Visual field analyser and threshold

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The Visual Field Analyser was introduced by Friedmann (1966), and further details of the instrument were published by Bedwell (1967).

The Analyser operates on the principle of multiple stimulus presentation. Two, three, or four stimuli of equal standard luminance, are presented simultaneously, the standard luminance being different for different age groups. Stimulus size and stimulus luminance have been selected so that normal subjects of a given age group should see all stimuli presented. This assumes that the given standard stimulus size and luminance is situated approximately at threshold level. Visual field investigation is, by definition, the investigation of the topography of the light sensitivity of the eye: that is, the investigation of the differential threshold. The purpose of this investigation was to study the distance between the standard stimulus of the Visual Field Analyser and the threshold.

It is not necessary to carry out the investigation at a standard luminance. As is commonly done in static perimetry, the luminance may be increased from the infraliminal level until the stimuli are observed. This poses the question whether the simultaneously presented stimuli reach the threshold simultaneously, that is at the same luminance or not. It may be concluded from what is known about the inter-individual differences of the form of the gradients of sensitivity in static perimetry\(^1\) that a simultaneous approach to the threshold is not possible (Harms, 1953; Aulhorn and Harms, 1967; Fankhauser and Schmidt, 1963; Verriest and Israel, 1965; Greve and Wijans, 1971).

Method

21 males between the ages of 20 and 30 years were investigated with the Visual Field Analyser, according to the method described previously by Greve (1970). One difference between this method and that described in the Visual Field Analyser instruction book is that a stimulus initially not seen is presented twice more. The stimulus is considered to have been missed if the subject observes it only once out of the three presentations. The stimulus is then presented at a higher luminance. This method prevents false positive results.

All subjects investigated had normal eyes, normal visual acuity, and no history of ocular disease. The investigation commenced from the infraliminal level which was at filter dial 2.8 on our instrument. As soon as the subject saw one or more stimuli, but fewer than the total number presented, he was asked to indicate where these were situated. Stimuli not observed were repeated as described above. In this manner a threshold luminance, expressed as filter dial position, was determined for each of the 46 stimuli.

The positions of the stimuli of the Visual Field Analyser are shown in Fig. 1, and the groups of stimuli presented in Fig. 2.

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\(^1\) In static perimetry the differential light-sensitivity is usually investigated on several locations along one meridian. The results are presented graphically as a curve that indicates the variation of log luminance (threshold-luminance) with retinal location. Such curves show the gradient of sensitivity, i.e. the variation of sensitivity with retinal location.
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**FIG. 1** Composite chart of the Visual Field Analyser

**FIG. 2** Fifteen positions, A to P, on the Visual Field Analyser
The light-source of the Visual Field Analyser is a Xenon tube. It is difficult to measure the luminance of these short flashes and to express it in customary luminance units. Bedwell (1967) described approximate values for both luminance and duration of flash. The luminance of the flash is reduced by means of Kodak Wratten neutral density filters in logarithmic steps. Each density step reduces the luminance by 0-2 l.u. (logarithmic units). The filter dial positions indicate the number of l.u. by which the original flash luminance has been reduced. A filter dial position of 2.0, for example, indicates that the stimulus luminance has been reduced by 2 l.u., which means that only 1 per cent. of the original luminance comes through. A high filter dial position means a low luminance and a low filter dial position a high luminance.

To avoid the problems of measuring flash tubes we have not indicated the stimulus luminance but instead the filter dial position, which seems to be the most easily understood for practical purposes.

Results

Fig. 3 shows the results for 26 of the 46 stimuli, for four subjects. The location is indicated along the abscissa, and the eccentricity increases from left to right. The filter dial positions are indicated along the ordinate. A straight line indicates simultaneous perception of all stimuli at one filter dial position.

Table I shows the results obtained from the 21 subjects for 26 stimuli of the Visual Field Analyser. The left-hand column shows the lowest luminance (highest filter dial position) at which subjects could still see one or more stimuli. The right hand column shows the number of subjects who saw these stimuli at the corresponding luminance. Only three subjects observed some stimuli at filter position 2.6; fourteen could observe some stimuli at 2.4, and four needed a filter position of 2.2 to observe some stimuli.

Table II shows that many stimuli were observed at different threshold luminances. The left-hand column shows the greatest differences in threshold-luminance found for each subject (intra-individual difference) expressed in log. units. The right-hand column gives the number of subjects who showed the difference in threshold luminance indicated.
Table I

<table>
<thead>
<tr>
<th>Highest filter dial position</th>
<th>No. of subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>2·6</td>
<td>3</td>
</tr>
<tr>
<td>2·4</td>
<td>14</td>
</tr>
<tr>
<td>2·2</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
</tr>
</tbody>
</table>

Table II

<table>
<thead>
<tr>
<th>Greatest difference</th>
<th>No. of subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>0·6</td>
<td>3</td>
</tr>
<tr>
<td>0·4</td>
<td>6</td>
</tr>
<tr>
<td>0·2</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
</tr>
</tbody>
</table>

in the left column. Three showed a difference of 0·6 l.u., which was present for only one stimulus in each subject. A difference of 0·4 l.u. was found in six subjects for several stimuli. In half of the subjects a difference of 0·2 l.u. existed.

Discussion

It appears that the standard luminance for subjects up to 40 years of age, that is the filter dial position 2·0 as recommended by Friedmann (1966) and Bedwell (1967), is 0·4 l.u. removed from threshold luminance for fourteen normal subjects. Consequently, it is possible to fail to detect a defect of 0·4 l.u. when using this standard luminance. An example of a 0·4 l.u. defect is given in Fig. 4, which was also investated kinetically with the Goldmann perimeter. This was not a small defect, as the patient had a pituitary tumour.

The difference between the recommended filter dial position and the individual optimum filter dial position can even be greater for the older age groups.

![Fig. 4](http://bjo.bmj.com/)

**Fig. 4** Example of a patient with a 0·4 l.u. defect due to a pituitary tumour
One should not forget in interpreting the results that, when all subjects are investigated from the infraliminal level, as is our practice, differences of 0·4 l.u., that is two filter dial steps, may be found even in normal subjects.

This difference may be due to the appreciable individual differences in the gradient of sensitivity, to the interaction of several of the stimuli of a simultaneously presented group, or to an incorrect choice of stimulus size and technical imperfections of the size of the different stimuli.

Apart from the loss of intensity of the stimuli, their position is, of course, of importance in interpretation.

We measured the sizes of the different stimuli and found that there are differences between stimuli that ought to have the same diameter. However, these differences are too small to explain the differences that we found in the threshold values.

While the multiple stimulus investigation was carried out, we also investigated the same subjects using a similar single stimulus method.

The differences between the threshold values for the single stimulus method were equal to those for the multiple stimulus method, so that the interaction of stimuli cannot account for the differences.

The cause is more likely to lie in individual departures from the average pattern of gradient of sensitivity which has been investigated by Greve and Wijnans (1971).

Conclusion

The purpose of this paper is to give a warning, not against the use of the Visual Field Analyser, but against its incorrect and thoughtless use.

We disapprove of the use of a fixed filter dial position except in mass investigations. It is preferable to start the investigation from the infraliminal level.

When interpreting the results one should take into account normal mutual differences of 0·4 l.u. and sometimes even 0·6 l.u. With these provisos the Visual Field Analyser will be found to be a useful instrument for rapid visual field investigation.

Summary

A warning is given against the incorrect use of the Visual Field Analyser. The recommended filter dial positions and the differences in threshold luminance between the various stimuli are discussed.

References

FANKHAUSER, F., and SCHMIDT, T. (1960) Ophthalmologica (Basel), 139, 409
FRIEDMANN, A. I. (1966) Ibid., 152, 1