The LEA Grating Test in assessing detection grating acuity in normal infants less than 4 months of age

Giovana Martini, MS, Abimael A. Netto, PhD, André M. Morcillo, PhD, Heloisa G. R. G. Gagliardo, PhD, and Denise F. de Oliveira, PhD

 PURPOSE
To assess binocular detection grating acuity using the LEA GRATINGS test to establish age-related norms in healthy infants during their first 3 months of life.

 METHOD
In this prospective, longitudinal study of healthy infants with clear red reflex at birth, responses to gratings were measured at 1, 2, and 3 months of age using LEA gratings at a distance of 28 cm. The results were recorded as detection grating acuity values, which were arranged in frequency tables and converted to a one-octave scale for statistical analysis. For the repeated measurements, analysis of variance (ANOVA) was used to compare the detection grating acuity results between ages.

 RESULTS
A total of 133 infants were included. The binocular responses to gratings showed development toward higher mean values and spatial frequencies, ranging from 0.55 ± 0.70 cycles per degree (cpd), or 1.74 ± 0.21 logMAR, in month 1 to 3.11 ± 0.54 cpd, or 0.98 ± 0.16 logMAR, in month 3. Repeated ANOVA indicated differences among grating acuity values in the three age groups.

 CONCLUSIONS
The LEA GRATINGS test allowed assessment of detection grating acuity and its development in a cohort of healthy infants during their first 3 months of life. (J AAPOS 2014;18:563-566)

The first year of life is critical for the development of visual function. Deprivation of adequate stimuli during this period can result in permanent visual loss. Grating acuity can be evaluated during the first year of life by means of a preferential looking test to assess the infant’s ability to detect gratings. In preverbal children, this measure is generally based on the child’s ability to resolve stripes or checkerboard patterns, a visual task called grating resolution acuity. The response provides a measure of the child’s ability to detect difference between the gray surface and the grating. The purpose of this study was to assess binocular detection grating acuity using the LEA GRATINGS test (Good -Lite, Elgin, IL) to establish age-related norms in healthy infants during their first 3 months of life.

 Subjects and Method
This prospective, longitudinal study adhered to the tenets of the declaration of Helsinki and was approved by the Research Ethics Committee of the University of Campinas FCM—UNICAMP, Campinas, Brazil. Infants examined at the School of Medical Sciences from January to October 2008 who met the following criteria were included: born at full-term and generally healthy, with no congenital malformations, infections, or abnormal perinatal events; weight and length appropriate for gestational age; clear red reflex at birth; and 1 month of age at the start of the study. All subjects were residents of the Campinas metropolitan region. Parents or legal guardians of included subjects provided written consent. Patients who missed one of the evaluations during follow-up before 3 months of age and those in whom visual disorders were detected during ophthalmological evaluation at 12 months of age were excluded.

The LEA GRATINGS test, developed by Lea Hyvärinen, measures detection grating acuity using four paddles, three with gratings on both sides and one with a gray surface (Figure 1). The frequency of gratings is defined as cycles per centimeter (cpcm) on the surface of the paddles.

Assessment was performed in a room with a luminance of 120-360 lux. Infants were held on their mothers’ laps at a distance of 28 cm from the test. The paddles were organized on a table with low spatial frequencies (wide stripes) on top. The gray surface and the grating were presented to the subject and were kept motionless. The response was based on observing the shift of fixation to the grating during binocular measurements. If an infant’s condition prevented measurement, the evaluation was rescheduled. All
Examinations were performed by one evaluator. The grating detection thresholds were defined as the spatial frequency of the finest grating that resulted in two positive responses (Figure 2).

Each subject was evaluated three times, at the end of the first, second, and third month of age. At 12 months of age, children were examined by an ophthalmologist, who performed a clinical evaluation comprising red reflex testing, Hirschberg test, cover test, assessment of ocular motor functions, retinoscopy, biomicroscopy, objective refraction, and dilated fundus examination. Infants diagnosed with ophthalmological abnormalities were excluded.

Data related to the infants’ birth conditions were obtained from the newborn’s health card and the data recorded on the evaluation protocols were transcribed and stored in the database of SPSS 16.0 (SPSS Inc, Chicago, IL). The data were represented in a frequency distribution as cycles per degree (cpd) and logMAR values. The technique presented in the manual of Teller Acuity Cards and in the study by Salomão and Ventura were used to determine the means and standard deviations of the cpd values. The data in cpd were converted into a one-octave scale for statistical analysis and data organization, that is, the cpd values were subjected to logarithmic transformation.

Acuity values were reconverted into cpd values for presentation of results. Standard deviations are presented in octaves. For comparison of grating acuity values at the three different ages, analysis of variance (ANOVA) was used for repeated measures. The profile test by contrasts was used to locate differences at different ages.

Results

The first examination, at the end of month 1, included 386 infants; the second, at the end of month 2, 253 infants; and the third, at the end of month 3, 178 infants. Of the 178, 11 were excluded for exceeding the age of 3 months. Thus 167 infants completed the longitudinal follow-up during the first 3 months of life. At the age of 12 months, only 145 children were available for the ophthalmologic evaluation. Of these, 8 were excluded because of incomplete examination, 1 for retinoblastoma, and 3 for constant strabismus, leaving a total of 133 infants (65 males [49%]). Considering an 8% margin of error the number of cases (N) for the present study was 133 infants.

The mean gestational age was 39.33 ± 1.12 weeks (range, 37 weeks to 41 weeks and 6 days). The mean birth weight was 3515 ± 387.4 g (range, 2215–4065 g). The Apgar index was ≥7 in 95.5% of cases during the first minute and 100% during the fifth minute.

The racial distribution of infants was as follows: 71 (53.4%), white; 35 (26.3%), black; and 6 (4.5%), other. The records of 21 infants (15.8%) did not provide demographic data.

In the first month, the mean age at the time of testing was 39.3 ± 4.0 days (range, 19–45 days); in the second month, 71.6 ± 3.8 days (range, 57–75 days); and in the third month, 102.3 ± 3.6 days (range, 90–105 days). Measurements were taken within 15 days of the exact age of 1, 2, or 3 months.

According to the data shown in Tables 1 and 2, binocular responses to gratings showed development toward higher mean values and spatial frequencies. At the age of 1 month, the mean grating acuity was 0.55 ± 0.70 cpd (1.74 ± 0.21 logMAR); at 2 months, 1.35 ± 0.69 cpd (1.35 ± 0.21 logMAR), and at 3 months, 3.11 ± 0.54 (0.98 ± 0.16 logMAR). ANOVA performed on the repeated measurements (at the ages of 1, 2, and 3 months) demonstrated the influence of age on the values (P < 0.0001); the profile test showed significant differences between values at each age. A curve depicting the development of the mean of detection grating acuity was constructed based on the mean values and respective standard deviations obtained for each age group (Figure 3).

Discussion

The present study represents the first attempt to determine prospectively a curve of normal development of detection grating acuity from a large cohort of normal infants evaluated longitudinally in the first 3 months of life by the LEA GRATINGS test. The improvement of infants’ ability to detect gratings observed in the present study is similar to findings in other studies using...
psychophysical or electrophysiological evaluation methodologies during the first 6-12 months of life.\(^2,10\)

To our knowledge, only 2 previous studies\(^5,11\) used the LEA GRATINGS test; however, although LEA gratings have a strong correlation both with Teller Acuity Cards\(^5\) and Cardiff acuity cards,\(^11\) the results of these studies were not compared with those of the current study because of differences in methodology and age groups. Nevertheless, the results for the three age groups in the current study are similar to those of studies that used the forced-choice preferential looking technique 1 month of age.\(^12,13\)

Other studies that measured infant visual acuity from birth to 28 days of life also found similar mean values.\(^14-16\) Values measured during the second month of life\(^17\) are close to the corresponding values of the current study; binocular values measured at the age of 3 months\(^18\) were slightly lower than ours.

In their study of normal values for the Teller Acuity Cards, Salomão and Ventura\(^8\) reported mean acuity was 0.66 cpd at 15 days of age, 2.02 cpd at 2 months, and 3.89 cpd at 3 months—similar to values obtained in the present study. All values of the present study are within the normal values presented in the utilization manual of the test of Teller Acuity Cards (TAC- II; Stereo Optical Co Inc, Chicago, IL).\(^7,8,14\)

In newborns, measured grating acuity values are strongly affected by the infant’s state of wakefulness. The challenge with this population is obtaining monocular measurements, given that occlusion can further affect infant cooperation. A large improvement in the value might mean that during the previous measurement the infant was not as awake as during the follow-up visit. On the other hand, if the follow-up measurement results in the same or a lower value than the previous measurement, it is wise to repeat the measurement the same day or within a week to confirm that the values are improving normally. Although the binocular values of a single measurement are relevant in infant assessment in the first months of life, it is more important to verify that the values obtained in follow-up tend to grow and remain within the normal range.

The American Academy of Pediatrics, the American Association for Pediatric Ophthalmology and Strabismus, and the American Academy of Ophthalmology recommend that visual functions and functioning should be assessed early.\(^19,20\) Detection grating acuity is an easy and quick measurement to monitor development of visual functions. Repeated observations on how infants reach the developmental milestones in visual communication and interaction and use vision in motor development are important clinical observations on the development of brain functions. Although the lack of monocular values is a limitation of this study, the binocular measurements provided valuable data on the visual development of infants. Used in conjunction with standard clinical examination techniques, the LEA GRATINGS test provides an easy way to monitor development of visual function in infants.

**Literature Search**

PubMed was searched on November 20, 2012, without date or language restrictions, using the following terms:

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**Table 1. Detection grating acuity values (cpd and logMAR) during the first 3 months of life (N = 133)**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>0.25, cpd 2.08, logMAR</th>
<th>0.50, cpd 1.78, logMAR</th>
<th>1.00, cpd 1.48, logMAR</th>
<th>2.00, cpd 1.18, logMAR</th>
<th>4.00, cpd 0.88, logMAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month 1</td>
<td>f</td>
<td>%</td>
<td>f</td>
<td>%</td>
<td>f</td>
</tr>
<tr>
<td>23</td>
<td>17.3</td>
<td>70</td>
<td>52.6</td>
<td>38</td>
<td>28.5</td>
</tr>
<tr>
<td>Month 2</td>
<td>6</td>
<td>4.5</td>
<td>74</td>
<td>55.6</td>
<td>43</td>
</tr>
<tr>
<td>Month 3</td>
<td>4</td>
<td>3.0</td>
<td>40</td>
<td>30.1</td>
<td>89</td>
</tr>
</tbody>
</table>

_Cpd, cycles per degree; logMAR, logarithm of the minimum angle of resolution._

**Table 2. Mean values of detection grating acuity (N = 133)**

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Mean, cpd</th>
<th>Mean ± 1.96 SD, cpd</th>
<th>Mean, logMAR</th>
<th>Mean ± 1.96 SD, logMAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month 1</td>
<td>0.55</td>
<td>0.21; 1.44</td>
<td>1.74</td>
<td>1.32; 2.16</td>
</tr>
<tr>
<td>Month 2</td>
<td>1.35</td>
<td>0.51; 3.52</td>
<td>1.35</td>
<td>0.93; 1.77</td>
</tr>
<tr>
<td>Month 3</td>
<td>3.11</td>
<td>1.50; 6.56</td>
<td>0.98</td>
<td>0.66; 1.30</td>
</tr>
</tbody>
</table>

_Cpd, cycles per degree; logMAR, logarithm of the minimum angle of resolution._

**FIG 3.** Improvement in the detection grating acuity values during the first 3 months of life in CPD and logMAR.
visual acuity, eye health, vision tests, infant care, vision disorders—prevention AND control.

Acknowledgments

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References

3. Hyvärinen L, Jacob N. What and how does this child see? Helsinki (Finland): Vistest Ltd 2011;33-8.

An Eye on the Arts—the Arts on the Eye

We don’t close our eyes to the Universe and then complain: “It’s dark”. We keep our eyes wide open, knowing that the light could lead us to do undreamed of things. That is all part of love.