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# Principles and Practice of Clinical Electrophysiology of Vision

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# Distribution of ERG Amplitudes, Latencies, and Implicit Times

Hiroyuki Iijima

When clinical electroretinograms (ERGs) are evaluated by using the parameters of amplitudes, latencies, and implicit times, we need normal values. In many ERG laboratories normal ranges are determined by means  $\pm$  2 SD of the data obtained from normal subjects because it is taken for granted that the normal data follow a normal gaussian distribution. However, because of concern that a normal distribution does not occur, it has been suggested that nonparametric methods be used for the clinical analysis of ERG data.<sup>1</sup>

Another important issue for interpretation of the clinical ERGs is the influence of age and sex. Many studies agree that most ERG amplitudes are age dependent.<sup>2-5</sup> The age effects on ERG timings and gender effects on amplitudes and timings are controversial. We studied 72 subjects (30 males with  $31 \pm 19$  years of age and 42 females with  $38 \pm 19$  years of age) and found no significant gender differences in

amplitudes and timings of the photopic and the scotopic ERGs (Table 37-1), while mild to moderate age dependency was found in amplitudes and timings (coefficients of correlation with age were  $-0.20$ ,  $-0.14$ ,  $0.45$ , and  $0.49$  for the photopic b-wave amplitude, the scotopic b-wave amplitude, the photopic b-wave implicit time, and the scotopic b-wave implicit time, respectively). The results suggest that older subjects have smaller amplitudes and more delayed timings. In order to study the distribution pattern in these normal subjects without the influence of age, we divided them into four age groups, that is, 0 to 19, 20 to 39, 40 to 59, and 60 to 79 years of age and calculated the means and standard deviations of amplitudes and timings for each age group (see Table 37-1). Then we normalized the individual datum by the equation

$$r = (x - M)/SD$$

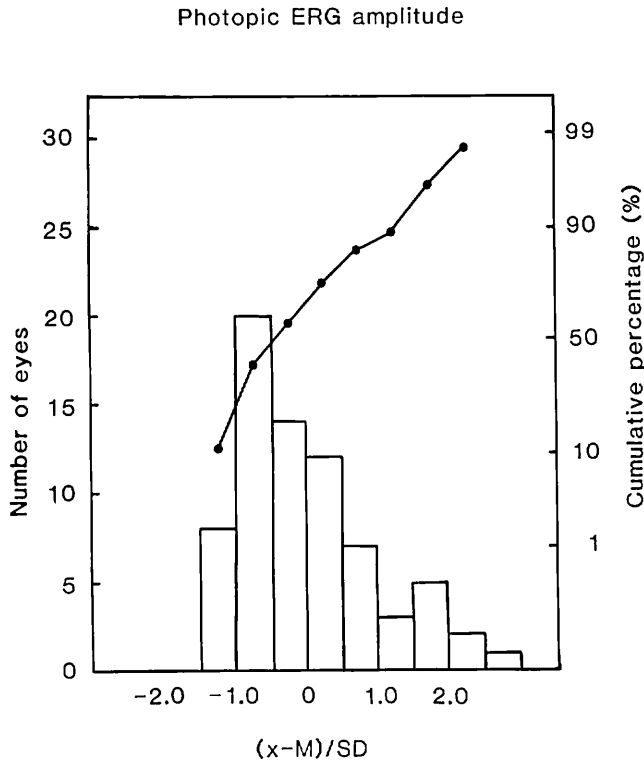
**TABLE 37-1.**

Amplitudes and Implicit Times of Photopic and Scotopic b-Waves in Normal Subjects\*

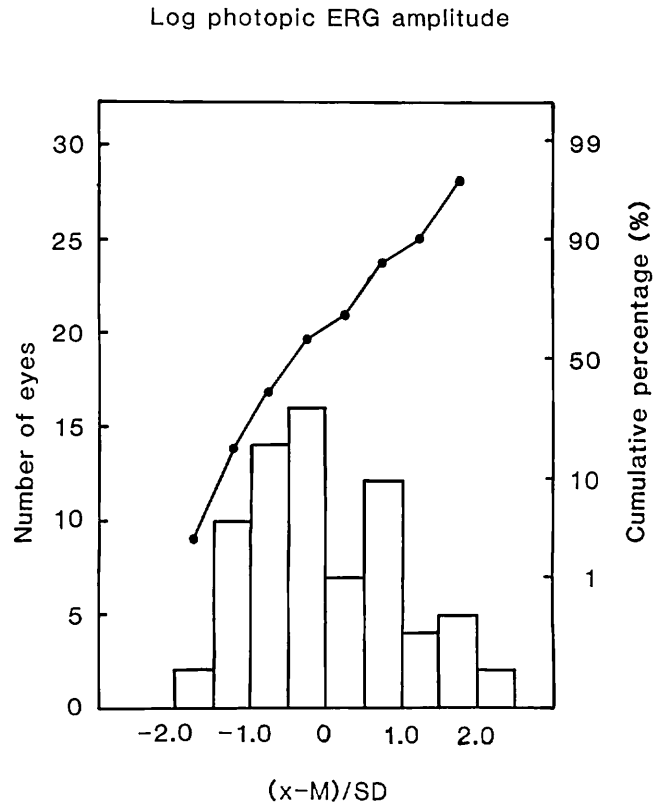
	bpt†	bs	bptT	bsIT
Male	155 $\pm$ 33	343 $\pm$ 53	31.8 $\pm$ 1.3	81.2 $\pm$ 10.0
Female	160 $\pm$ 40	368 $\pm$ 68	32.0 $\pm$ 1.3	77.6 $\pm$ 7.3
Age groups (yr)				
0-19	172 $\pm$ 48	364 $\pm$ 66	31.4 $\pm$ 1.1	74.5 $\pm$ 6.3
20-39	160 $\pm$ 36	366 $\pm$ 62	31.4 $\pm$ 1.1	77.4 $\pm$ 8.0
40-59	144 $\pm$ 28	358 $\pm$ 68	32.5 $\pm$ 1.3	81.8 $\pm$ 7.8
60-79	152 $\pm$ 21	321 $\pm$ 44	32.8 $\pm$ 1.2	87.2 $\pm$ 10.0

\*Data from the UCLA Visual Physiology Laboratory are means and standard deviations of male and female patients and patients by age group.

†bp = photopic b-wave amplitude; bs = scotopic b-wave amplitude; bptT = photopic b-wave implicit time; bsIT = scotopic b-wave implicit time.



**FIG 37-1.** Histogram and its cumulative percent frequency on a probability paper for the normalized value of photopic ERG amplitude in 72 normal subjects.



**FIG 37-2.** Histogram and its cumulative percent frequency on a probability paper for the normalized value of log photopic ERG amplitude in 72 normal subjects.

where  $r$  represents the normalized datum,  $x$  is the original datum,  $M$  is the normal mean of the corresponding age group, and  $SD$  is the standard deviation of the corresponding normal age group. With this normalization ERG data of the subjects in the different age groups can be analyzed together.

Among the ERG data the photopic b-wave amplitude had an apparently asymmetrical distribution pattern (Fig 37-1), while the log of it distributed almost evenly around zero and the distribution pattern simulated the normal distribution (Fig 37-2). This result indicates that the log normal distribution fits better for the photopic b-wave amplitude in the normal population. Conclusive results have not yet been obtained from the analysis of the distribution patterns of other amplitudes and timings, probably because of the relatively small number of subjects.

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