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Effects of Ambient Lighting on Photosensitivity and Television Epilepsy

†C. D. Binnie, †R. A. de Korte, ††C. E. Darby, †P. van Egmond, ‡A. J. Wilkins, and †R. Veldhuizen

†Instituut voor Epilepsiebestrijding, Heemstede, The Netherlands; ††Runwell Hospital, Wickford, United Kingdom; ‡MRC Applied Psychology Unit, Cambridge, United Kingdom

It is widely accepted as good EEG practice to perform intermittent photic stimulation (IPS) in semi-darkness (5,7) and indeed, one might expect the effectiveness of IPS to be increased by diminished background illumination as the result of dark adaptation, pupillary dilatation, and enhanced contrast between flash and background. It is similarly assumed that in television epilepsy, the provocative effects of TV will be increased in darkness and reduced by bright lighting. It has therefore been recommended, for instance by Jeavons and Harding (6), that people with TV epilepsy should view only in a well-lit room. There seems to be no published experimental evidence concerning the effects of ambient lighting on TV sensitivity, and evidence concerning sensitivity to IPS is very limited, largely anecdotal, and contradictory (3,4,8,10).

STUDY I: MATERIAL AND METHODS

During a period of 3 months, testing for sensitivity to IPS was performed in all patients referred to our department for diagnostic EEG investigation under conditions of both normal lighting (typically about 3400 lux) and with the minimal illumination required for visibility of the EEG chart (approximately 20 lux in the patient area). Diffuse IPS was performed with a Grass PS 22 photic stimulator at a distance from the nasion of about 300 mm and an intensity of 100 nit-s/flash. A standard, effective procedure was employed, which we have reported elsewhere (2), both for detecting photosensitivity and for determining the range of flash frequencies. IPS was performed with eyes open and with eyes closed, and the order of testing lighting conditions was randomized. Patients were considered photosensitive only if a classical generalized photoconvulsive response (1) could be consistently elicited under at least one test condition. Other anomalous reactions to IPS, which some authors describe as photosensitivity, were excluded (9).

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Twenty-three photosensitive patients were studied. All had epilepsy: primary generalized in 8, secondary generalized in 6, and partial in 9. The mean age was 17.4 years, and 13 of the subjects were female.

RESULTS

The numbers of subjects who were sensitive under each of the 4 conditions are shown in Table 1. The conclusion that a patient was not sensitive under a particular condition was based on a negative response to at least 10 trials of IPS, at frequencies widely spaced over the range 6 to 55 flashes/s (2), including those to which the patient was sensitive under other conditions. There is no difference between lights ON and lights OFF; but pooling the data across these conditions, there is a significant positive association of photosensitivity with the eyes-closed state ($\chi^2 = 5.64$, $p < 0.02$). For all the subjects who were sensitive under each of the 4 test conditions, the median lower and upper limits of photosensitivity and the sensitivity range are also shown. There are no significant differences in photosensitivity ranges between eyes open and closed or lighting ON or OFF (by the Mann-Whitney μ test, z values 0.22 to 0.8).

Of more practical importance, perhaps, is the number of patients sensitive under only one-eye or lighting condition (Table 2). Although a conservative strategy for detecting photosensitivity is to perform IPS both with lights ON and OFF, it seems most important to ensure that the eyes-closed state is tested. There is no apparent advantage in the usual practice of testing only in darkness, and it will generally be more agreeable for the patient if the lights are left on.

STUDY II: MATERIAL AND METHODS

A further study was performed on the effect of background lighting on TV sensitivity. From 94 consecutive photosensitive patients, 16 were selected by the following criteria:

TABLE 1. *Numbers of subjects sensitive under each of four conditions*

	Lights on		Lights off	
	Eyes open	Eyes shut	Eyes open	Eyes shut
Sensitive	15	19	14	20
Insensitive	8	4	9	3
Photosensitivity, median values (flashes/sec) excluding negative results				
Lower limit	14	13	13	12
Upper limit	18	30	23	24
Range	3	11	10	18
[a]Condition for maximum range	4	11	4	7

[a]Ties entered in more than one cell.

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TABLE 2. *Patients sensitive under one-eye or one-lighting condition*

Lights	On only	1
	Off only	2
Eyes	Open only	1
	Shut only	5

(a) At least 1 epileptiform discharge/min during TV viewing under the most epileptogenic conditions

(b) Spontaneous epileptiform activity absent, morphologically different from that elicited by visual stimulation, or of very much lower incidence than during TV viewing

(c) Discharges self-limiting, without increase in incidence or duration with repeated stimulation

(d) The patients had been referred for investigation of TV epilepsy or had given informed consent to the research.

The diagnoses were as follows: primary generalized epilepsy, 6; secondary generalized epilepsy, 4; partial epilepsy, 2; and epilepsy of uncertain classification, 4. Ten patients were female, and the mean age was 15.3 years.

The patients viewed a 620 mm black-and-white television from an initial distance of 2 m, which was progressively decreased until epileptiform EEG activity consistently occurred or a viewing distance of approximately 300 mm (close to the near point of vision) was reached. If the discharges were of more than 1 sec duration, exposure was limited to repeated periods of up to 10 sec and terminated whenever a discharge occurred. The epileptiform activity was quantified, depending upon its nature, in individual patients as either the percent time, discharges/minute of continuous viewing, or the probability of discharge within a 10 sec exposure. The procedure was carried out with room lighting both ON and OFF; once a combination of distance and lighting was found that consistently elicited epileptiform activity, both lighting conditions were tested at least twice. Eight subjects were tested viewing a static image of an "old master" painting, and the remainder playing a television game. In both cases, the presentation was of constant brightness with a mean intensity of 2,800 nits and the range of 1,500 to 7,000 nits.

RESULTS

The results are summarized in Table 3. In two subjects, it was possible to obtain estimates of discharge incidence at distances both greater and less than 1 m. All patients tested at a viewing distance of 1 m or less showed more epileptiform activity in the lights ON condition, and in this subgroup the higher incidence of activity with the room lighting ON is significant ($p < 0.001$ by the sign test). Sensitivity at a distance $>$ 1 m was confined to subjects sensitive to IPS at 50 Hz

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TABLE 3. *Epileptiform activity: study on effect of background lighting on TV sensitivity*

Patient	Photosensitivity range (flashes/sec)	Test distance (cm) ⊣ 1 m	Test distance (cm) ⊢ 1 m	Lighting condition associated with greater TV sensitivity
50 Hz IPS-sensitive				
1	7–50	(60	105	OFF
				ON
2	8–57	(60	200	OFF
				ON
3	4–60		300	OFF
4	14–55		200	OFF
5	11–60	50		ON
6	8–56	100		ON
7	10–55	300		ON
Not 50 Hz IPS-sensitive				
8	8–47	65		ON
9	13–40	80		ON
10	8–45	100		ON
11	9–40	75		ON
12	6–25	40		ON
13	6–44	30		ON
14	7–48	50		ON
15	6–43	100		ON
16	10–33	80		ON

and in 4 cases out of 5 was greater with the lights OUT. The associations of distance with 50 Hz IPS sensitivity and with the effects of lighting conditions are also significant ($p < 0.005$ by Fisher's exact probability test).

SUMMARY

It is widely assumed that sensitivity to environmental visual stimuli of people with photogenic epilepsy should be reduced by bright ambient lighting. Persons with TV epilepsy are therefore advised to view only in a well-lit room, and in routine clinical EEG, intermittent photic stimulation (IPS) is performed in darkness.

Sensitivity to IPS was tested in 23 consecutive photosensitive epileptic subjects under normal and reduced lighting. Darkening the room to 20 lux increased neither the incidence of photosensitivity nor the range of flash frequencies that was effective. In a further series of 16 patients showing consistent EEG sensitivity to television stimulation, the effects of bright (3,400 lux) and dim (20 lux) lighting were studied. In 14 patients testable at not more than 1 m viewing distance, TV induced less epileptiform activity under reduced lighting. Of 5 consistently TV sensitive at a distance greater than 1 m, 4 exhibited more epileptiform activity in darkness.

The findings cast doubt on current practice in performing IPS and on the advice generally given to people with TV epilepsy. They also support our previous studies, which suggest that different mechanisms underly TV sensitivity at great and small viewing distances.

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CONCLUSIONS

It may be possible to identify some patients with TV epilepsy who are sensitive to 50 Hz IPS and in whom sensitivity is consistently reduced by bright ambient lighting. However, it is clear that, in general, the advice that people who have TV epilepsy should view in a well-lit room is, at best, unsubstantiated, and is unsound in the case of those patients whose attacks occur only when they approach the TV. In 75% of our patients, TV sensitivity was not demonstrable at a viewing distance greater than 1 m (at which the diagonal subtense of the screen was 34 degrees). Thus, for the majority of people who have TV epilepsy, the most useful advice may be either to obtain a set with a screen so small that its subtense is less than this angle at the near point of vision, or to view from as far away as possible and to cover one eye when approaching the set, as suggested by Jeavons and Harding (7).

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