Abnormal Acuity Development in Infantile Esotropia

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Monocular and binocular grating acuities were measured using a swept spatial frequency visual evoked potential (VEP) technique in a group of fifteen infants with esotropia and alternating fixation. Both monocular and binocular acuity measures fell significantly below the mean for age-matched normals. Infants with esotropia and alternating fixation did not have significant interocular acuity differences. Invest Ophthalmol Vis Sci 29:327–329, 1988

Clinical assessment of vision in infants relies heavily on both binocular and monocular fixation patterns. In infantile esotropia, it is widely assumed that free alternation of fixation from one eye to the other indicates equal acuity and does not lead to amblyopia. The fixation pattern does not reflect visual acuity directly, rather, it is a motor response (ie, ability to maintain fixation) which may be a correlate of a sensory abnormality (ie, amblyopia).

Recent advances have made it possible to compare motor fixation patterns to sensory measures of acuity obtained either by behavioral or electrophysiological means. Behavioral data obtained with the forced-choice preferential looking (FPL) technique indicates that the development of grating acuity in infants with esotropia and alternating fixation is indistinguishable from that of normal infants during the first year of life. A recent prospective study of infants with esotropia, however, indicates that the FPL acuity of the better eye of esotropic 3-year-olds is significantly lower than that of age-matched controls.

Acuity development as indexed by the VEP is more rapid than that observed with the FPL technique and may thus be sensitive to earlier changes in the acuity development of infants with esotropia.

Materials and Methods. Monocular and binocular grating acuities were obtained from 15 infants with infantile esotropia who had central, steady and maintained fixation with each eye (alternating fixation). Each infant had a documented onset of esotropia before 6 months of age, with equal refractive errors less than +2.0 diopters, normal fundus examination, no prior treatment for esotropia, no clinically observable latent nystagmus and no history of neurologic disease. The infants ranged in age from 10 to 50 weeks on initial VEP recording. Five of the infants were tested on more than one occasion. A total of 21 recordings was obtained for the 15 infants. Informed parental consent for participation in the VEP testing

![Figure 1](https://iovs.arvojournals.org/...access?url=data/journals/iovs/933369/ on 11/21/2018)
Grating acuity was measured using a swept spatial frequency VEP technique. A vertically oriented sinusoidal grating was phase-alternated at 12 contrast reversals per second and at the same time swept in spatial frequency over a 30:1 range during a 10 second trial. Acuity was estimated by an extrapolation of the VEP amplitude versus spatial frequency function to zero amplitude. Monocular and binocular grating acuities and interocular acuity differences were compared to norms established on 65 infants under 1 year of age tested with the same apparatus.

**Results.** Monocular and binocular grating acuities for 15 infants with esotropia (21 sessions) are compared to those of normal infants in Figure 1a and 1b, respectively. The striped area indicates ±2 standard deviations for the population of normal infants and the solid line indicates the mean acuity. The monocular acuities of the infants with esotropia are plotted with a vertical line connecting the right eye and left eye acuity values for each infant. At the time of the first recording, the monocular acuities of 14 of the 15 infants fell below the normal mean, eight of these by more than 2 standard deviations. One infant, age 10 weeks, scored at the normal mean. Binocular acuities for all 15 infants fell below the normal mean with nine infants having acuities more than 2 s.d. below the mean. Six infants who scored within 2 s.d. of the normal mean were younger than 20 weeks. Three of these infants were tested in later sessions and each subsequently scored more than 2 s.d. below the normal mean for monocular testing.

Figure 2 plots for each infant the difference in their acuity compared to the mean for their age for the right eye (upper panel), left eye (middle panel) and both eyes (lower panel). The infants with esotropia averaged 1.04 octaves below normal on right eye testing ($t_{20} = 11.3, P < 0.001$), 1.06 octaves below normal on left eye testing ($t_{20} = 11.2, P < 0.001$) and 0.75 octaves below normal on binocular testing ($t_{20} = 10.1, P < 0.001$).

Figure 3 plots the interocular acuity differences observed for each of the infants with esotropia as a function of age. An upward bar indicates that the right eye acuity was better than the left eye acuity. Interocular acuity differences within the normal range of 0.59 octaves (95% confidence interval) were obtained in 20 out of 21 recordings. The largest interocular difference observed was 0.6 octaves, but the mean difference was only 0.23 octaves.

**Discussion.** Infants with esotropia and alternate fixation show a distribution of acuities that averages 1 octave below age norms for monocular testing and 0.75 octaves below age norms for binocular testing. These infants, however, did not have significant interocular acuity differences.

Our results stand in contrast to a previous study which found monocular grating acuity, measured with an operant FPL technique, to be within normal limits during the first year of development. In the present study, infants with esotropia failed to demonstrate sweep VEP acuities above 10 c/deg during the second semester of infancy, a period during which a normal VEP acuity of 15 to 20 c/deg is expected. Acuity norms for FPL during the second semester are
Fig. 3. Interocular acuity differences as a function of age, for the 21 test sessions on the infants with esotropia. The dashed horizontal lines indicate the 95% confidence interval for interocular acuity differences in normal infants.

substantially lower than those for the VEP, ranging from 6 to 12 c/deg. It is thus possible that the FPL testing was not sensitive enough to demonstrate the loss of acuity we have measured with the VEP technique, since the loss appears to occur at spatial frequencies above the normal limits of the FPL test. The FPL technique, however, has shown significantly lower acuities in 3-year-olds with a history of infantile esotropia. By this age, the FPL age norms are substantially above 10 c/deg.

The acuity loss of approximately 1 octave which we have measured, while statistically reliable, is relatively small. Perhaps reflecting this, the clinical literature has focused on motor alignment and fusional outcomes in older children, rather than on acuity.

Ing included the Snellen visual acuity measurements of 106 children who had been treated for congenital esotropia. Re-analysis of Ing's data from 55 patients, 4 to 18 years of age, who met the same inclusion criteria used in the present study (Methods section above) indicates that 36% (ages 5 to 11) demonstrated 20/30 acuity or worse in the better eye. Although Ing's study did not include acuity results from age-matched controls, it is possible, given previous normative data for Snellen acuity in children, that the distribution of acuities in Ing's sample of esotropic children is negatively skewed relative to that for normal children of the same age.

Since the effect of esotropia on acuity appears to be small, carefully controlled studies of both grating and Snellen acuity in older children and adults will be necessary to determine if subtle acuity abnormalities persist.

Key words: infantile esotropia, grating acuity, visual development, amblyopia, visual evoked potentials

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References