Photosensitive Seizure

Photosensitive epilepsy is the name given to that form of epilepsy in which seizures are provoked by flickering light encountered in everyday life. Both natural and artificial light sources may precipitate seizures, but the commonest precipitant appears to be television.

A very small percentage of people may experience a seizure when exposed to certain visual images, including flashing lights or patterns that may appear in video games. Even people who have no history of seizures or epilepsy may have an undiagnosed condition that can cause these "photosensitive epileptic seizures" while watching video games.

It is often assumed that everybody with epilepsy is photosensitive, but only 5 per cent of people with epilepsy are. This sensitivity occurs at a rate of approximately 1:4000 of a young (20 or under) population. The onset of photosensitive epilepsy occurs below the age of 20 years and the condition appears to be most common between the ages of 9 and 15. Females are more affected by photosensitivity than males. There is evidence, too, of a genetic factor in this condition.

Seizures may occur only in response to light stimulation (pure photosensitive epilepsy) or they may occur spontaneously but may be triggered by light stimulation (epilepsies or epileptic syndromes in which photosensitive seizures may occur).

Most people (84%) with photosensitive epilepsy have generalized tonic-clonic seizures in response to light. Absence seizures with or without eyelid movements, lip smacking or mouthing occurred in 6%. Bilateral myoclonic seizures occurred in 1.5%; focal seizures, in 2.5%, and mixed, in 6%.

Recent clinical and EEG data suggest that at least 17% of people with photosensitive seizures may have focal occipital lobe (visual cortex) seizures with secondary generalisation. Subtypes include idiopathic photosensitive occipital lobe epilepsy and other visual sensitive epilepsies.

Various types of seizure may be induced by flickering light, but a tonic-clonic (grand mal) seizure is certainly the most frequent type induced by television, perhaps preceded by myoclonic jerking (brief jerking of the limbs). These seizures may have a variety of symptoms, including light-headedness, altered vision, eye or face twitching, jerking or shaking of arms or legs, disorientation, confusion, or momentary loss of awareness. Seizures may also cause loss of consciousness or convulsions that can lead to injury from falling down or striking nearby objects.

TV

Factors that contribute to TV-induced seizures include: flickering light (especially at the frequency of the electrical supply), flashes or images; high contrast between images, e.g., alternating bright and dark frames; speed of change (lower the speed, the lower the risk, e.g., less than 3 per sec); rapid color changes, e.g., red is a provocative color; faulty vertical or horizontal holds; approaching to adjust the TV set; and sitting too close (60 cm or less). A 100-Hz screen is less provocative than a 50-Hz screen but more expensive.

The important factor here is the larger area of the eye's retina which is stimulated by the flicker frequency of the picture on a television that is, in fact, functioning normally. The nearer the subject is to the set, the more the picture is filling the whole field of vision and so the more likely is an abnormal response in the brain and, therefore, a seizure. In addition, subjects sitting close to the set can see the 25Hz flicker of the lines as well as the 50Hz mains flicker on the screen as a whole. Only 50 per cent of photosensitive people are sensitive to 50Hz but 75 per cent are sensitive to 25Hz.

Seizures may occur, therefore, when the viewer is watching a faulty set or adjusting the set, or is very near to the set. Associated factors include the angle from which the set is being viewed, sensitivity to geometric patterns and the effect of tiredness and alcohol.

Simple measures may be taken to avoid having a seizure while watching television. The set should always be viewed in a well lit room, from a distance of 2.5 metres or more, with a small illuminated table lamp placed on top of the set.

The person should avoid approaching the television, adjusting it and switching channels. Covering one eye with the palm of the hand so as to cut down the number of brain cells that are stimulated by the flicker should be practised if the person has to go near the television set. Television sets with remote control enable people to adjust their set from a distance and are therefore useful. 100Hz television sets will almost entirely solve the problem, or alternatively, sets with small screens (less than 14") will help.

> One of the most dramatic examples of this happened in 1997 when a sequence of red to blue flashing during an episode of the Pokemon cartoon caused hundreds of seizures in Japan.
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> Investigation revealed that this colour change was linked to the fact that many televisions emitted unusually bright long-wavelength red light.
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> Partly as a result, a team in Gifu Hospital in Japan have developed the filter, which blocks red light at long wavelengths, and cuts down the overall brightness of the image.

Computer games

Most current computer displays (CRT or Cathode Ray Tube) have scan frequencies of 70 per second and above. These are unlikely to provoke seizures.

Computer displays with active matrix liquid crystal displays (LCDs), also known as Thin Film Transistors (TFTs), are flicker free. On a standard laptop/notebook screen they have 786,432 pixels at 1024 x 768 resolution. Images are sharper, brighter and distortion free compared to CRTs. The brightness and sharpness, however, may increase the risk to people with photosensitive epilepsy, if high contrast patterns are presented.

The risk of photosensitive epileptic seizures may be reduced by taking the following precautions:

- Play in a well-lit room
- Do not play when you are drowsy or fatigued

Software packages

When you use software packages on an LCD or TFT, the screen responds by only changing those pixels affected. On a CRT monitor the whole screen is constantly refreshed. On LCDs/TFTs, standard software packages, such as 'Office', produce very tiny changes to the screen. Full motion video (such as DVDs), when viewed at full screen on LCDs/TFTs, produce many changes to the screen. These changes can be reduced by running the video image within a window, thereby minimising the number of pixels changing at any given time. For watching full motion video (where there is a great deal of action on the screen) CRTs may be preferable. This is because CRTs refresh quicker than LCDs/TFTs.

Where the material being displayed contains flicker or repetitive patterns, it will carry the same risk whether it is viewed on CRTs, LCDs/TFTs or conventional television.

In summary:

* The high flicker rate of CRTs means they present a very small risk to people with photosensitive epilepsy.

* LCD and TFT screens do not flicker at all.

* Increased brightness and sharpness of LCD and TFT screens may increase the risk to people with photosensitive epilepsy. This risk can be minimised by reducing the brightness of the screen.

* Any material being displayed that contains flicker or repetitive patterns on any type of screen poses a risk to people with photosensitive epilepsy.

* If you primarily use 'Office' or similar packages, an LCD/TFT screen is the better medium.

* For watching DVDs at full screen, a CRT is the better medium.

Anti-glare screens are frequently recommended for eyestrain. While these can be of help in reducing glare, they do not reduce the flicker rate and are therefore of no specific benefit to people with photosensitive epilepsy.

Visual display units (VDUs)

Contrary to public belief, the use of VDUs rarely presents any risk to the person with epilepsy. To ensure that any risk is kept to an absolute minimum, it is important to consider both the type of software and the display screen you intend to use it on.

Lighting

Repetitive flashing lights may induce seizures in these individuals. The flash frequency of concern is from 5 Hz to 70 Hz, with most individuals only susceptible in the range of 15 Hz to 20 Hz.

- A flashing strobe (or a close combination of multiple strobes sequenced together) must not be programmed to flash in the 5 Hz to 70 Hz frequency range.
- Slower flash rates, and randomly flashing lights are not known to be a cause of photosensitive epilepsy.
- Point sources of light are much less likely to induce seizures than a diffuse source of light which covers a large part of a person's field of vision.
- To induce a seizure the light must be present in the center of the field of vision as opposed to the periphery.
- Reducing brightness or increasing distance between a photosensitive viewer and the light source is effective for preventing photosensitive epileptic seizures.
- Lights flashing in the distance, even in the frequency range of concern, are not known to cause seizures when in the presence of other lights of a more natural or chaotic nature.
- The probability of inducing a seizure is greatly increased (by up to a factor of ten) if the light source is arranged in a regular pattern, such

as a raster scan image. Stated another way, avoid adding spatial contrast (pattern) to temporal contrast (flickering).

Research and experience is quite limited with the strobe effects which may be generated with a controller numerous small strobes distributed over a field of view. There are no industry consensus standards from which to draw specific guidance regarding the responsible creative implementation of large quantities of strobes. Neither is there any evidence that these strobe effects have ever caused a single epileptic seizure. Still, it would seem that there is a risk, so each designer must consider what is known about photosensitive epilepsy when creating strobe lighting effects.

It should be noted that it is not the "strobe" that is the problem. Any light flashing at the noted frequencies may be a problem. In fact, flashing television images are the best known source of concern.

The most common flash rates that produce seizures are between 12 and 24 flashes per second.

Do not program strobes to flash at continuous rates between 5 and 70 Hertz, particularly when the strobe light is in close proximity to observers. Increasing distance between the viewer and the strobe light and decreasing light intensity are both effective for eliminating the risk of photosensitive epileptic seizures. Less clear is "how far" and "how bright is too bright". Little research has been done to determine the extent to which reducing brightness or increasing distance eliminate the possibility of inducing seizures. However, there is clear evidence that both of these are valid techniques for preventing photosensitive epileptic seizures. Indications are that the flashing light must be present in a substantial part of a susceptible individual's field of vision to induce a seizure.

Large commercially available and widely used strobes exist for theatrical and night-club applications. Some are easily programmed to operate up to 15 Hz (and reportedly faster).

other sources

Factors precipitating seizures in photosensitive epilepsy apart from television flicker include sunlight reflected off wet surfaces or through leaves of trees, or seen when the person is moving rapidly past trees or railings illuminated by sunlight shining from the side. Flashing lights such as those used in discotheques and the flickering of fluorescent lighting may also induce seizures.

People with photosensitive epilepsy are generally encouraged to avoid discotheques or places where flashing lights are likely to be encountered. It should be borne in mind that people with photosensitive epilepsy are unlikely to be troubled by a flicker rate of under five per second, but using photochromic (light responsive) glasses with one lens totally darkened will render 95 per cent of sensitive people safe. While wearing such glasses in darkness, the untreated photochromic lens will be clear, enabling you to see - as far an anyone can in the average disco. Should any flashing light come on without warning and protective glasses are not being worn, immediately cover one eye with the palm of the hand.

The wearing of polarised sunglasses out of doors on sunny days is of assistance in removing flickering reflections (from water, etc). Non-polarised sunglasses are of no value in this condition.