Variation in latency times of visually evoked cortical potentials

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SUMMARY Latency times of visually evoked cortical potentials stimulated by reversal of a slow checkerboard pattern are highly dependent on the time needed to accomplish the reversal movement. If, owing to the method, the pattern reversal time is not kept stable, variability of the latency times is unnecessarily high for clinical purposes. This may be the case when television equipment is used.

Halliday et al. (1972, 1973) showed that measurement of latency times of the visually evoked cortical potentials (VECPs), elicited by the reversal of a slow checkerboard pattern, is a very sensitive method of detecting disease in the visual pathways, especially in cases of optic neuritis and multiple sclerosis. Later Asselman et al. (1975) confirmed these findings. With this method of measuring latency times problems may occur, one of which is caused by the method used. We fell into this trap and by publishing our experience hope to help others avoid it.

Television systems are increasingly used to produce pattern stimuli, since they are more versatile in respect of size of check pattern, modulation depth, and mean luminance than other methods (Arden and Faulkner, 1977). Applying a TV system to determine latency times as Halliday did to diagnose multiple sclerosis, we found that the spreading of the normal range was much greater than his data showed. Consequently, we compared the latency times obtained by our TV system with those obtained by Halliday’s methods.

In experiments with the TV system, the pattern had a check size of 20°, 40°, or 80°, a modulation depth of 98%, a mean luminance of 180 asb, and a field size of approximately 26°. Since no differences in the standard errors were found between the 3 check sizes used, only those obtained with the 40° check size are mentioned here.

The apparatus as used by Halliday is a projector with a checkerboard slide and a moving mirror in front of it (Cobb et al., 1967). Its check size was 1°, the modulation depth 80%, the mean luminance 400 or 40 asb, and the field size 28°. In both groups of experiments the reversal frequency was 2 Hz (periodicity 1 Hz), the band width of the amplifiers was 0.16 to 75 Hz, and 125 counts were averaged with an analysis time of 500 ms. The electrical potentials were led off from surface electroencephalograph electrodes positioned at 5 and 15° above the inion in the midline referential to the earlobe, as well as bipolar from 5 to 25% (10 to 20% EEG-system). Twenty normal subjects were examined.

Results

An example of the recordings obtained with the 2 methods is shown in Fig. 1; amplitude and latency time were measured as indicated. In Table 1 the data of the 2 methods are compared. It appears that the amplitudes of the projector system are somewhat higher and the latency times somewhat longer than those of the TV system. These differences may be due to differences in check size and mean luminance. Much more impressive, however, is the large standard deviation (SD) in latency times obtained with the TV system, which is about twice as high as that of the projector system. Standard deviations of the amplitudes relative to the mean value are approximately the same.

A large standard deviation in latency time was also found when bipolar leads were applied instead of referential leads (Table 2). By decreasing the mean luminance the latency time itself is lengthened and the standard errors are not much influenced. On the amplitudes and their standard errors the mean luminance had not much influence either, both being larger in the referential leads than in the bipolar leads (Table 3).

Discussion

It is evident that the large differences in standard errors between the 2 methods cannot be explained
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Figure 1: Visually evoked cortical potentials after a slow checkerboard pattern reversal stimulation of 1 Hz, obtained with the TV system (upper curve) and with the projector system (lower curve).

Table 1: Latency times and amplitudes, obtained with a referential lead and in the projector method a mean luminance of 400 asb

<table>
<thead>
<tr>
<th></th>
<th>Projector</th>
<th>TV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latency</td>
<td>98.29 ms</td>
<td>94.27 ms</td>
</tr>
<tr>
<td></td>
<td>SE 8.63</td>
<td>SE 16.04</td>
</tr>
<tr>
<td>Amplitude</td>
<td>9.11 µV</td>
<td>6.9 µV</td>
</tr>
<tr>
<td></td>
<td>SE 4.08</td>
<td>SE 2.93</td>
</tr>
</tbody>
</table>

Table 2: Latency times obtained with the projector method at 2 different luminances from bipolar and referential leads

<table>
<thead>
<tr>
<th></th>
<th>400 asb</th>
<th>40 asb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bipolar</td>
<td>109.7 ms</td>
<td>116 ms</td>
</tr>
<tr>
<td></td>
<td>SE 19.45</td>
<td>SE 20.76</td>
</tr>
<tr>
<td>Referential</td>
<td>98.29 ms</td>
<td>110.93 ms</td>
</tr>
<tr>
<td></td>
<td>SE 8.63</td>
<td>SE 7.61</td>
</tr>
</tbody>
</table>

Table 3: Amplitudes obtained with the projector method at 2 different luminances from bipolar and referential leads

<table>
<thead>
<tr>
<th></th>
<th>400 asb</th>
<th>40 asb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bipolar</td>
<td>6.2 µV</td>
<td>5.62 µV</td>
</tr>
<tr>
<td></td>
<td>SE 2.85</td>
<td>SE 2.65</td>
</tr>
<tr>
<td>Referential</td>
<td>9.11 µV</td>
<td>8.10 µV</td>
</tr>
<tr>
<td></td>
<td>SE 4.08</td>
<td>SE 3.89</td>
</tr>
</tbody>
</table>
somewhat less than 10 ms, by which the difference in standard errors between the 2 systems is sufficiently explained.

The jitter in latency time, using a TV system can be improved, as mentioned above, by synchronising pattern reversal and frame, were it not that 50 Hz signals probably via the TV set seriously impaired the evoked potentials. Furthermore, if the fixation is not accurately and constantly in the middle of the screen, variations in latency times may also occur. This implies that TV systems like ours are less suitable for latency measurements than projector systems.

The influence of the mean luminance on the latency time itself needs attention if patients are examined with narrow or wide pupils. The relative difference of retinal illumination, being dependent on the pupil size \((\pi r^2)\), between a pupil of 2 and 8 mm amounts to more than 1 log unit.

References


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