An Interocular Comparison of the Multifocal VEP: A Possible Technique for Detecting Local Damage to the Optic Nerve

Donald C. Hood,1 Xian Zhang,1 Vivienne C. Greenstein,2 Shreya Kangovi,1 Jeffrey G. Odel,3 Jeffrey M. Liebmann,4 and Robert Ritch1

PURPOSE. To develop a quantitative measure of local damage to the ganglion cells/optic nerve based on an interocular comparison of multifocal visual evoked potentials (mVEP).

METHODS. Multifocal VEPs were recorded from both eyes of six normal subjects and four patients; each eye was stimulated separately. Two of the patients had glaucoma, one had ischemic optic neuropathy, and one had unilateral optic neuritis. All four patients had considerably more damage in one eye than in the other, as indicated by their Humphrey visual fields. The multi-input procedure of Sutter was used to obtain 60 VEP responses to a scaled checkerboard pattern. The amplitude in each response was obtained using a root mean square measure of response magnitude. For each of the 60 pairs of responses, a ratio between the amplitude of the responses from the two eyes was obtained as a measure of the relative health of one eye compared with the other. The mean and SD of this ratio measure for the control group were used to specify confidence intervals for each of the 60 locations. All patients had Humphrey 24-2 visual fields performed. To allow a comparison of the mVEP responses to the visual fields, a procedure was developed for displaying the results of both tests on a common set of coordinates.

RESULTS. Except for a small interocular difference in timing attributable to nasotemporal retinal differences, the pairs of mVEP responses from the two eyes of the control subjects were essentially identical. Many of the pairs of responses from the patients were significantly different. In general, there was reasonably good agreement with the Humphrey 24-2 visual field data. Although some regions with visual field defects were not detected in the mVEP due to small responses from the better eye, other abnormalities were detected that were hard to discern in the visual fields.

CONCLUSIONS. Local monocular damage to the ganglion cell/optic nerve can be quantitatively measured by an interocular comparison of the mVEP. (Invest Ophthalmol Vis Sci. 2000;41:1580–1587)

Optic nerve and ganglion cell damage produce changes in the visual evoked potential (VEP).1–6 However, the VEP has its limitations when it is applied to visual field testing. The traditional VEP technique is limited to obtaining responses to stimulation in only a few field locations within a single session. Baseler et al.7 argued that this limitation could be overcome by using the multiple-input method described for the electroretinogram by Sutter and his colleagues.8,9 In particular, they showed that 60 or more local VEP responses, called the multifocal VEP (mVEP), could be obtained over a wide retinal area if the stimulus array was scaled (see Fig. 1A) to account for cortical magnification. They concluded, however, that intersubject variability was too great to make this technique viable for clinical field testing. However, recently, Klistorner and coworkers10 argued that if the recording electrodes were judiciously placed, then mVEP responses could be recorded from most field locations and the technique could be used to detect local field defects. In particular, they showed that there was qualitative agreement between Humphrey visual field defects and regions of diminished mVEP responses in patients with ganglion cell and/or optic nerve damage.

Although electrode placement may decrease intersubject variability of the mVEP, published records indicate,7,10 and we confirm here, that substantial variation still exists among the mVEP responses from different individuals. It was this variability among normal subjects that led Baseler et al.7 to conclude that the technique would not be useful for clinical field testing. The major source of variability among individuals is cortical anatomy. Individuals differ in the way the cortex is folded, the position of the primary visual area within these folds,11,12 and the relationship of external landmarks, such as the inion, to underlying brain structures.13 These differences can lead to markedly different mVEP responses.

A potential way around intersubject variability is to compare, within a subject, the two sets of mVEP records obtained...
by stimulating each eye separately. Although the mVEP responses differ among individuals, the mVEP responses from both eyes of the same individual should be very similar if both eyes are healthy. The anatomic basis for this statement is well known. Although points in the visual field fall on different hemi-retinas of the two eyes, they project to the same cortical location. For example, a point in the left visual field falls on the temporal retina of the right eye and on the nasal retina of the left. But these corresponding retinal points project via ganglion and geniculate cells to cortical regions within a few hundred microns of each other. Thus, in principle, if the optics, retina, and pathways are functioning equally well in both eyes, then the mVEP should be the same from both eyes when referenced to the stimulus location in the visual field. In practice, this would fail to be true if the nasal and temporal retinal inputs to the cortex were different or if one eye dominated the VEP because of an asymmetry in the input. However, if the monocular mVEP responses from the two eyes of control subjects are reasonably similar, then a comparison of the two monocular mVEP recordings from patients may allow the detection of early and localized damage of the ganglion cells or optic pathway. Early signs of these diseases are unlikely to be identical in the temporal retina of one eye and the nasal retina of the other.

One purpose of this study is to determine the degree to which the mVEP responses from the two eyes of normal subjects agree. We find that interocular differences do exist. However, these differences are subtle and will not interfere with the ability of this technique to detect optic nerve damage. A second purpose is to develop methods to quantify interocular differences in the mVEP obtained from patients. Finally, the third purpose is to present the interocular mVEP differences in a form that will allow for easy comparison to local sensitivity changes as measured with the Humphrey visual field analyzer. These methods are illustrated with four patients with diseases of the ganglion cells/optic nerve.

**METHODS**

**Subjects**

Six control subjects ranging in age from 19 to 57 years (mean, 31.8 years) with no known abnormalities of the visual system participated in the study. Four patients with ganglion cell/optic nerve damage also participated. Both groups are relatively small but serve the purpose here of testing the feasibility of a quantitative measure of local damage based on the mVEP. A larger group of age-matched normals may change the pattern of the defects observed, but these changes should be relatively minor given the magnitude of the observed z-scores. Table 1 presents the patient information.

<table>
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<th>Patient</th>
<th>Age</th>
<th>Eye</th>
<th>Visual Acuity</th>
<th>Visual Field (MD)</th>
<th>Visual Field (CPSD)</th>
<th>Diagnosis</th>
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<td>OD</td>
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<td>Normal</td>
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<td>12.7</td>
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<td>OD</td>
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<td>1.3*</td>
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<td>0*</td>
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<td>-7.4</td>
<td>6.9</td>
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<td>4.0</td>
<td>NTG</td>
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<tr>
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<td></td>
<td>OS</td>
<td>20/20</td>
<td>-18.2</td>
<td>13.5</td>
<td>NTG</td>
</tr>
</tbody>
</table>

MD, mean deviation in decibels; CPSD, corrected pattern standard deviation in decibels; ION, ischemic optic neuropathy; POAG, primary open-angle glaucoma; and NTG, normal tension glaucoma.

* Not significant at the 0.05 level or better.
The Multifocal VEP (mVEP) Stimulus

The stimulus array was produced with VERIS software (Dart Board 60 With Pattern) from EDI (Electro-Diagnostic Imaging, San Mateo, CA). The stimulus (Fig. 1A) consisted of 60 sectors each with 16 checks, 8 white (200 cd/m²) and 8 black (<1 cd/m²). The entire display had a diameter of 37°. The sectors had 216 × 1 elements and required approximately 14.5 minutes with the low- and high-frequency cutoffs set at 3 and 100 Hz.

To obtain an mVEP, the continuous VEP record was amplified as the ground. All responses in the figures are displayed with an electrode placed at the inion. A forehead electrode served as the reference electrode. An electrode was placed 4 cm above the inion and referenced to an electrode placed at the inion. A forehead electrode served as the ground. All responses in the figures are displayed with the reference (inion) electrode as negative. Following the suggestion of Klistorner et al.,10 we also tried lowering the electrode pair such that the reference fell 2 cm below the inion and the active 2 cm above. A comparison of these two electrode placements was made by simultaneously recording the mVEP from both configurations. In five of the seven control subjects run in this experiment, the records were essentially identical. One of the other two subjects showed larger responses to one placement, whereas the other showed larger responses to the other. For this group of seven individuals, there was no advantage to placing an electrode below the inion. Furthermore, this placement has the disadvantage of being more difficult to apply and maintain.

Electrode Placement

An electrode was placed 4 cm above the inion and referenced to an electrode placed at the inion. A forehead electrode served as the ground. All responses in the figures are displayed with the reference (inion) electrode as negative. Following the suggestion of Klistorner et al.,10 we also tried lowering the electrode pair such that the reference fell 2 cm below the inion and the active 2 cm above. A comparison of these two electrode placements was made by simultaneously recording the mVEP from both configurations. In five of the seven control subjects run in this experiment, the records were essentially identical. One of the other two subjects showed larger responses to one placement, whereas the other showed larger responses to the other. For this group of seven individuals, there was no advantage to placing an electrode below the inion. Furthermore, this placement has the disadvantage of being more difficult to apply and maintain.

Displaying the Responses

Figure 1B contains the records from one of the control subjects. For clarity of presentation, the positions of the individual records do not correspond to the locations of the sectors in Figure 1A. To allow the reader to make comparisons between the mVEP from the two eyes and to increase the signal-to-noise ratio, the mVEP responses were grouped and averaged. The 16 groups are shown in Figure 1D, which, unlike Figure 1A, is not drawn to scale. Twelve of these groups had four responses (see group 15 in Figs. 1B and 1D), whereas the middle four groups had three responses. The responses from the upper field are usually reversed in polarity from those in the lower field.7,10,15,16 In our experience the responses along the vertical midline can also differ in waveform from other responses. The groups, in general, respect these differences. The exception can be found for the central four groups; in some subjects they may be averages of responses that differ in waveform. Because we felt it important to allow the reader to see the comparisons between the records from the two eyes, this exception for some subjects seemed a small price to pay at this stage of the development of the technique (the typical VEP, of course, is a single response averaged across the entire area tested). In any case, a summary measure of all 60 responses is shown in Figure 5.

Visual Fields

Humphrey 24-2 visual fields were obtained as part of the patient’s routine visit to the ophthalmologist. The spatial relationship of the test spot locations of the 24-2 visual field to the multifocal stimulus is shown in Figure 1C. The mean deviation and corrected pattern standard deviation values for the Humphrey 24-2 visual fields are shown in Table 1. For three of the patients, the values for the better eye were within the 95% confidence intervals, and for all four patients these values were substantially smaller in the better eye.

RESULTS

Comparing the mVEP from Two Eyes

Figure 1B shows the mVEP records from the left eye of a control subject. As previously reported,7,10,15,16 the upper records are, in general, reversed in polarity and smaller in some locations than are the lower records. The grouped responses for the records in Figure 1B are shown in Figure 2A as the blue traces. The grouped responses from the left eye of a second control subject are shown in red. In some locations these two subjects have nearly identical responses. However, in many locations, the responses show substantial differences. In particular, in some cases one subject’s responses are larger, and in other cases the other subject’s responses are larger. Similar variations in the implicit times can be seen. The variation across a group of subjects is, as expected, even more extreme. Figure 2B shows the largest and smallest responses for each of the 16 groupings for the six control subjects. Notice that in a number of locations the smallest response is hard to distinguish from noise. The same analysis is shown in Figure 3A for all 60 responses. At many of the 60 locations, at least one subject had a response too small to be reliably discriminated from noise.

In Figures 2C and 2D, the mVEP responses from the left eye of each of two subjects (from Fig. 2A) are shown in red,
and the records from the right eyes of these subjects are shown in blue. The mVEP responses from the two eyes are extremely similar at all locations. This degree of within-subject similarity was found for all the control subjects.

There are various ways to measure these responses. A common measure of response magnitude, called amplitude here, is the root mean square (RMS) calculated over some time interval (see note 1). The RMS has the advantage that it does not depend on the identification of a particular aspect of the response waveform but merely requires the specification of a time interval. The choice of the interval is not particularly critical for the purposes of this study. We used the interval from 45 msec, where the mVEP is first obvious, to 120 msec, a time after the major positive peak occurs in control subjects. The relative size of the responses from the two eyes was obtained as the ratio of the RMS value from the right to that from the left eye. On average, responses from the two eyes were about the same amplitude; the mean for all 60 RMS ratios was 1.05 (SD = 0.16). The log of the OD/OS RMS ratio was used as the measure of relative response at each field location for both the controls and patients. This log scale has the advantage of being symmetrical around a mean of 0. That is, if the responses from the two eyes are of the same amplitude, then the log ratio is 0; and if one eye has twice the amplitude of the other, then the log ratio is either 0.3 or −0.3 depending on which eye has the larger response. The log scale has the further advantage of being comparable to the log scale (in decibels) of the Humphrey field.

Nasotemporal Retinal Differences

There is a small but consistent difference between eyes that can be seen in all subjects. Notice in Figures 2C and 2D that the responses along the midline from the left eye (red) tend to lead the responses from the right (blue) eye in the left visual field and follow them in the right visual field. This timing difference was quantified by shifting the grouped responses on a time axis to bring them into register with each other. This required a mean shift of 4.8 msec (SD = 1.0 msec) for the six control subjects. These differences in timing do impose a practical limitation. They preclude a comparison of the two eyes via subtraction of the mVEP responses. Subtracting the responses of one normal eye from the other produces surprisingly large differences for the more peripheral midline locations due to these small latency differences. The basis of these differences in latency will be considered in the Discussion section.

Detecting Abnormal mVEP Responses

The grouped mVEP responses from the four patients are shown in Figures 2E through 2H. All 60 pairs of responses for patient P3 are shown in Figure 3B. These patients were chosen because their visual fields indicated that the damage to one eye was considerably greater than to the other eye. Figure 4 shows the total deviation plots from the Humphrey 24-2 fields for both eyes of the patients. Virtually all points in the field of the more affected eye showed a greater loss in sensitivity than the other eye. As will be seen below there is a minor, but interesting, exception in the case of P4.

There are clear differences between the mVEP responses from the two eyes of all four patients. To provide a quantification of these differences, the ratio of the amplitude (RMS) for each pair of responses was determined, as described above for the controls. The asterisks shown in Figures 2E through 2H next to some records indicate that this ratio fell more than 2 SD from the mean of the controls. The color of the asterisk denotes which eye gave the significantly larger response. P1 with ischemic optic neuropathy showed significantly larger responses in his right, unaffected, eye (blue) in 12 of the 16 pairs of responses, and P2 with optic neuritis showed significantly larger responses in his left, less affected, eye in 14 of the 16
response pairs. In fact, there are only two cases in which the relatively unaffected eye had a significantly larger response. In the case of P4, the mVEP is probably identifying a real difference. We will see below that the pair of responses with the red asterisk is in the region of her field in which her relatively more affected left eye was actually more sensitive than her right eye.

**Probability Plots for the mVEP**

The right-most column of Figure 5 presents the mVEP results for all 60 pairs of responses for each of the patients. Each square locates the center of one of the 60 sectors of the stimulus display. The black squares indicate that the response ratio was within 2 SD of the control values. The colored squares indicate that the response ratio was more than 2 SD (lighter desaturated color) or 3 SD (darker saturated color) from the mean of the controls. The color denotes whether the right (blue) or left (red) eye had the larger response. The results are similar to those for the grouped data. The ratios more than 2 SD from the controls are nearly always associated with the more affected eye as identified by the 24-2 fields. As will be seen below, the red squares in the mVEP of P4 in Figure 5H are not false positives. In the case of P3, the two red squares may be false positives, although the central one replicated when this patient was tested 6 months later.

**A Qualitative Comparison between mVEP and Visual Fields**

Although the mVEP probability plots in Figure 5 can be compared with the Humphrey probability plots in Figure 4, the Humphrey field data also can be represented as interocular difference fields so as to make the comparison to the mVEP easier. The left-most column of Figure 5 shows probability plots for the difference between the Humphrey visual fields from the two eyes. Figure 6 illustrates how these were obtained. Figures 6A and 6B show the deviation values for P1’s left and right eyes. These values underlie the plots in Figure 4. They are part of the standard printout of the Humphrey visual field report and represent the difference in decibels between the patient’s threshold values at each test location and the age-corrected normal values for that location. Figure 6C is simply the difference between these numbers. These numbers represent how much worse relative to normal is the left eye, compared with the right eye. To obtain the interocular probability plots for the Humphrey 24-2 visual fields in Figure 5

![Image of mVEP responses](image-url)
The points were coded assuming that the SD is 2.8 dB. The SD will not be the same at every location, but 2.8 dB is a reasonable estimate (see note 2). For the three patients with largely unilateral damage (P1, P2, P3), these plots should resemble the deviation plots in Figure 4 for the more affected eye. In fact, fewer points show up as significantly different largely because the better eye in the patient had points slightly (i.e., 1–3 dB) less sensitive than the control values (e.g., see Fig. 6B).

Now a direct comparison between the visual field data and the mVEP can be made. It is clear, for example, that P2 (Figs. 5C, 5D) shows abnormal mVEP responses far beyond the region of the visual field that appear abnormal on the Humphrey. The mVEP is reduced in amplitude and/or delayed in implicit time in regions of the field where both eyes have normal visual field sensitivity. The results for P4 are interesting as well. There is a small region in both visual and mVEP fields in which the left (red) eye is superior. The presence of this region was confirmed with our modified Humphrey field where it appears as a horizontal white region in Figure 7. For the other two patients, it is fair to say that there are regions in which the two fields agree and regions in which they appear to differ. The relationship of the mVEP probability plot to the Humphrey plots will be considered in the Discussion section.

**DISCUSSION**

Previous work suggested that visual field defects caused by ganglion cell or optic nerve damage can be visualized in the mVEP records. However, individual variations are sufficiently great that Baseler et al. concluded that the mVEP technique would not be useful for clinical field testing. Our results confirm that it would be difficult to detect subtle, or presumably early, damage by comparing monocular mVEP responses of patients to those of a control group. In fact, at some locations, relatively extreme damage may be impossible to detect reliably. Consider the red records in Figure 3B, which are from the more affected eye of P3. The responses at many of the locations fall well within the range of the normals shown in Figure 3A. It has recently been suggested that this problem can be circumvented to some extent by using multiple recording electrodes. Here we take a different approach and ask if an interocular comparison of the mVEP can circumvent the variability inherent in intersubject comparisons.

One purpose of the present study was to determine the extent to which mVEP responses obtained from two eyes of subjects with normal vision agree. The results showed that the pairs of responses tend to be very similar; the interocular comparisons were far more similar than any intersubject comparisons. It is important in interpreting these results to keep in mind that any given pair of responses reflects cortical activity from essentially the same cortical region, but that the two responses originate from different parts of the retinas of the two eyes. Recall that any point in the visual field falls on the temporal retina of one eye but on the nasal retina of the other. Yet, despite coming from different retinal locations and traveling via different pathways (crossed versus uncrossed), the mVEP responses are essentially identical in control subjects. We did find small differences in latency across the midline of these responses. These latency differences were in the range of approximately 5 msec and probably reflect a small difference in the time it takes signals to arrive at V1 from the nasal as opposed to the temporal retina. Most likely, this small difference is due to the conduction time of the unmyelinated ganglion cell axons on the retinal surface. The action potentials from the ganglion cells in the temporal retina travel farther to the optic disc than do the action potentials from corresponding points on the nasal retina (see review in Ref. 18). Whatever the source of these differences, they are small and do not affect the usefulness of the interocular comparison.

Our second purpose was to explore a method for quantifying the differences between the two eyes. The RMS ratio measure appears to work well. Here the RMS value in an interval from 45 to 120 msec was taken as our response measure. This interval allows for detection of delays in the responses as well. For example, in Figure 2F, the responses in the upper left field for P2 are outside 2 SD because the re-
sponse from the affected eye is delayed, causing it to fall partially beyond the 45 to 120 msec window. It is likely that, in at least some cases, a different time interval or different measure may better discriminate between affected and less affected or nonaffected regions of the two eyes. However, it is clear that the mVEP responses from the two eyes can be quantitatively compared. Furthermore, this quantitative measure correctly identifies the more affected eye, as defined by the Humphrey visual field results.

Comparison of mVEP Fields to Visual Fields

Our third purpose was to present the mVEP in a form that allows comparisons to visual fields. The probability plots in Figure 5 allow a comparison to the probability plots of Figure 4. An interocular 24-2 probability plot was devised to make the plots more directly comparable. In general, the agreement between the mVEP and visual field plots is good. However, there are places where the visual field shows a difference between the two eyes, but the mVEP does not, and other places where the reverse is the case. To understand these discrepancies, it is necessary to keep in mind the problems and assumptions involved in comparing mVEP and visual field measures. Below we consider four reasons why such discrepancies might exist.

First, each measure has its own sources of variability, and the test giving the more reliable results may depend on the subject. In the case of visual field measures, results for some subjects may have a low reliability due to excessive fixation losses, false-negative error rates, and/or false-positive error rates. On the other hand, it may be more difficult to detect differences in the mVEP in some subjects than in others due to muscle artifacts, alpha waves, and cortical anatomy.

Second, local discrepancies between mVEP and visual fields may exist because the data from some field locations may be less reliable than data from other locations. The peripheral locations of the Humphrey visual field are occasionally unreliable due to occlusion by anatomic facial features or due to the difficulty some patients have in judging the presence or absence of peripheral lights. Some locations give less reliable mVEP responses because of the orientation of their primary visual area in the cortex. These areas include the upper field, central fovea, and midline. Notice in Figure 5 that P1, P3, and P4 all have locations in the upper field that are significantly different in the visual field plot but not the mVEP plot. This is in part attributable to the smaller and more variable mVEP responses from the upper field (see Fig. 3A).

A third possible explanation for the discrepancies between mVEP and visual field probability plots is that the mVEP may detect pathologic changes where none are apparent in the visual field. The Humphrey visual fields can be within the normal range even when the ganglion cells show substantial damage.19 The mVEP from the patient with optic neuritis illustrates this point well.

Finally, the discrepancies may be due to the underlying assumptions made to compare visual fields to mVEP responses. We assume that the threshold measured with the 24' Humphrey test spot is a good proxy for the sensitivity of the immediate region. If half the ganglion cells are missing in that region, then it should follow that the mVEP will be smaller, perhaps by one half. However, it is less clear how this will affect visual field sensitivity. In the extreme, if the damage is

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**Figure 6.** An illustration of how the interocular difference fields (24-2 Humphrey) in Figure 5 were derived. (A) The 24-2 total deviation field for the left eye of P1. (B) The 24-2 total deviation field for the right eye of P1. (C) The difference between the numbers in (A) and (B). This difference is color-coded to produce the 24-2 fields in Figure 5 using the following rule. If one eye is more than 8.4 dB (3 SD) less sensitive, then it is denoted by a dark saturated color. Likewise, the light desaturated colors indicate a difference of more than 5.6 dB. Red indicates that the left eye is less sensitive; blue indicates that the right eye is less sensitive.

**Figure 7.** A modified Humphrey field obtained with 103, 40' test spots positioned in the centers of the hexagons used for the multifocal ERG.20 The numbers represent sensitivity loss in decibels relative to a group of controls. The white regions are within 2 SD of values for the controls, and the black regions are greater than 4 SD from the control values.
uneven with islands of either good or bad sensitivity, then, depending on where the 24′ test spot falls, the visual field sensitivity could be either better or worse than indicated by the mVEP. The results from P4 illustrate this point. Here the mVEP suggests that her more affected eye (OS) has a region of good vision (the red region in Fig. 5H) that is not apparent in her 24-2 field of Figure 4D. Figure 7 shows a Humphrey visual field for her left eye obtained with 103 test locations.20 The field has an island of near normal sensitivity (white area) surrounded by a large region of depressed sensitivity (black region). The agreement with the mVEP probability plot is quite good.

In summary, the interocular analysis of the mVEP suggested here allows for an objective and quantitative identification of monocular field defects. Because the analysis depends on a comparison of the mVEP responses from corresponding points in the visual field, it cannot detect abnormalities that would affect these points equally. In particular, damage to corresponding points in the nasal retina (or optic nerve) of one eye and the temporal retina (or optic nerve) of the other, as well as damage to the optic tract beyond the optic chiasm, would go undetected. However, this leaves a wide range of possible clinical and basic science applications. For clinical purposes, the recording sessions used here are probably too long. The records in this study were obtained with 30 minutes of recording. But for clinical testing and screening, it should be possible to substantially reduce the recording time. Whether the mVEP technique will prove more useful in some cases than other traditional tests such as the visual field remains to be determined. The results here are encouraging enough to warrant using this technique on patients who show little or no visual field loss.

Authors’ Notes

1. The amplitude (magnitude) for each eye is calculated as

\[
RMS_{OE} = \left[ \frac{1}{N} \sum_{t=45}^{120} (r_t - u_{45-120})^2 \right]^{0.5}
\]

where \( r_t \) is the response amplitude at time \( t \), \( u_{45-120} \) is the average of the amplitudes from 45 to 120 msec, and \( N \) is the number of samples in the time period.

The ratio of the RMS values of the right eye to the left eye was calculated as

\[
\text{ratio}(OD/OS) = \frac{RMS_{OE}}{RMS_{OS}}
\]

2. The estimate of 2.8 dB was obtained by analyzing unpublished data from 100 subjects supplied by Dr. Chris Johnson and published data from Johnson and Spry.21 Each subject had 24-2 fields obtained from both eyes at the same visit to the Eye Clinic at the University of California, Davis. A difference field was obtained as in Fig. 6C and standard deviations were obtained at each point. Excluding the points around the blind spot, the median SD was 2.8 dB with a range of 2.3 to 4 dB. These values are only marginally higher than those from interocular comparisons of corresponding retinal points: Brenton et al.22 reported a median standard deviation of approximately 2.1 dB for the interretinal comparison. Given the nature of the field defects, standard deviations anywhere within the range of 2 to 4 dB should have only minor effects on the probability plots of Figure 5.

References