necessitating sedation or general anesthesia in the dog. Episcleral venous pressure in man is affected by position; the recumbent pressure is at least 1 mm Hg higher than that in the sitting position.\(^5\) Regardless of the limitations of this method, differences between the normotensive and glaucomatous beagles, if present, should be detectable.

The episcleral venous pressures in the normotensive dogs, as estimated by this method, were similar to those reported with the pressure-chamber systems.\(^7\),\(^8\) The range of 10 to 18 mm Hg of the canine episcleral venous pressure is similar to the intrascleral venous pressures measured by direct cannulation in the anesthetized cat of 6.8 mm Hg (S.D. \(\pm\) 0.60), with a mean IOP of 20 mm Hg.\(^6\) In both the cat and dog the episcleral and intrascleral vessels are related, in part, to the venous circle of Hovius, which may also branch with the anterior ciliary and vortex veins. Whether these anatomic differences in the anterior segment venous pathways are important differences to man in relationship to aqueous humor dynamics has not been ascertained; however, it is reasonable to assume the pressures are important considerations.

Variations of the episcleral venous pressures of the normotensive and glaucomatous Beagles under halothane anesthesia were measured within veins in the same eye were not significant (\(p < 0.45\) and \(p < 0.50\), respectively), supporting the reproducibility of this method. Nor were the changes different between episcleral veins of the fellow eyes in the same dog with all three methods of anesthesia. The lack of a significant difference of episcleral venous pressure between the normal and glaucomatous beagles suggests the trabecular meshwork and/or intrascleral plexus connective tissues are the major site of resistance for the outflow of aqueous humor in inherited glaucoma in the beagle.

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Key words: Episcleral venous pressure, ocular normotensive, glaucoma, dogs

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Ultrasound axial length measurements and psychophysical vernier acuity thresholds were determined for a pair of identical human twins, one of whom had been monocularly deprived since birth with a congenital lens opacity. Axial lengths of both eyes in the normal twin and the nondeprived eye in the other twin differed by less than 0.2 mm, whereas the axial measurement of the deprived eye was approximately 2.0 mm longer. Monocular vernier acuity thresholds in the nondeprived eye of the one twin were not significantly different from those obtained in the normal twin. Our findings are consistent with previous reports of increased axial length after monocular deprivation but do not support the concept of enhanced vernier acuity in the nondeprived eye of monocularly deprived humans. (Invest Ophthalmol Vis Sci 23:135-138, 1982.)

Since the introduction of the monocular deprivation paradigm almost two decades ago by Wiesel and Hubel,\(^1\) a voluminous literature has documented the behavioral, anatomic, and physiologic
consequences of depriving one eye of patterned visual input during early development. In general, these studies have supported the view that the functional impairments resulting from monocular deprivation are largely due to placing the projections from the deprived eye to the visual cortex at a competitive disadvantage during a sensitive developmental period. A question that has received little attention (see ref. 14), although it was noted by Wiesel and Hubel in their early work, is the possibility of enhanced visual capability of the eye that was at a competitive advantage during development. This might be expected, since it is known that projections to visual cortex from the nondeprived eye are more extensive than normal. We encountered a rare opportunity to examine this issue in identical human twins, one of whom was monocularly deprived from birth. These individuals were trained as psychophysical observers on a highly sensitive visual resolution task, vernier acuity. We now report that vernier acuity does not differ significantly in the nondeprived eye of a monocularly deprived human in comparison with that of an identical twin with normal vision. We also found that early monocular deprivation in the human induces myopia in the deprived eye, resulting from an increased axial length, as has been previously reported for monkeys, cats, and humans with unilateral ptosis and other forms of unilateral deprivation.

Materials and methods. Our subjects were 22-year-old identical male twins who were similar in all respects except for the presence of a unilateral lens opacity in one. By history, the lens opacity had been a long-standing problem, and a clinical ophthalmologic examination confirmed that the opacity was a congenital posterior subcapsular cataract resulting from a tissue remnant of the hyaloid stalk during ocular development (Fig. 1). Visual acuity in the eye with the opacity was 20/200 without correction, and 20/80 with correction. A dilated, cycloplegic refraction for this eye was $-6.25 +5.25 \times 115$. The fellow eye exhibited a latent hyperopia of approximately 0.5 diopters and a visual acuity of 20/13. The normal binocular twin displayed a latent hyperopia of 0.5 D and a visual acuity of 20/13 in both eyes. All other aspects of their clinical eye examinations were normal.

Results. Ultrasonic A-scan measures of the axial lengths of the two eyes were performed to determine the basis for increased myopia in the deprived eye. Three A-scan measurements were performed for each eye and the results were analyzed according to standard clinical ophthalmic procedures. The mean and standard deviation of axial length measurements are presented for each eye in Fig. 2. For the normal binocular twin, the axial length measures showed a difference of approximately 0.1 mm between eyes. These values are within 0.2 mm of the nondeprived eye of the other twin. The deprived eye displayed an axial length
Fig. 3. a, Monocular and binocular vernier acuity thresholds (75% correct level) for the normal and monocularly deprived twin. The I-bars represent ±1 S.E.M. b, Psychometric functions for monocular and binocular vernier acuity determinations for the monocularly deprived twin. c, Psychometric functions for monocular and binocular vernier acuity determinations for the normal twin.

Figure 3. a, Monocular and binocular vernier acuity thresholds (75% correct level) for the normal and monocularly deprived twin. The I-bars represent ±1 S.E.M. b, Psychometric functions for monocular and binocular vernier acuity determinations for the monocularly deprived twin. c, Psychometric functions for monocular and binocular vernier acuity determinations for the normal twin.

Resolution properties were assessed psychophysically by measuring foveal vernier acuity thresholds. This technique was employed since it provides a sensitive measure of resolution function in human observers. Furthermore, it has been reported that monocularly deprived humans have supernormal vernier acuity in their nondeprived eye in comparison to subjects with normal binocular vision.

Vertical line stimuli (16.0 by 0.6 min arc, 25.7 cd/m²) were generated on a Tektronix 4010 graphics terminal located 17.4 m from the subjects. Background luminance was 0.74 cd/m². The upper line stimulus position was held fixed while the lower line was presented randomly left or right of the upper stimulus by a predetermined offset. Stimulus duration was 2 sec. For each experimen-

tal session, monocular and binocular vernier acuity determinations were based on 50 trials for each of seven fixed offsets (2.45 to 17.15 sec arc with equal step intervals). The order of presentation of offsets and viewing conditions (monocular vs. binocular) was counterbalanced across sessions. Subjects were given an optimal refractive correction for the stimulus display conditions and were tested on the same days.

The monocular and binocular vernier acuity thresholds for both subjects are presented in Fig. 3. These data were collected after practice effects had reached asymptotic levels. The right-hand curves display psychometric functions for both subjects. Each point is based on the mean of 300 trials obtained over six experimental sessions. The percent correct data were transformed to probability of detection values (0.0 to 1.0) and were then converted to Z-scores. A least-squares linear regression was performed on the Z-scores, and the Y-intercept (Z-score corresponding to 75% correct level) and standard error of estimate were recorded. Correlation coefficients were all above 0.96. The left-hand graph in Fig. 3 presents histo-
grams of the monocular and binocular vernier acuity thresholds (75% correct level) for both subjects.

As may be seen in Fig. 3, the vernier acuity thresholds of the twin with normal vision are lower with binocular (5.6 sec arc) than with monocular (8.3 sec arc) viewing conditions. This difference is statistically significant (t = 2.61, df = 10, p < 0.05). For the monocularly deprived twin, the monocular (nondeprived eye) and binocular vernier acuity thresholds are essentially the same (7.1 and 7.3 sec arc, respectively). Comparison of the deprived twin’s monocular thresholds (nondeprived eye) with the normal twin’s monocular thresholds indicates no statistically significant difference (t = 0.897, df = 10, p > 0.30). Therefore the resolution capability in the nondeprived eye of the one twin is not superior to the corresponding eye in the other twin.

Discussion. Our results do not support the conclusion by Freeman and Bradley that human amblyopes exhibit significantly higher-than-normal vernier acuity in the nondeprived eye. The vernier acuity thresholds of the present study are consistent with those reported by Westheimer and are lower than those obtained by Freeman and Bradley. Since it is known that practice influences vernier acuity, the differences between our findings and those of Freeman and Bradley could be due to the fact that these investigators used untrained subjects and a smaller number of trials to determine thresholds. Furthermore, the subjects in the Freeman-Bradley study were not a homogeneous population but rather consisted of strabismic amblyopes, anisometropic amblyopes, and subjects with other monocular anomalies. Our investigation of identical twins with equivalent optical properties (except in the deprived eye) and equal practice opportunities provides a high degree of comparability of the deprived and control groups. In our study of monocular deprivation in humans we did not find statistically significant improvements in vernier acuity in the nondeprived eye.

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Key words: monocular deprivation, vernier acuity, identical twins

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We have measured the impairment of vision that accompanies a saccadic eye movement under whiteout conditions. Translucent plastic diffusers were fitted around the

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