Original article

Epileptic Disord 2007; 9 (1): 57-64

Screen sensitivity in photosensitive children and adolescents: patient-dependant and stimulus-dependant factors

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Received December 6, 2005; Accepted November 8, 2006

ABSTRACT – Television viewing is the most frequent cause of photogenic attacks in daily life. In the present study, we examined 48 photosensitive children and adolescents to find out: 1) whether hypersynchronous activity is induced less often by viewing a PC monitor than a television screen and 2) whether certain images are more likely to cause hypersynchronous activity than others. All subjects were tested for sensitivity to intermittent photic stimulation (IPS) and to a black and white striped pattern on cards. Additionally, all were subjected to stimuli from four different images (vertical black and white striped pattern, geometric figures, text, and a painting by Max Pechstein – 1913, Italian church), presented on a television screen (with an image regeneration frequency of 50 Hz) and on PC screens (with regeneration frequencies of 48 and 100 Hz). A total of 21 non-photosensitive, healthy children and adolescents served as controls. Of the 48 photosensitive subjects 13% were also pattern sensitive (cards), and 33% exhibited screen sensitivity. No differences were found between the three monitor types. However, the hypersynchronous reactivity to the four images presented was significantly different, with high contrast vertical striped pattern being the most provocative. Non-photosensitive subjects did not react to any of the stimuli. The results of the present study show that screen-dependant factors are less important than image-dependant factors.

Key words: photosensitvity, screen sensitivity, epilepsy, pattern sensitivity, personal computer

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doi: 10.1684/epd.2007.0060

Epileptic activity induced by visual stimuli can be elicited at least by two different triggering mechanisms:

A) A stimulus from intermittent light flashes can trigger hypersynchronous activity on an electroencephalogram (EEG), which is termed a photoparoxysmal reaction (PPR). About 9% -25% of epilepsy patients are photosensitive (Doose, 1995, Wolf and

Gooses 1986). With a general incidence of 1.5/100,000 (Waltz *et al.* 1997, Quirk *et al.* 1995), girls are affected more frequently than boys, at a rate of 1.7:1 (Jeavons and Harding, 1975). The cause of photosensitivity seems to be multifactorial (Doose and Gerken, 1973, Doose and Waltz, 1993, Waltz *et al.* 1992), and is associated with altered function of the parvocellular neuronal systems in the brain.

B) Hypersynchronous activity induced by high-contrast patterns represents a further triggering mechanism in epileptic activity and seizures. Depending on the study group, pattern sensitivity rates of 51%-72% have been found among photosensitive subjects (Brinciotti *et al.* 1994, Kasteleijn-Nolst Trenité, 1989, Stefánnson *et al.* 1977). Black and white striped patterns with one to four cycles per degree of visual angle (Wilkins *et al.* 1979a) induce hypersynchronous activity more frequently than colorful patterns with low contrast.

Photosensitivity is elicited more frequently by a time-related, light-dark contrast during intermittent photic stimulation (IPS) as compared to pattern sensitivity with a space-related light-dark contrast upon pattern stimulation. Television viewing is the most frequent cause of photogenic attacks in daily life (Kasteleijn-Nolst Trenité, 1989, Beaumanoir *et al.* 1989, Zifkin and Kasteleijn-Nolst 2000). According to Harding and Jeavons (1994), 61% and to Brinciotti *et al.* (1994), 87% of all photogenic attacks are caused by television viewing, whereby both the content of the image and how the image is rendered play a decisive role. Differences could also be shown between 50 and 100 Hz television screens.

A further contributing factor is how the television image is rendered. The television screens available in Europe operate mainly at an image regeneration frequency of 50 Hz, rarely at 100 Hz, based on the interlacing principle. An interlaced, double linear raster pattern flickers with a frequency of 25 Hz or 50 Hz, respectively (Ricci *et al.* 1996, Ricci *et al.* 1998, Wilkins *et al.* 1979b). This can only be perceived however, at a distance of less than 1 m or at a distance that represents about double the diagonal length of the screen.

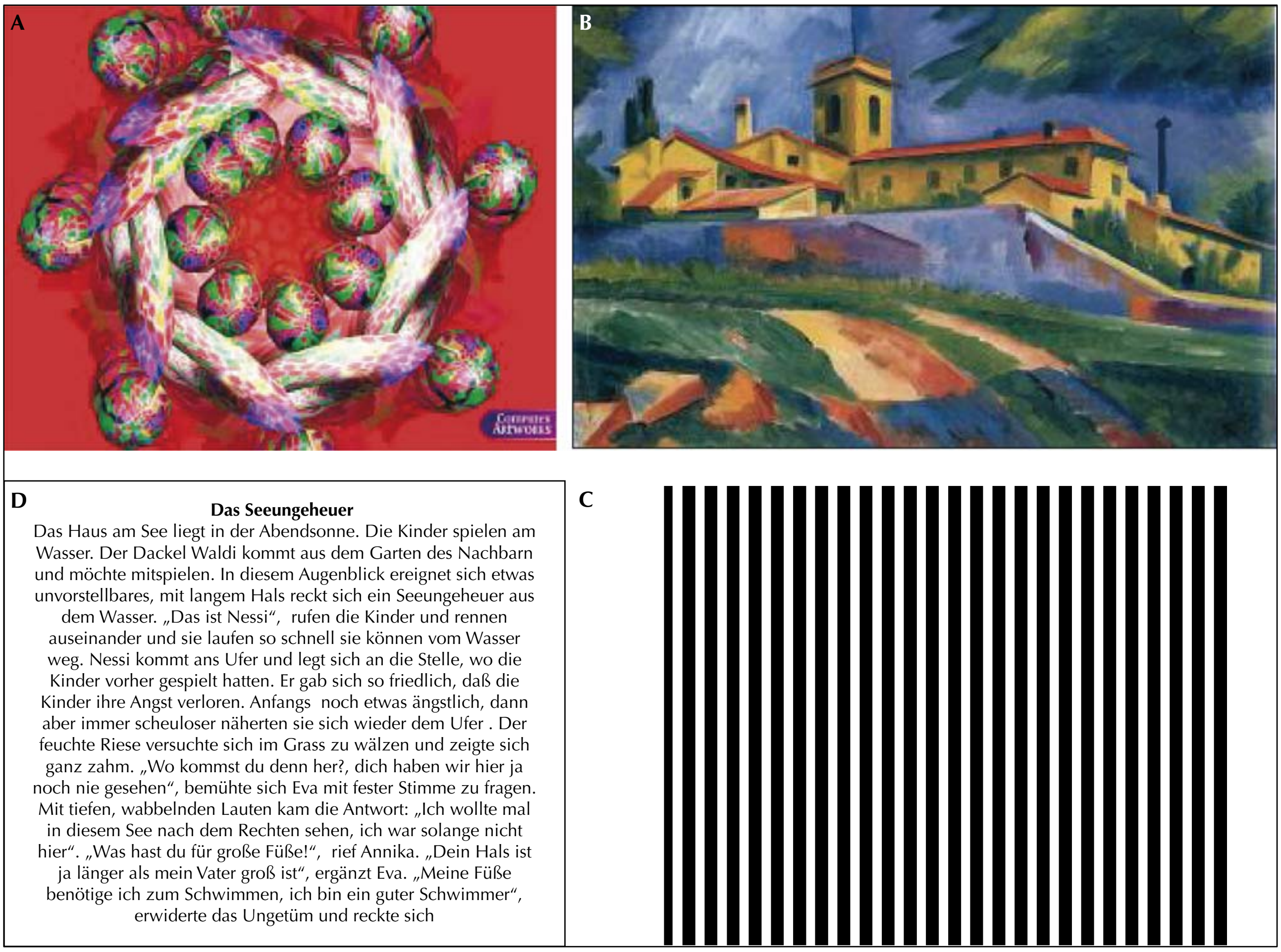

Figure 1. A) Geometric figure. **B**) Painting by Max Pechstein. **C**) Text. **D**) Black and white striped pattern.

The images on standard, commercially available PC monitors are presented by a so-called non-interlaced process. In contrast to interlacing on a television screen, the image is completely constructed in every cycle at a standard image regeneration rate of 70 Hz. The most commonly used resolution is 800 pixels horizontally and 600 pixels vertically.
This study was performed in photosensitive children and adolescents to analyze which patient-dependant and which stimulus-dependant factors influence the occurrence of screen sensitivity.

Materials, methods and patients

The 69 subjects included in the study were allocated to a photosensitive group (group P, n = 48) and a non-photosensitive group made up of healthy children control group (group C, n = 21). The subjects were aged between six and 18 years in group P (mean 12.6 years, SD 3.46) and seven and 18 years in group C (mean 12.1 years, SD 3.4). There were more girls in group P than in group C, with a male to female ratio of 1:1.72 in group P and 1:1.54 in group C.
After receiving parental consent, all subjects were examined with respect to photosensitivity, pattern sensitivity, and screen sensitivity.
An EEG was conducted throughout the course of the investigation and the results recorded on paper. Resting EEG, pattern stimulation, photostimulation, and screen stimlulation examinations were performed on the three monitors, with four different images, in a darkened room and in random order. The resting EEG however, was always performed first.

Patient characteristics - photosensitive group (group P)

Of the 48 photosensitive subjects, 23 had previously experienced an epileptic seizure. Ten of the 17 male subjects and 13 of the 31 female subjects had suffered at least one seizure. In three of the subjects, focal seizures had occurred (6.25%). In 17 subjects, idiopathic, generalized epilepsy presented with various forms of seizures (absences, generalized tonic-clonic seizure, myoclonic seizure, and myoclonic astatic seizure). Non-classified seizures occurred in three subjects (6.25%). Two subjects had only experienced febrile seizures.
The other 25 subjects repeatedly showed a PPR in a routine EEG conducted because of other neurological or behavioural abnormalities, such as headache, learning disabilities or suspicion of epileptic seizures.
Of the group of 23 subjects who had experienced epileptic seizures, eight (five girls and three boys) reported photogenic seizures (35%). This was unequivocally determined to be the cause of the seizure, thus permitting it to be classified as a photogenic seizure. Seven of these eight subjects (88%) were diagnosed with idiopathic generalized epilepsy. Non-classified seizures had occurred in one girl.
In three of the eight subjects, the seizures only occurred while watching television; among these subjects an 8-year-old girl reported experiencing more than 10 episodes, with loss of consciousness under such conditions. Two other subjects experienced seizures while playing video and computer games. A 12-year-old girl had seizures while watching television and while riding down a tree-lined road. A 16-year-old girl had only experienced a seizure when riding along a tree-lined road. Stroboscopic light caused an absence in a 9-year-old boy. Of all the possible conditions under which seizures can occur, watching television was the most common. In total, four subjects (75%) indicated that this had triggered the seizures. Six of eight subjects (75%) experienced seizures while watching television or playing video games on the television or on the PC.
At the time of the study, 20 of the 48 subjects were being treated with anticonvulsants. Of these 20, 15 were receiving valproate. Other drugs or combination treatments were only rarely used. Only five of the 20 subjects being treated (25%) had received a combination therapy or had taken carbamazepine, phenobarbital, or ethosuximide.
Thirteen of the 48 subjects have family members with a PPR.
Patients with a photomyoclonic response or photic driving were not included in this group.

Patient characteristics – control group (Group C)

The control group consisted of 21 healthy children with normal neurological findings on EEG.

Resting EEG

Findings were normal on the resting EEG in 42 of 48 subjects in Group P. Age-specific background activity without hypersynchronous activity was observed. Six subjects showed unprovoked hypersynchronous activity as generalized spikes and waves.

Intermittent photic stimulation

Photostimulation was conducted with a photostimulator (Knott Electronic, LT1001, 1450000 Lux), at a distance of 30 cm from the nasion. The lamp was 15 cm in diameter so that the stimulus spanned a visual angle of 28°.
With the eyes closed, the study subject received a stimulus for 60 s, slowly increasing and then decreasing the frequency. The duration of the stimulus was 30 s at all the possible frequencies (5, 10, 12, 15, 20, 25, 30, and in individual cases, 18 Hz also). After 10 s, the study subjects were asked to open their eyes for 3 s and then close them again.
At the end, another 30-s stimulus was given at rapidly changing frequencies. If generalized spikes appeared dur-

ing stimulation, the procedure was stopped immediately and repeated after a short interval at the same frequency. If spikes appeared again, the stimulus was interrupted again for a short time and then continued at decreasing frequencies - starting at 30 Hz. In this way the photosensitivity range could be established.

Classification of photoparoxysmal reaction (PPR) during IPS

If hypersynchronous activity appeared during photostimulation, the PPR was classified according to Waltz *et al.* (1992):

– *Type I:* spikes within the occipital rhythm,
– *Type II:* parieto-occipital spikes with a biphasic slow wave,
– *Type III:* parieto-occipital spikes with a biphasic slow wave and spread to the frontal region,
– *Type IV:* generalized spikes and waves.

Photoparoxysmal reactions - Group P

During the photostimulation, PPRs of varying degrees (grade I to IV – Classification of Waltz *et al.* 1992) were triggered in all subjects in group P.

Photogenic seizures occurred in eight children. A type IV PPR was triggered in five of the eight subjects (63%) who had experienced photogenic seizures, a type III reaction in only one, and a type II reaction in two subjects.

Pattern stimulation

A black and white striped pattern 30.6 cm wide and 24.4 high was printed on white paper. It corresponded to the size of the visible images on a television screen and a PC monitor.

Taken vertically, the stripes were 0.6 mm wide. Thus, at a distance of 70 cm from the eye of the study subject, the pattern spanned 1.03 cycle repeats per visual angle (one cycle corresponds to one black and one white stripe). Taken horizontally, the pattern was also 30.6 × 24.4 cm; however, the width of the individual stripe was 0.4 cm, giving a repetition of 1.54 cycles per degree of visual angle.

At a distance of 70 cm, the patterns on the cards spanned a visual angle of 24.66° in width and 19.77° in height. The patterns on the cards were shown to the study subjects in random order for one minute at a distance of 70 cm, whereby the subjects were asked to fix their gaze on a small red dot in the middle. Between the two runs of the test, the study subjects were asked to keep their eyes closed for 30 s. If generalized spikes were evident in the EEG, the stimulation was concluded after testing the reproducibility.

If hypersynchronous activity appeared, it was classified according to Waltz *et al.* (1992).

Examination at the television screen and PC monitor

For the examination at a color television (Sony, Triniton Color TV), the screen had a 50-Hz image frequency and a diameter of 47 cm. The PC monitor used was a 19-inch ECOMO 19H99 ELSA, with a visible image area of 31 × 25 cm and a resolution of 800 × 600 dpi.

The frequencies on the PC monitor were set at 48 and 100 Hz in order to achieve conditions comparable to those of the television screen. The individual images (striped pattern, geometric figures, text, and a painting by Max Pechstein – 1913, Italian church) were shown at a distance of 70 cm for 1 min each. In the breaks, the screen was black.

The vertically striped pattern (stripes) corresponded to the size and width of the stripes of the pattern on the cards. While the striped pattern was visible, the patient was asked to focus on a dot in the middle of the picture, read the text (text) quietly to themselves, keeping their eyes on the monitor for the entire time of the examination, even when the screen was black.

If generalized spikes and waves appeared on the EEG, the screen was covered with a cloth immediately. The stimulation was resumed after a short break to test for reproducibility. The hypersynchronous activity was classified according to Waltz's classification of PPR (Waltz *et al.* 1992).

Statistics

Significance calculations were based on a four-way table with a chi squared test and the McNemar test.

The 2x2 chi squared test of independence was used for two independent samples with dichotomic values. The McNemar test was used to calculate the significance in two dependent samples.

Results

Pattern stimulation

Among the 48 photosensitive subjects in group P, pattern stimulation triggered hypersynchronous EEG activity in six (13%). These reactions were classified according to the criteria of PPR during IPS on the routine EEG (Waltz *et al.* 1992). A type II reaction was triggered in two subjects, a type III reaction in two, and a type IV reaction in another two. The male to female ratio was 1:2.7.

All six pattern-sensitive subjects had had epileptic seizures; five (83%) of them had experienced a photogenic seizure. Therefore, significantly more subjects who had experienced photogenic seizures were pattern sensitive than those subjects who had not ($p < 0.001$). Of all subjects who suffered photogenic seizures, 63% were also pattern sensitive.

Screen sensitivity

Using a television screen or PC monitor as stimulus, hypersynchronous activity was triggered in 17 of the 48 subjects (35%); four males, 13 females. Of these 17 subjects, 13 (76%) showed reactions to both the television screen and the PC monitor. In one boy, a reaction could only be induced by the television, and in two other girls only by the PC monitor. Thus, 14 subjects showed reactions to the television screen (29%, three boys and 11 girls), also 14 (two boys and 12 girls) to the 48-Hz PC monitor, and another 13 (three boys and 10 girls) to the 100-Hz PC monitor.

No age relationship could be established.

The subjects focused on four different image stimuli on the screens *(figure 1)*. In four of these 17 individuals, hypersynchronous activity was also triggered by at least one image other than the black and white striped pattern on the TV screen. In only one individual did the PC monitor trigger additional reactions. This 16-year-old boy, who had repeatedly shown reactions while watching the television, reacted to all images presented on the PC monitor.

Of all 48 subjects, 14 (29%) showed reactions to the television images; 71% of them reacted only to the stripes. Furthermore, 14 of 48 (29%) also showed reactions to the PC monitor images, 13 of these (93%) only from the stripes. None of the patients showed clinical signs during testing.

Of the 16 subjects who showed reactions, eight had previously experienced epileptic seizures. Six of these eight (75%) were known to have had photogenic seizures and in five of the six, the seizures had been triggered by viewing a TV screen (83%). Thus, in six of the total of 16 subjects, photogenic seizures were triggered as a reaction to the TV screen or PC monitor, in contrast with two subjects with photogenic seizures who did not show a reaction to the TV screen or monitor.

In the group of subjects who had experienced photogenic seizures, six out of eight (75%) showed a positive reaction to a screen image stimulus. Of the group of 40 subjects without known photogenic seizures, 10 (25%) showed a reaction to the screen images. According to the four-way test, a significantly lower reaction rate is seen in this group ($p < 0.01$). Significantly more subjects who had experienced photogenic seizures were also screen sensitive as compared to subjects who had not experienced photogenic seizures.

With respect to screen sensitivity, no difference was found between subjects with epilepsy and those without. Eight of the 23 epilepsy subjects and nine of the 25 subjects without epilepsy showed a reaction.

In all subjects in whom hypersynchronous activity could be induced by the pattern cards, the screen stimulus also triggered hypersynchronous activity. Thus, six of the 14 screen-sensitive subjects (43%) were also pattern sensitive. Only four subjects showed a reaction to stimuli other than the striped pattern. Three of these (75%) were also sensitive to the pattern cards. The reaction to the screens did not correlate significantly with the degree of photosensitivity. It is interesting that patients with focal epilepsy showed a PPR, also only with a grade 2 or 3. In the studies of Doose, (1989) and Doose, *et al*. (1997), 28 and respectively 36% of patients with focal sharp waves showed a PPR as an additional EEG finding.

Upon examination of the photosensitivity, we found that 24 of 48 subjects showed hypersynchronous activity at a frequency of 25 Hz. Among the 14 subjects in whom a television sensitivity was established, 10 (71%) showed a reaction to photostimulus at a frequency of 25 Hz. The other four (29%) were sensitive to frequencies below 25 Hz. Thus, according to the McNemar test, significantly more subjects with television sensitivity who showed a reaction at 25 Hz ($p < 0.05$) were screen sensitive than those who did not show a reaction at 25 Hz.

Patient characteristics and EEG activation of each image are shown in *table 1*.

Control group (group C)

No photosensitive individuals were included in the control group. Photostimulus did not trigger hypersynchronous activity in any of these individuals. Furthermore, none of the controls reacted to a stimulus with the pattern cards in the sense of a pattern sensitivity, or showed any reaction during the examination while viewing the various screens.

Discussion

In order to analyse patient-dependant and stimulus-dependant factors associated with or being the cause of screen sensitivity, the following questions were addressed:

1) is hypersynchronous activity induced less often when viewing a PC monitor than a television screen as hypothesized by previous studies (Harding and Jeavons, 1994);

2) do image-dependant factors influence the occurrence of hypersynchronous activity;

3) does the degree of photosensitivity or the existence of pattern sensitivity to pattern cards contribute to the occurrence of screen sensitivity;

4) we wanted to clarify whether there is a connection between existing epilepsy or previously occurring photogenic seizures and screen sensitivity.

Screen sensitivity was found in 35% of subjects. No difference in the epileptogenicity between the television screen and the PC moin nitors was found.

Patient-dependant factors: clinical characteristics

Wolf and Gooses (1986) demonstrated that there is an association between photosensitivity and idiopathic generalized epilepsy. Our study addressed the question of

Table 1. Clinical background and individual results

	Sex	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
	Age (years)	11	16	8	17	12	8	14	16	6	8	13	6	11	7	8	10	11	12	12	13	13	13	15	15	16	17	18	18	18	7	13	15	9	16	8	12	7	18	12	14	16	12	12	13	13	13	15	16
	Epilepsy	x_1	x_1	x_2	x_4	x_6	x_1	x_1	x_1	x_2	x_2	x_2	x_5	x_5																			x_1	x_2	x_3	x_1	x_1	x_2	x_2	x_5	x_6	x_6							
	Febrile seizures																														x	x																	
	Other diagnosis														#1	#3	#2		#3	#1		#3	#2	#1	#7	#2	#1	#1	#3	#3													#5	#7		#6	#7	#7	#4
	Photogenic seizures	x	x	x	x	x																											x	x	x														
	Photosensitivity grade	4	4	4	2	3	2	4	1	3	4	4	2	3	2	4	4	3	3	2	2	4	3	4	1	2	2	3	1	3	4	4	2	4	4	4	4	4	2	2	2	3	4	2	2	3	4	3	2
	Pattern sensitivity (cards)		x	x	x	x					x																								x														
TV screen (50 Hz) (interlaced)	Striped pattern	x	x	x	x	x					x											x					x	x	x	x					x							x							x
	Geometric figures					x																													x														x
	Text		x																																x														
	Painting																																		x														
PC screen (48 Hz) (non – interlaced)	Striped pattern	x	x	x	x	x					x									x		x	x				x		x	x					x							x							
	Geometric figures																																		x														
	Text																																		x														
	Painting																																		x														
PC screen (100 Hz) (non – interlaced)	Striped pattern	x	x	x	x	x														x		x						x	x	x					x						x	x							
	Geometric figures																																		x														
	Text																																		x														
	Painting																																		x														

Epilepsy: x_1 Idiopathic generalized epilepsy with generalized tonic – clonic seizures (GTCS); x_2 Idiopathic generalized epilepsy with absences; x_3 Idiopathic generalized epilepsy with myoclonic – astatic seizures (MAS); x_4 Idiopathic generalized epilepsy with myoclonic seizures); x_5 Focal seizures; x_6 Unclassified seizures.

Other diagnosis: $\#_1$ headache; $\#_2$ suspicion of seizures; $\#_3$ learning disability; $\#_4$ concussion/simple head trauma; $\#_5$ phlegmon; $\#_6$ Tourette syndrome; $\#_7$ syncope.

whether photosensitive subjects with epilepsy present more often with screen sensitivity than non-epileptic subjects, and especially whether there is an association between screen sensitivity and photogenic seizures in everyday life.
Fifty percent of the photosensitive subjects had had epileptic seizures. We did not find a difference in the occurrence of screen sensitivity in subjects with or without epilepsy. In those subjects known to have epilepsy and who showed a reaction to the screen, the majority had idiopathic generalized epilepsy.
Of the 23 subjects with epileptic seizures, 35% (8 subjects) had already had a photogenic seizure. Six of these eight subjects (75%) reacted to the screen image stimulus compared to 10 of the 40 subjects (25%) who had not experienced a photogenic seizure. In epileptic subjects with photogenic seizures, screen sensitivity is found significantly more often than in subjects who have not had photogenic seizures. In the subjects who have had photogenic seizures, the seizure had also occurred mainly while watching television. Hence, it seems that this group of individuals has a predisposition to react to images on a screen.
Why did ten more subjects, who had not experienced photogenic seizures, exhibit screen sensitivity? Screen-dependant and image-dependant factors must be considered.

Patient-dependant factors: grade of photosensitivity

The reaction to the screens did not correlate significantly with the degree of photosensitivity.
Some of the PPRs could have been missed with maximum stimulation frequency of 30 Hz. However, a PPR is found in an interindividual different frequency range of 1 to 60 Hz, mainly between 15 and 20 Hz (Wilkins *et al.* 1980, Topalkara *et al.* 1998). Only 15% of the photosensitive patients were sensitive at 60 Hz (Wilkins *et al.* 1979b).

Patient-dependant factors: sensitivity to patterns (cards)

According to the present study, 13% (6 of 48) of photosensitive subjects also showed pattern sensitivity after a stimulus from pattern cards, a rather low rate compared to other studies. In the literature, pattern sensitivity rates of 51 to 71% were found in photosensitive subjects (Brinciotti *et al.* 1994, Kasteleijn-Nolst Trenité *et al.* 1989, Stefánnson *et al.* 1977). The differing incidences reported in the individual studies can be explained by the stimulation methods and patient selection; here, the pattern stimuli were given on cards with no additional lighting, and individuals with a low PPR grade were also included in the study. All pattern-sensitive subjects (cards) showed reactions both to stimuli from the television screen and the PC monitor, *i.e.* screen sensitivity. Significantly more pattern-sensitive subjects (6 out of 6) were screen sensitive than non-pattern-sensitive individuals (10 of 42). A similar association has been found between video game sensitivity and pattern sensitivity (Ricci and Vigevano 1999). Pattern sensitivity could be a possible determinant of screen sensitivity. In addition to those pattern-sensitive subjects who showed a reaction to patterns on the cards, another 10 subjects showed a reaction to the screen image stimuli. This seems to indicate that a screen stimulus - whether on television or PC - is more effective than a pattern stimulus on cards.

Screen-dependant factors

Another determinant of screen sensitivity is the frequency range of photosensitivity in an individual patient. The interlaced screens and frame rate of 50 Hz in European television screen monitors produce flicker components of 50 and 25 Hz on the screen. As already demonstrated (Binnie *et al.* 1980, Brinciotti *et al.* 1994, Fylan and Harding 1997), in the present work, significantly more study subjects who were photosensitive at 25 Hz showed a reaction to the television screen images. As expected, significantly fewer subjects who were photosensitive at 25 Hz reacted to the PC monitor with a non-interlacing screen and without a 25 Hz flicker component. Thus, sensitivity to 25 Hz in IPS can be excluded as a major component of sensitivity to a PC monitor, whose stimulus was as strong as that of the television screen.
The human eye cannot distinguish individual dots at a frequency higher than 90 Hz and perceives the image as one unit. Thus, this factor can also be excluded as an explanation for the reaction to the PC monitor (100Hz).

Image-dependant factors

Significantly more study subjects showed a reaction to the black and white striped pattern displayed vertically on the screens than to any of the other images. The striped patterns represented the strongest stimulus on both screens. Hypersynchronous activity was also triggered on the screens by the other image stimuli that had a low contrast. This occurred more frequently from viewing the television screen than from viewing the PC monitor (not statistically significant). Horizontally striped patterns were not displayed on the screens; however, the results were the same for both orientations on the pattern cards.
No subject showed a reaction to the black screen on the television or on the PC in this study although the fine horizontal lines on the interlaced screen of the television can still be perceived at a distance of 70 cm. In Fylan's and Harding's study (1997), none of the study subjects showed a reaction to a blank screen either. This was explained by the fact that another contrast or a certain strength of light is required to trigger a reaction.
High contrast stripes represented the strongest stimulus in our study. We assume that when strong stimuli such as high contrast stripes are used, the method of image generation is less important for triggering hypersynchronous activity than the content of the image. Screen sensitivity is

pattern sensitivity (image content), with an additive effect of the screen characteristics. Maybe screen characteristics play a more important role when images with a lower contrast are shown.

Because it has been electroencephalographically proven that hypersynchronous activity can be triggered by viewing a PC monitor, a distance similar to that for watching television - at least 50 cm – should be maintained when playing games on the computer. In this way the size of the pattern – and thus its epileptogenicity - can be reduced. This is particularly important in computer games; factors causing hypersynchrony should be avoided, such as light flashes at a frequency of more than 3 per second, rapidly changing pictures, and high-contrast patterns (Beaumanoir *et al.* 1989, Matricardi *et al.* 1990). These factors are not found when using word processing etc., so that a triggering of hypersynchronous activity in this situation is very unlikely.

To confirm these findings, a study should be conducted using these sequences at different light intensities on both television screens and PC monitors, LCD and plasma screens using another method of image generation. The guidelines formulated by the Epilepsy Foundation (Fisher *et al.* 2005) should be applied not only to the usage of TV screens, but also to PC monitors. □

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