

*Short report*

## Photosensitive patients: symptoms and signs during intermittent photic stimulation and their relation to seizures in daily life

D G A KASTELEIJN-NOLST TRENITÉ, C D BINNIE,\* H MEINARDI

*From the Instituut voor Epilepsiebestrijding "Meer en Bosch" & "De Cruquishoeve" Heemstede, The Netherlands; and the \*Maudsley Hospital, London, UK*

**SUMMARY** Thirty six patients were studied with a classical photoparoxysmal EEG response to intermittent photic stimulation (IPS). Clinical observations and complaints reported by patients during standardised IPS were recorded and compared with historical data. Twenty seven patients experienced impaired consciousness or showed motor phenomena such as involuntary opening of the eyes or jerking on one or both sides of the body. Twenty five patients had sensations such as pain in the eyes, jerking etc. There existed no relation between the duration of the evoked discharges (0.5-3 seconds) and observed signs or complaints. In 11 instances the clinical features found during IPS were not reported in a history taken from the patient and relatives.

Some 5% of all persons with epilepsy show a classical photoparoxysmal response in the EEG on conventional intermittent photic stimulation (IPS) using a stroboscope.<sup>1,2</sup> Thirty to seventy per cent of these patients report visually induced seizures in daily life.<sup>1-3</sup>

IPS can induce seizures, usually tonic-clonic, myoclonus or absences. Several investigators have reported that the photoparoxysmal response often occurs without any accompanying clinical reaction.<sup>1,4,5</sup> There is, however, considerable variation in definitions of the response<sup>6-8</sup> and in techniques of IPS.<sup>3,9,10</sup> Another point of difference is undoubtedly quality of clinical observation during IPS. The EEG technician is occupied in operating the stroboscope, monitoring the EEG response and instructing the patient, and cannot carry out close clinical observation.

In the case of spontaneous epileptiform EEG dis-

charges it is generally accepted that there is a relation between the duration of the discharge and the occurrence of observable clinical features. If generalised spike-wave discharges last less than 3 seconds, they often pass unnoticed by the patient and the observer.<sup>11,12</sup> However, it is not known whether photically-induced epileptiform activity differs in this respect from spontaneous discharges.

In a previous study of 38 photosensitive patients we found that 39% reported various forms of ocular discomfort (sore eyes, headache, etc.) induced by potentially epileptogenic stimuli, such as disco lighting and the sun shining through trees or on water.<sup>13</sup> It is unknown whether subjective complaints during IPS<sup>1,4</sup> have any relation to clinical features during IPS or to visually-induced seizures in daily life. We have therefore prospectively examined an unselected group of photosensitive patients, with particular attention to subjective and objective clinical events during IPS.

### Patients and methods

Patients were studied who showed at least once a classical generalised photoparoxysmal response which outlasted the

Address for reprint requests: D G A Kasteleijn-Nolst Trenité, PO Box 21, 2100 AA Heemstede, The Netherlands.

Received 25 November 1986 and in revised form 5 May 1987.  
Accepted 8 May 1987

**Photosensitive patients**

stimulus<sup>15 16</sup> during routine EEG investigation. In addition an age-matched control group of non-photosensitive patients with epilepsy was selected from routine referrals to our EEG department. After informed consent was obtained, they underwent, seated upright, a second EEG investigation with extensive IPS with a Grass PS-22 photic stimulator at a distance from the nasion of about 300 mm and an intensity of 100 nit-sec/flash. IPS was performed for 4–6 s at the frequencies 2, 6, 8, 10, 15, 18, 20, 25, 30, 40, 50, and 60 Hz under the three different conditions: starting at the moment of eye-closure, with eyes closed and with eyes open. As soon as a generalised epileptiform discharge appeared in the EEG, the stimulation was terminated.

An investigator (DGA K-NT) was always present in the same room during stimulation, seated in front of the patient at a distance of about 2 m to detect any clinical events without seeing the EEG recording. All patients were given instructions to report any sensations they might have. The control patients were questioned by the investigator about their feelings during IPS after the recording had finished.

Thirty six photosensitive patients (19 female, 17 male) were studied (mean age 18 yr, range 4–41). The majority (81%) suffered from generalised epilepsy (primary 53%, secondary 28%), a minority from partial epilepsy (17%). In one patient the classification was uncertain. The different seizure types,<sup>17</sup> are shown in table 1.

Thirteen patients were not receiving medication at the time of examination, nine were on valproate monotherapy (600–1200 mg) and five took valproate in combination with carbamazepine, ethosuximide, phenytoin, phenobarbitone or flunarizine; eight patients were on mono- or poly-therapy without valproate.

The control group of 24 non-photosensitive patients consisted of 16 females and eight males (mean age 22 yr, range 9–63).

**Results**

Twenty six patients showed a classical photoparoxysmal response in all three eye-conditions, the other 10 in at least one condition. In the figure the sensitivity range for all patients is given; there were no differences between eye conditions.

Eight patients (22%) evoked generalised epileptiform discharges by slow voluntary eye-closure (self-induction).<sup>18 19</sup> In 27 patients (75%) ictal clinical phenomena were seen. In 32 out of 36 patients (89%) EEG discharges of at most 3 seconds duration were elicited: clinical features were observed in 24 of these patients (72%). If the EEG discharge exceeded 3 seconds, it was always accompanied by clinical features. Even very short discharges lasting from 0.5 to 1.5 seconds, however, were usually also accompanied by clinical features (71%).

In table 2 a summary is given of the different signs and symptoms during IPS in relation to the maximum duration of evoked EEG discharges per patient. No distinction is made between signs and symptoms seen during IPS in the different eye-conditions and during the different frequencies of stimulation. Sixteen out of

**Table 1** Frequency of the different seizure types in 36 photosensitive patients

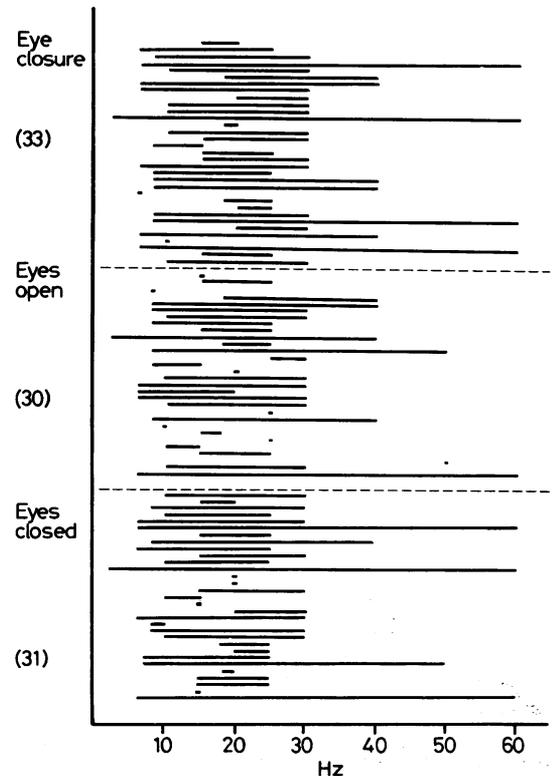
Seizures	(Over 2 yr seizure free)
Tonic-clonic	18 (8)
Absence. Complex partial (B.2.a)*	20 (4)
Myoclonic	18 (1)
Complex partial with automatisms and/or motor symptoms	4 (0)

\*According to the International Classification of Epileptic Seizures (1981).

36 patients (44%) thus showed one clinical phenomenon during IPS, 11 patients (31%) at least two.

In only one of the five patients with asymmetric jerks, did the EEG show an asymmetry (right occipital maximum); this patient had jerks in the right or the left arm or in both arms together. Twenty-five patients (69%) reported subjective symptoms during IPS.

In the control group only six patients (25%) had symptoms: dizziness (four), headache (one) or a queer feeling in the stomach (one). There were no complaints about pain in or near the eyes, even on specific questioning.



**Fig** Photosensitivity range of 36 patients in three different eye conditions.

Table 2 Frequency of different symptoms and (in parentheses) of different signs in relation to maximum duration of IPS evoked EEG discharges per patient

Sec. duration	0.5	1	1.5	2	2.5	3	Sub total	4	6	8	Total
Consciousness				(1)		(1)	0 (2)	(1)	1 (2)	(1)	1 (6)
Myoclonic jerks:											
Eye-lids		1 (3)	(2)	(5)	1 (2)	(1)	2 (13)	(1)	(1)	(1)	2 (16)
Body	(1)	1 (2)	1 (1)	1 (3)		(1)	3 (8)		1 (1)	(1)	4 (10)
Head	(1)		(1)	1 (1)		1	2 (3)			(1)	2 (4)
Shoulders			(1)				0 (1)			1	1 (1)
R arm			(1)	(1)			0 (2)		(1)		0 (3)
L arm			(1)	1 (1)	1 (1)		2 (3)				2 (3)
Arms (R + L)	1			(1)		(1)	1 (2)		(2)		1 (4)
Opening of eyes		(3)	(3)				0 (6)				0 (6)
Feelings:											
Pain/awkward feeling in eye	2	1	2	4	1	3	13		1		14
Dizziness	1			1	1	1	4				4
Queer feeling in stomach			1	1			2		1		3
Crying							0		1		1

Comparing the subjective symptoms and the objective observations, nine patients reported jerks which were in all cases visible to the observer. However, 20 patients (56%) did show clinical signs during IPS without being aware of them. Seven patients had neither signs nor symptoms. Only two out of 16 patients who showed myoclonus of the eyelids mentioned this to the investigator.

We also compared the data from the general history concerning seizures in daily life with the data of the observed clinical features during IPS. In 22 out of 36 patients (61%) the data were concordant. Of the other 14 patients, in whom the objective clinical features did not resemble their seizures in daily life, two experienced at least the same symptoms during IPS as during their habitual seizures.

## Discussion

In 75% of the 36 patients clinical symptoms were seen during IPS. Eighty-nine per cent of the IPS evoked discharges had a duration of 3 seconds or less. In the literature short-lasting discharges without readily observable ictal events are generally called sub-clinical<sup>11 20-22</sup> and spontaneous discharges of this duration most usually pass unnoticed by the patient or other people. Cognitive impairment during short discharges can, however, often be shown by sophisticated psychological testing.<sup>23</sup> The high incidence of symptoms and visible motor events during short EEG discharges evoked by IPS is therefore surprising. Myoclonic seizures are usually accompanied by multiple spikes in the EEG. The high incidence of jerking could therefore be attributed to the fact that especially poly-spikes were commonly evoked during IPS. Two patients showed predominantly generalised

poly-spikes, the other generalised spike-waves and poly-spike waves (in a minority the classical 3/Hz spike-waves). In our experience with IPS, depending on the frequency used, various wave forms could be evoked in one patient. Because of our method of investigation, we were therefore not able to establish a correlation between the presence of multiple spikes and the observed clinical features.

Gastaut<sup>24</sup> mentioned in 1951 asymmetrical bilateral jerking in the arms during IPS but to our knowledge no one has described jerking in one arm. In our study this was seen in five patients, all of them with generalised epileptiform discharges, only one of whom showed an asymmetrical onset or maximum of the discharges. These findings do not fit any of the physiopathological models developed following the first investigations on IPS by Grey Walter *et al* in 1946<sup>25</sup> or by others.<sup>7 26</sup> The findings are consistent with the idea of a "loose" relationship between brain function and surface EEG.<sup>27 28</sup>

Another aspect that is worth noting is that the duration of the evoked discharges did not have a predictive value concerning the type of clinical symptoms: jerks in the whole body were seen during generalised discharges of 0.5 seconds duration as well as of 8 seconds. The reduction of consciousness was the only variable clearly related to the length of discharges.

The spontaneous opening of the eyes during IPS in the eyes-closed or eye-closure condition without jerking of the eyelids seems to be another ictal phenomenon comparable to the opening of the eyes in absence seizures, even though this phenomenon was present during very short discharges (1 or 1.5 s duration), which is not the case in classical absence seizures.

*Photosensitive patients*

More than half of the patients had symptoms during IPS, the most common finding being pain in the eyes (39%). This is in accordance with our previous findings that approximately 40% of photosensitive patients have symptoms of ocular discomfort when subjected to epileptogenic visual stimuli in daily life.<sup>13</sup>

In the control group nobody complained about pain in the eyes, a surprising finding as IPS is commonly found to be disagreeable.

Only two photosensitive patients noticed the myoclonic jerking of their eyelids. The high prevalence of both eyelid jerking, and of pain in the eyes, suggests there may be a relation. Of the 14 patients with symptoms of pain in the eyes, nine showed also signs of eyelid jerking.

No patient complained of myoclonic jerking or loss of consciousness which was not also observed by the investigator. If photosensitive patients complain of myoclonic jerks it is thus worthwhile to investigate whether natural visual stimuli in their daily life (disco, television, sun shining through trees, etc.) are responsible. On the other hand, 11 patients (31%) showed clinical features, not mentioned by the patient or relatives. Overweg<sup>29</sup> found in his study of withdrawal of antiepileptic drugs in supposedly seizure-free adult patients that four out of the nine patients who nevertheless did show spontaneous seizures during the initial long-term EEG monitoring, were also photosensitive.

When withdrawal of antiepileptic medication is considered, account should be taken of the fact that photosensitive patients may have subtle seizures (especially myoclonic jerks) without being aware of them.

This work was made possible by the EEG technicians (especially R de Korte) and the cooperation and support of my colleagues. I thank W van Ernde Boas, R Naquet, J Overweg, JAP Van Parys, AJ Wilkins and J Willemse for their critical and stimulating comments and JA Oosting for his statistical advice. I am very grateful to Mrs J de Wit and to Mrs A Tesselaar for their help in making suitable appointments with the patients and in preparing the manuscript.

This work was supported by the Commissie Landelijk Epilepsie Onderzoek (CLEO).

**References**

- 1 Jeavons PM, Harding GFA. *Photosensitive Epilepsy*. London: Heinemann, 1975.
- 2 Klass DW, Fischer-Williams M. Sensory stimulation, sleep and sleep deprivation. In: Rémond A, ed. *Handbook of EEG, Vol. 1B*. Amsterdam: Elsevier 1976:5-73.
- 3 Engel J. Selective photoconvulsive responses to intermittent diffuse and patterned photic stimulation. *Electroencephalogr Clin Neurophysiol* 1974;37:283-92.
- 4 Herrlin KM. EEG with photic stimulation: a study of children with manifest or suspected epilepsy. *Electroencephalogr Clin Neurophysiol* 1954;6:573.
- 5 Newmark ME, Penry JK. *Photosensitivity and Epilepsy: a Review*.

New York: Raven Press, 1979:220.

- 6 Dooze H, Gerken H. On the genetics of EEG abnormalities in childhood. IV. Photoconvulsive reaction. *Neuropaediatric* 1973;4:162-71.
- 7 Wilkins AJ, Binnie CD, Darby CE. Visually-induced seizures. *Prog Neurobiol* 1980;15:85-117.
- 8 Mundy-Castle AC. The clinical significance of photic stimulation. *Electroencephalogr Clin Neurophysiol* 1953;5:187-202.
- 9 Brandt H, Brandt S, Vollmond K. EEG response to photic stimulation in 120 normal children. *Epilepsia* 1961;2:313.
- 10 Binnie CD, Wilkins AJ, De Korte RA. Interhemispheric differences in photosensitive epilepsy. II Intermittent photic stimulation. *Electroencephalogr Clin Neurophysiol* 1981;52:469-72.
- 11 Gibbs FA, Lennox WG, Gibbs EL. The electro-encephalogram in diagnosis and in localization of epileptic seizures. *Arch Neurol Psychiatr* 1936;36:1225-35.
- 12 Goode DJ, Penry JK, Dreifuss FE. Effects of paroxysmal spike-wave and continuous visual motor performance. *Epilepsia* 1970;11:241-54.
- 13 Kasteleijn-Nolst Trenité DGA, Binnie CD, De Korte RA, Overweg J, Peters ACB, Wilkins AJ. Correlative electrophysiological and clinical studies in photosensitive epilepsy. In: Betts TA, Hoepfner RJ, Petersen V, eds. *Br J Clin Pract. (Symp. Suppl.)* 18. London: Medical News Tribune Group, 1982:81-3.
- 14 Davidson S, Watson CW. Hereditary light-sensitive epilepsy. *Neurology* 1956;6:235.
- 15 Bickford RG, Sem-Jacobsen CW, White PT, Daly D. Some observations on the mechanism of photic and photometrazol activation. *Electroencephalogr Clin Neurophysiol* 1952;4:275-82.
- 16 Reilly EL, Peters JF. Relationship of some varieties of electroencephalographic photosensitivity to clinical convulsive disorders. *Neurology* 1973;23:1050-7.
- 17 Commission on Classification and Terminology of the International League Against Epilepsy: Proposal for revised clinical and electroencephalographic classification of epileptic seizures. *Epilepsia* 1981;22:489-501. (This classification was approved by the International League Against Epilepsy in September 1981.)
- 18 Radovici A, Misirlidou V, Gluckman M. Epilepsie réflexe provoquée par excitations optiques des rayons solaires. *Rev Neurol (Paris)* 1932;1:1305-8.
- 19 Binnie CD, Darby CE, De Korte RA, Wilkins AJ. Self-induction of epileptic seizures by eye closure: incidence and recognition. *J Neurol* 1980;43:386-9.
- 20 Kooi KA, Hovey HB. Alterations in mental function and paroxysmal cerebral activity. *Arch Neurol Psychiatry* 1957;78:264-71.
- 21 Tizard B, Margerison JH. The relationship between generalized paroxysmal EEG discharges and various test situations in two epileptic patients. *J Neurol Neurosurg Psychiatry* 1963;26:308-13.
- 22 Mirsky AF, Van Buren JM. On the nature of the "absence" in centrencephalic epilepsy: a study of some behavioural, electroencephalographic and autonomic factors. *Electroencephalogr Clin Neurophysiol* 1965;18:334-48.
- 23 Aarts JHP, Binnie CD, Smit AM, Wilkins AJ. Selective cognitive impairment during focal and generalized epileptiform EEG activity. *Brain* 1984;107:293-308.
- 24 Gastaut H. L'Epilepsie Photogénique. *Rev Prat (Paris)* 1951;1:105-9.
- 25 Grey Walter W, Dovey VJ, Shipton H. Analysis of the electrical response of the human cortex to photic stimulation. *Nature* 1946;158:540-1.
- 26 Naquet R, Fegersten L, Bert J. Seizure discharges localized to the posterior cerebral regions in man, provoked by intermittent photic stimulation. *Electroencephalogr Clin Neurophysiol* 1960;12:305-16.
- 27 Pampiglione G. The scope and limitation of clinical electroencephalography. *St. Mary's Hospital Gazette* 1953;59:1-5.
- 28 So EL, King DW, Murvin AJ. Misdiagnosis of complex absence seizures. *Arch Neurol* 1984;41:640-1.
- 29 Overweg J. *Withdrawal of antiepileptic drugs in seizure-free adult patients*. Thesis, 1985.