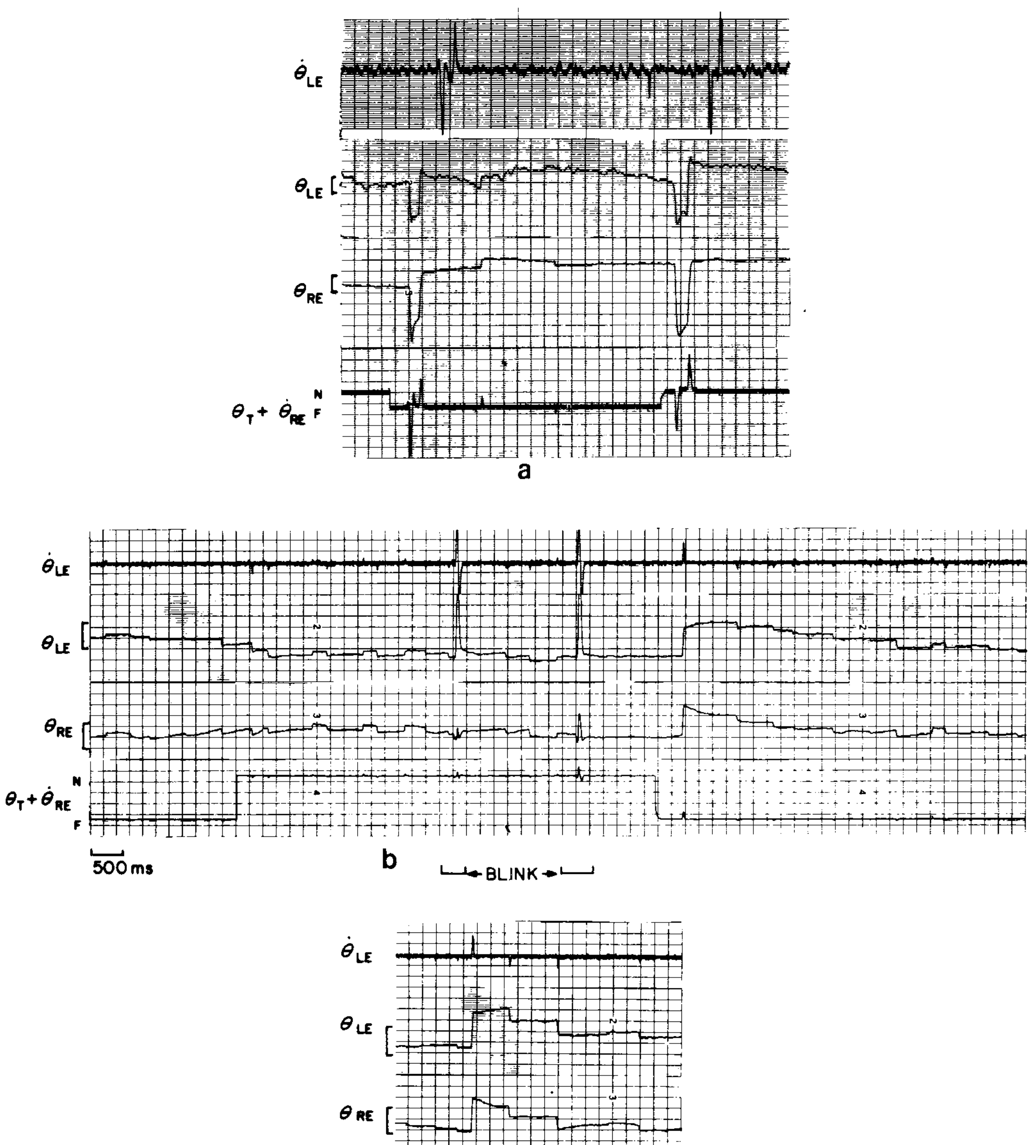

FIG. 9. Accommodative vergence to targets along the visual axis of the nondominant eye of patients with deep amblyopia. a: Patient with amblyopia of 6/189 (20/630) and strabismus in the left eye. Little if any accommodative vergence can be seen in the covered eye. Instead, there is a pair of saccades when the targets produce an accommodative stimulus. The saccades seem to act initially to place the covered eye on the new target each time. b: Patient having only amblyopia in the right eye of 6/120 (20/400). Mostly saccades are found in these responses and little vergence in the covered eye. These responses are different from those of normal subjects (Fig. 1). c: Same patient as in b anticipating the change of targets from near to far. This response with no change in target position is similar to those when the target did produce an accommodative demand. This similarity may show that these responses are not part of the stimulus but are programmed or learned responses.

driven. When visual acuity is further reduced to 6/189 (20/630), as in the constant strabismus amblyope whose response is shown in Fig. 9a, accommodative vergence in the covered dominant eye is essentially absent. The response consists only of a pair of binocular saccades that produce no net movement of the viewing eye.

Thus, accommodative vergence records with the nondominant eye alone viewing can provide us with information on the accommodative response in amblyopia and the effect of amblyopia on the accommodation system. For many years the accommodative vergence response has been used to indicate the state of accommodation in both experimental and clinical situations.[4, 12, 13] Our preliminary results indicate that the accommodative sensory processing is defective in deep amblyopia. Further studies using this stimulus paradigm may aid us in understanding the effects of amblyopia on the development and control of the accommodation system.

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REFERENCES

1. Müller, J., Elements of Physiology, translated by W. Baly (1843), Vol. 2, London, Taylor and Walton, 1826, pp. 1147-1148.
2. Allen, M. J., An objective high speed photographic technique for simultaneously recording changes in accommodation and convergence, Am. J. Optom. Arch. Am. Acad. Optom. 26(7): 279-289, 1949.
3. Alpern, M., and P. Ellen, A quantitative analysis of the horizontal movements of the eyes in the experiment of Johannes Mueller, 1. Methods and results, Am. J. Ophthalmol., 42(4, pt. 2): 289-296, 1956.
4. Brodkey, J., and L. Stark, Accommodative convergence—An adaptive nonlinear control system, Presbyt. St. Luke's Hosp. Med. Bull., 6: 30-43, 1967.
5. Hermann, J. S., and C. R. Samson, Critical detection of the accommodative convergence to accommodation ratio by photosensor-oculography. Arch. Opthalmol., 78(4): 424-430, 1967.
6. Keller, E. L., Accommodative vergence in the alert monkey: motor unit analysis, Vision Res., 13(8): 1565-1575, 1973.
7. Pickwell, L. D., Variation in ocular motor dominance, Br. J. Physiol. Opt., 27(2): 115-119, 1972.
8. Yamamoto, H., Studies on accommodative convergence, Jpn. J. Ophthalmol., 12(3): 155-161, 1968.
9. Yamamoto, H., Further studies on accommodative convergence, Jpn. J. Ophthalmol., 14(2): 102-110, 1970.
10. Kenyon, R. V., K. J. Ciuffreda, and L. Stark, Binocular eye movements during accommodative vergence, Vision Res., 18(5): 545-555, 1978.
11. Semmlow, J., and N. Venkiteswaran, Dynamic accommodative vergence components in binocular vision, Vision Res., 16(4): 403-411, 1976.
12. Krishnan, V. V., S. Phillips, and L. Stark, Frequency analysis of accommodation, accommodative vergence and disparity vergence, Vision Res., 13(8): 1545-1554, 1973.
13. Phillips, S. R., Ocular neurological control systems; accommodation and the near response triad, Ph.D. dissertation, University of California, Berkeley, Dept. of Mechanical Engineering, 1974.
14. Westheimer, G., and A. M. Mitchell, Eye movement responses to convergence stimuli, Arch. Ophthalmol., 55(6): 848-856, 1956.
15. Riggs, L. A., and E. W. Niehl, Eye movements recorded during convergence and divergence, J. Opt. Soc. Am., 50(9): 913-920, 1960.
16. Rashbass, C., and G. Westheimer, Disjunctive eye movements, J. Physiol., 159(2): 339-360, 1961.
17. Zuber, B. L., and L. Stark, Dynamical characteristics of the fusional vergence eye-movement system, IEEE Trans. Systems Sci. Cyb., SSC-4(1): 72-79, 1968.
18. Westheimer, G., and D. E. Mitchell, Sensory stimulus for disjunctive eye movements, Vision Res., 9(7): 749-755, 1969.
19. Kenyon, R. V., Vergence eye movements in strabismus and amblyopia, Ph.D. dissertation, University of California, Berkeley, Dept. of Physiological Optics, 1978.
20. Travers, T. àB., Suppression of vision in squint and its association with retinal correspondence and amblyopia, Br. J. Ophthalmol., 22(10): 577-604, 1938.
21. Jampolsky, A., Characteristics of suppression in strabismus, Arch. Ophthalmol., 54(5): 683-696, 1955.
22. Pratt-Johnson, J. A., H. S. Wee, and S. Ellis, Suppression associated with esotropia, Can. J. Ophthalmol., 2(4): 284-291, 1967.
23. Pratt-Johnson, J., and H. S. Wee, Suppression associated with exotropia, Can. J. Ophthalmol., 4(2): 136-144, 1969.
24. Bagolini, B., Sensorial anomalies in strabismus, Doc. Ophthalmol., 41(1): 1-22, 1976.
25. Ciuffreda, K. J., R. V. Kenyon, and L. Stark, Different rates of functional recovery of eye movements during orthoptics treatment in an adult amblyope, Invest. Ophthalmol. Visual Sci., 18(2): 213-219, 1979.
26. Hubel, D. H., and T. N. Wiesel, Binocular interaction in striate cortex of kittens reared with artificial squint, J. Neurophysiol., 28(6): 1041-1059, 1965.
27. Ikeda, H. and M. J. Wright, Is amblyopia due to inappropriate stimulation of the "sustained" pathway during development? Br. J. Ophthalmol., 58(3): 165-173, 1974.
28. Ikeda, H., and K. E. Tremain, Different causes for amblyopia and loss of binocularity in squinting kittens, J. Physiol., 269(1): 26P-27P, 1977.
29. Baker, F. H., P. Grigg, and G. K. von Noorden, Effects of visual deprivation and strabismus on the response of neurons in the visual cortex of the monkey, including studies on the striate and prestriate cortex in the normal animal, Brain Res., 66(2): 185-208, 1974.

30. Eggers, H. M., and C. Blakemore, Physiological basis of anisometropic amblyopia, Science, 201(4352): 264-266, 1978.
31. Blakemore, C., and R. C. Van Sluyters, Reversal of the physiological effects of monocular deprivation in kittens: further evidence for a sensitive period, J. Physiol., 237(1): 195-216, 1974.
32. Kenyon, R. V., K. J. Ciuffreda, and L. Stark, Dynamic vergence eye movements in strabismus and amblyopia: symmetric vergence, Invest. Ophthalmol. Visual Sci., 19(1): 60-74, 1980.

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GRANTSMANSHIP

A 2-day course entitled, How You Can Get More Grants and a 1-day Proposal Writing Workshop will be held at the Philadelphia Sheraton, Philadelphia, Pennsylvania, November 17 to 19, 1980. The instructor is David Bauer. The courses are designed for nonprofit organizations. Registration information may be obtained from John J. Ekberg, Capitol Publications, Seminar Division, 2430 Pennsylvania Avenue, N.W., Washington, D. C. 20037.

AMERICAN OPTOMETRIC ASSOCIATION

The 83rd Annual Congress of the American Optometric Association was held in Denver, Colorado, June 25 to July 1, 1980. About 1,000 optometrists attended.

The officers for 1981 are:

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