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Interference of 50 Hz electrical cortical potentials evoked by TV systems

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SUMMARY Application of TV systems for generating patterned stimuli for the examination of the electrical cortical potentials has disadvantages caused by the frame frequency of 50 Hz of TV sets. Apart from a larger variability in latency times of the electrical potentials as compared to the results obtained by projector systems, a 50-Hz noise on the recordings mediated through the visual system may be seen. These disadvantages can be ameliorated by increasing the frame frequency of the TV set.

In a previous paper (van Lith *et al.*, 1978) some disadvantages of the application of television (TV) systems as a stimulus device for evoking electrical cortical potentials (EPs) were discussed. We paid attention mainly to the variability in latency times due to the frame frequency of the TV. Another disadvantage, namely, a 50 Hz interference in the recordings, was mentioned as being present only when the starting points of the visual stimuli were synchronised with frame of the TV screen. The cause of this 50 Hz noise was not discussed because we thought it originated in induction, but the cause of it has since turned out to be different.

Materials and methods

A TV stimulus device, similar except in inessential details to Arden's (Arden and Faulkner, 1977), was applied. Synchronisation of stimulus and frame caused a 50 Hz ripple, which particularly hampered the measurement of small potentials (Fig. 1). Tests to diminish this ripple were carried out with a blank TV screen, without a luminance or patterned stimulus. The field size of the TV screen was approximately 26°. Electrode positions were the same as in the previous paper. The band width of the amplifiers was 0·1 to 100 Hz, and 128 counts were averaged. The 50 Hz noise was investigated further (Figs. 2 and 3) with a band filter of 50 Hz. Experiments were carried out on persons whose recordings always showed much of this 50 Hz noise.

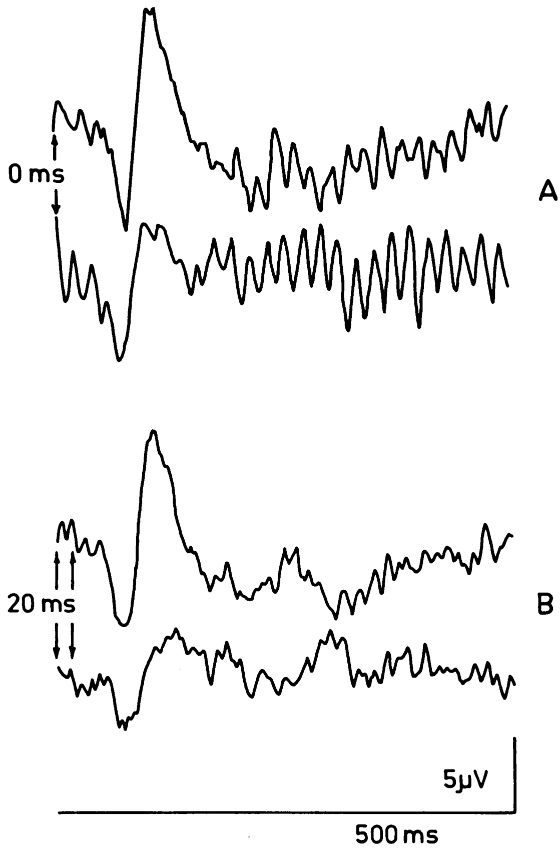

Fig. 1 *EPs to a 1-Hz pattern flash stimulus of 40 ms duration.* (A) *synchronisation between the frame frequency of the TV set and the pattern generator;* (B) *no synchronisation, i.e., the stimulus starts at random within 20 ms. The upper recordings of each pair are from bipolar leads over the occipital lobe, the lower ones are made in reference to the ear lobe*

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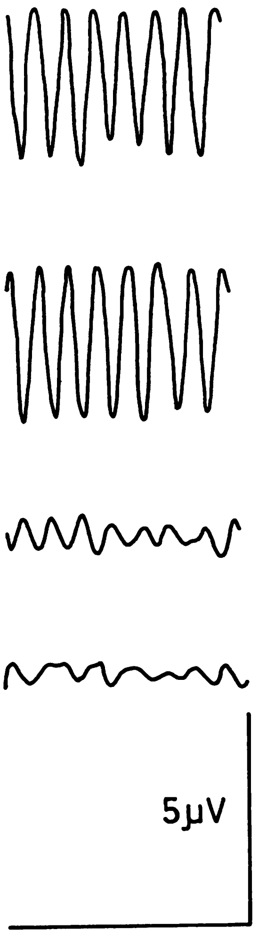

Fig. 2 *50-Hz potentials of approximately 4 µV, registered from the occipital lobe and provoked by a blank TV screen, synchronised with the averager.* (A) *unshielded;* (B) *electrically shielded;* (C) *visually shielded;* (D) *visually and electrically shielded*

Results

We did not succeed in diminishing the 50 Hz noise by shielding the subject electrically as carefully as possibly (Figs. 2A and B), nor had a 50 Hz notch filter much influence. However, if all the metal shielding was taken away and the eyes were simply closed or a black cloth was held before the screen, the 50 Hz potentials almost entirely vanished (Fig. 2C). Little further improvement was attained when the electrical shields were added. Apparently these potentials were responses mediated through the visual system and not artefacts caused by induction. Further evidence for this inference was obtained by varying the luminance of the screen, which clearly showed the luminance dependence in two subjects (Fig. 3). We called these 50 Hz potentials 'visual hum'.

Discussion

We believe the 2 factors responsible for the variable latency times (van Lith *et al.*, 1978) also cause the visual hum. These 2 factors were the sequential lighting up of the TV screen every 20 ms and the small EP visual field—that is, the part of the visual field from which the EPs are mediated.

The picture on a TV screen is built up by a light point which runs over the screen in 20 ms. When the light point is outside the EP visual field, the screen is dark for the electrode which records the evoked potential. When the light point runs inside the EP visual field, the screen lights up in relation to the electrode placed over the visual cortex. This implies that every 20 ms, that is, 50 times per second, the electrode over the cortex sees a light stimulus and registers an evoked potential, at least if the 50 Hz flicker is below the critical fusion frequency (CFF) of the visually evoked cortical potentials.

Data about the latter can be obtained from a

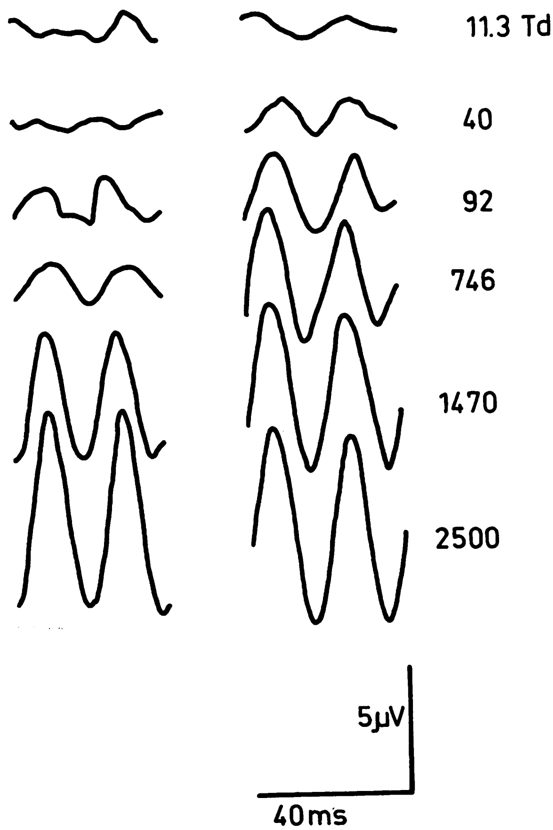

Fig. 3 *Dependence of the 50-Hz potentials ('visual hum') on retinal illumination*

paper by Kelly (1964), which states that the CFF of EPs is just below or over 50 Hz, the result being dependent on retinal illumination. This means that 50 Hz is a critical frequency, which it also appears to be from the results in our tests. Some of our patients transmit the 50 Hz to the registering electrode, others do not. Since it is caused by a characteristic of TV systems, visual hum will not be present when projector systems are used.

When using a TV system there are 2 ways to get rid of visual hum, namely, by lowering the mean luminance of the screen, though this will depress the height of the EPs too and will lengthen the latency time, and by increasing the frame frequency of the TV set. The latter solution will also decrease the variability in latency time.

References

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