Visual acuity development in human infants: a re-evaluation

To the Editor:

Marg and associates have recently studied the development of visual acuity in human infants. They measured the visually evoked potential to squarewave gratings of various spatial frequencies in infants ranging from 1 to 7 months of age. Their results indicated that normal adult acuity values are obtained by 4 to 5 months of age. The potential significance of this finding should be emphasized for it suggests that visual development proceeds very rapidly and, consequently, that early visual assessment is of utmost importance.

The manner in which Marg and associates present their data is somewhat misleading, however. I would like to briefly present an alternative representation of their data which I believe yields a more accurate picture of the growth of visual acuity. The rate of acuity growth reported by Marg and associates in their Fig. 2 appears to be very rapid from 1 to 2 months of age and to be less and less rapid from 2 to 7 months. Indeed, the authors emphasize this fact by stating that "...the greatest increase [in acuity] occurs during the first eight weeks" (p. 150). This apparent rapid rise in acuity during the one- to two-month period is actually an artifact of the manner in which Marg and associates plotted their data. Acuity is expressed as resolution in minutes of arc, resolution referring to the width of an individual stripe in the finest resolvable squarewave grating (highest spatial frequency). Resolution values, however, are plotted on a linear scale so that corresponding spatial frequency values are plotted on an inverse scale (spatial frequency = 30 × 1/resolution in minutes of arc [minarc.]). This is shown in Fig. 1, A of the present note. Fig. 1, A is a reproduction of the original Fig. 2 of Marg and associates. This unusual manner of plotting acuity data leads to unwarranted conclusions about the rate of acuity development. This point is best illustrated by an example. A 2-fold increase in acuity from 30 minarc. (1 cycle per degree) to 15 minarc. represents a 2-fold increase in acuity (1 to 2 cy./deg.) whereas that same interval from 16 minarc. to 1 minarc. represents a 16-fold increase (1.9 to 30 cy./deg.). The way in which Marg and associates have plotted their data results in an expanded representation among low acuity values. Thus, the steep slope of their acuity growth curve between 1 and 2 months is a consequence of the low acuity values observed at these ages rather than of differential rates of acuity development.

It would seem more reasonable to plot these data in a different manner such that doublings or triplings of acuity would be expressed by similar intervals along the ordinate. The general practice is to plot acuity on a logarithmic scale when age comparisons are being made. With this in mind, I have replotted these data with resolution expressed on a logarithmic scale (Fig. 1, B). This produces a plot in which 2-fold (or 3-fold, etc.) increases in acuity are represented by similar intervals on the ordinate. The rate of acuity development expressed on this plot is relatively constant from 1 to 5 months. Indeed a best-fitting straight line yields a Pearson correlation of 0.83 between the observed acuity values and points on the line. I have also fitted the Marg and associates data with a curvilinear function of the form ax + b log x + c; the best-fitting function of this form is: 0.15x + 1.1 log x and is shown as a solid line. The Pearson correlation between the data and this line is 0.92. The average slope of the best-fitting curvilinear function between 1 and 2 months is approximately 0.45. The average slope between 2 and 5 months is 0.30. Thus, even when the acuity data in this plot are fitted with a curvilinear function, the slope of the best-fitting function is relatively constant from 1 to 5 months of age. The rate of acuity development between 1 and 2 months thus does not appear to differ significantly from that between 2 and 5 months.*

One more point should be made concerning the interpretation of the Marg and associates study. The authors found that acuity values of 30 cy./deg. were observed from 5 to 7 months of age. They conclude from this that adult acuity is reached by this age, assuming the 30 cy./deg. is equivalent to normal adult acuity. In actuality, psychophysical measurements of acuity in adults

*I have assumed that the acuity growth curve is discontinuous since the Marg and associates data indicate no acuity change after 5 months of age. Quite similar results are obtained when a continuous curve from 0 to 7 months is assumed.
The intention of this note is not to discredit the results of Marg and associates. In fact, the finding that acuity growth is very rapid during the first 6 months and that adult acuity values are obtained during the first year of life is borne out by other infant evoked potential studies.\(^5\)\(^6\) Given this, I simply wish to point out that the authors' manner of plotting acuity growth is somewhat misleading and that comparative adult data should be presented along with the infant data.

**REFERENCES**


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Clinically, 20/20 vision (30 cycles per degree) is generally considered normal vision regardless of the method used, and despite better performance by many adults. We used this in the sense that it is a standard of normal adult vision rather than the maximum attainable. Actual adult data for comparison are currently in press.\(^*\)

Different methods of plotting data can be used

to emphasize different aspects of them. We used linear units as has been the custom in earlier clinical visual acuity studies. By spreading out the points at the highest spatial frequencies, the new plot makes the inflection sharp at 5 months of age. We thank Dr. Banks for the statistical treatment and for presenting a new look at our data.

The important scientific finding in our paper, that adult acuity is achieved at about 5 months of age, is illustrated by Dr. Bank's new plot. The practical consequence is that we now have a means of examining infants during the sensitive period while the neurosensory visual system is still plastic. This may allow us to prevent amblyopia and perhaps squint that can develop during this time.

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Announcements

Baylor Ophthalmological Congress

Baylor Ophthalmological Congress will be held Feb. 22 through 25, 1978, in Houston, Texas, at the Baylor College of Medicine. For further information contact The Department of Ophthalmology, Baylor College of Medicine, 1200 Moursund, Houston, Texas 77030.

Tenth Annual Meeting of the Philadelphia Pediatric Ophthalmology Society

The Philadelphia Pediatric Ophthalmology Society meeting will be held on June 11 through 14, 1977, at the Cherry Hill Hyatt House, Cherry Hill, N. J. For further information contact: Harold P. Koeller, M.D., Symposium Chairman, 1601 Spring Garden St., Philadelphia, Pa. 19130.

$25,000 award for eye research presented at Academy Meeting

Medicine's most valuable prize for eye research—the $25,000 RPB Trustees Award of Research to Prevent Blindness, Inc. (RPB)—was presented to Dr. A. Edward Maumenee (left) before 5,000 eye physicians attending the recent annual meeting of the American Academy of Ophthalmology and Otolaryngology at Las Vegas, Nevada. Dr. Maumenee is Director of the Johns Hopkins Wilmer Eye Institute, Baltimore. Dr. Jules Stein, chairman and co-founder of Research to Prevent Blindness, Inc., made the presentation "for outstanding ophthalmic achievement" in the name of the Trustees of RPB, the nation's leading voluntary organization in support of eye research. Dr. Stein cited Dr. Maumenee as "a towering presence in contemporary ophthalmology whose achievements have profoundly influenced the development of effective new concepts and techniques for saving sight." RPB has channeled more than $30 million into eye research since 1960.

Macula Tutorial Conference

A Macula Tutorial Conference to be held in New Orleans at the Royal Sonesta Hotel on March 31, April 1, and April 2, 1977, sponsored by the Touro Infirmary Eye Research Laboratory. The seminar panelists will include Drs. Alan Bird and Emmanuel Rosen of England, Martin Vogel of Germany, Howard Schatz of San Francisco, Myron Yanoff of Philadelphia, Lawrence Yannuzzi of...