

# 209 Pattern-Sensitive Epilepsy

Arnold Wilkins

Pattern-sensitive epilepsy is a condition in which seizures are induced by visual patterns, most typically of stripes.

## Classification

Pattern-sensitive epilepsy is a form of reflex epilepsy, and may occur in primary generalized, secondary generalized, and partial epilepsy (Harding and Jeavons 1994).

## Demographic Data

**Onset.** The onset of pattern sensitivity is most likely at puberty or a few years before, and it can remain throughout life. **Gender.** Girls are nearly twice as likely to be affected as boys. **Prevalence.** Photosensitivity occurs in about 4% of adults with epilepsy, but the prevalence is greater in the young. Pattern sensitivity is present in most photosensitive patients, but with clinical significance only in about 30–50% (Harding and Jeavons 1994).

## Clinical Manifestations

Seizures are more likely if the patterns are striped (▶ Fig. 209-1a), subtend a large visual angle at the eye (▶ Fig. 209-1b), if they are brightly lit and strongly contrasted (▶ Fig. 209-1c), and if the periodic elements within the pattern are regularly spaced (▶ Fig. 209-1d) and have a spatial frequency close to 3 cycles per degree (▶ Fig. 209-1e). Epileptogenic patterns include gratings, the metal stair tread of escalators, and striped clothing. The seizures can be of any type, ranging from fleeting absence to major convulsion (Wilkins 1995).

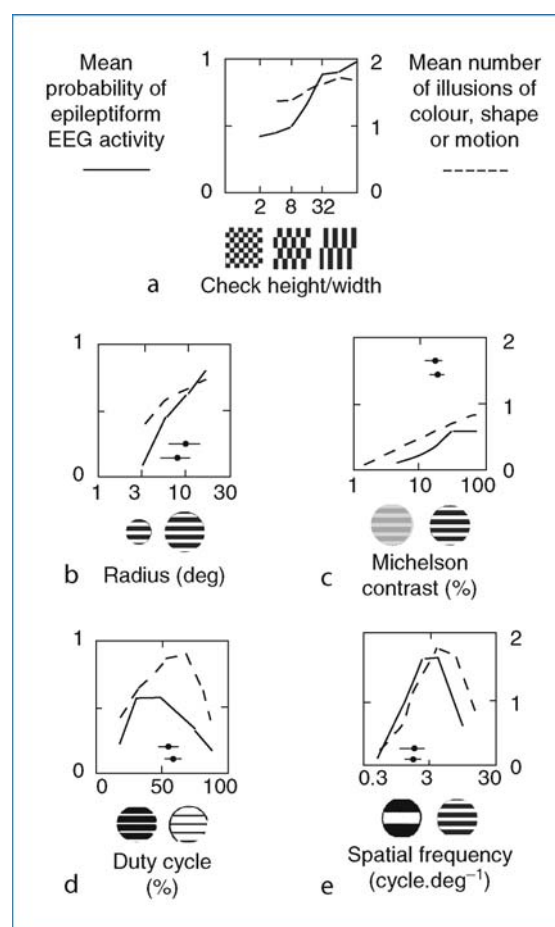
## Etiology

Etiology is most often idiopathic, but can be secondary. Diseases that render the visual cortex hyper excitable can potentially give pattern-sensitive epilepsy.

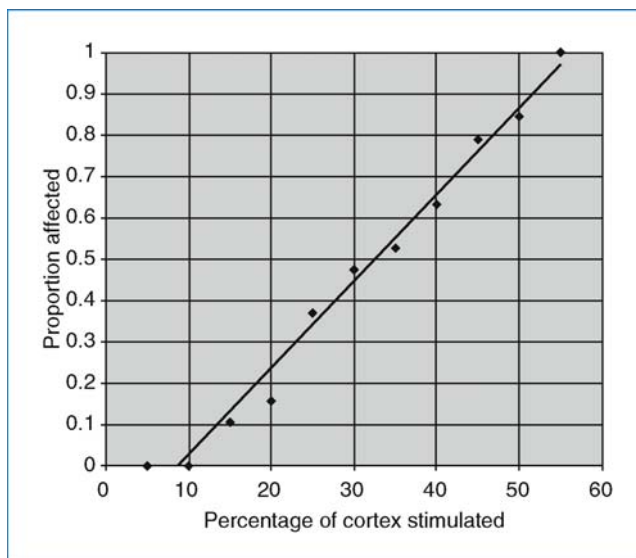
## Pathophysiology

The seizures arise when normal cortical excitation involves a region of the visual cortex of sufficient size (▶ Fig. 209-2), stimulating complex cells within a limited number of orientation columns (▶ Box 1 and ▶ Fig. 209-3). The discharge begins within one cerebral hemisphere and can generalize, or remain confined within that hemisphere, in which case it is associated with an ipsilateral posterior epileptiform EEG (▶ Box 1 and ▶ Fig. 209-4). For seizures to occur, the

excitation needs to be (1) strong and (2) synchronized. Synchronization occurs when the pattern is stationary, and its retinal image is moving by virtue of the normal instability of the eye during fixation. The motion stimulates neurons selective to one direction of motion then another, synchronizing the activity. The epileptogenic potential of the pattern is greatly increased if it alternates in phase at a frequency of



**Figure 209-1.** Probability of epileptiform EEG activity in patients with pattern-sensitive epilepsy shown as a function of several spatial characteristics of the pattern (solid curves). The dotted curves show the number of illusions of color, shape or motion reported by normal observers, illusions to which those with migraine are particularly susceptible. The horizontal bars show the characteristics of text, when considered as a striped pattern. Icons beneath each graph represent variation in the relevant spatial characteristic (Wilkins 1995)



**Figure 209-2.** Proportion of patients showing epileptiform EEG activity in response to a pattern of stripes, shown as a function of the proportion of the visual cortex to which the pattern projects. The data are taken from several studies that included the patterns shown in [Fig. 209-3a–d](#) (Wilkins 1995)

about 10–20 Hz, or if it vibrates at similar frequency in a direction orthogonal to the stripes ([Fig. 209-5](#)). If the patterns drift continuously in one direction (at a similar rate), they are not epileptogenic (Wilkins 1995).

### Diagnostic Procedures

Most patients with pattern-sensitive epilepsy are sensitive not only to patterns but also to flickering light, and conventional diagnostic procedures using intermittent photic stimulation may be expected to give rise to a photo-paroxysmal EEG response (PPR). However, there are exceptional patients who show a photoparoxysmal response only to patterns. The most epileptogenic patterns are strongly illuminated (mean luminance  $>100 \text{ cd m}^{-2}$ ), subtend at least  $20^\circ$  of arc at the eye, and consist of stripes subtending about 15 min of arc. Several such patterns at a variety of orientations should be available for routine testing during the EEG examination (Wilkins 1995).

### Differential Diagnosis

The demonstration of pattern sensitivity in a photosensitive patient is clinically important because it shows the additional range of visual stimulation to which the patient is susceptible. Text can provide a sufficient pattern stimulus in some patients (horizontal bars, [Fig. 209-1](#)). Patients with migraine show aversion and perceptual distortion (dotted curves, [Fig. 209-1](#)) when viewing epileptogenic patterns, but this is because the patterns induce a strong neurological response;

#### Box 1

Evidence for trigger within visual cortex of one hemisphere, or visual cortices of both hemispheres independently (Wilkins 1995)

- Probability of epileptiform EEG activity increases linearly with log of line length/width, [Fig. 209-1a](#) (implicating cells with linear receptive fields).
- Some patients with no astigmatism are sensitive only to patterns with a limited range of orientations (implicating cells with oriented receptive fields).
- Horizontal pattern presented to right eye and vertical pattern to left eye are less epileptogenic than same pattern to both eyes (implicating binocular cells).
- Spatial and temporal parameters are independent, see [Fig. 209-4](#) (implicating cells with spatial properties independent of retinal locus, e.g. complex cells).
- Cortical magnification. Pattern 3c and d have similar effects, see [Fig. 209-2](#).
- Scalp topography of spikes follows that of underlying cortex: Stimulation of a lateral field ([Fig. 209-3e, f](#)) gives contralateral spikes ([Fig. 209-5a, b](#)). Upper field stimulation ([Fig. 209-3g](#)) has lower topography ([Fig. 209-5c](#)) than lower field ([Fig. 209-5d](#)). (Implies that spikes can originate in and be sustained within visual cortex.)
- Patterns in upper and lower fields ([Fig. 209-3g, h](#)) are less epileptogenic than lateral patterns ([Fig. 209-3e, f](#)), (implies a critical aggregate is necessary within visual cortex of one cerebral hemisphere).
- The size of unilateral patterns ([Fig. 209-3e, f](#)) sufficient to induce epileptiform activity can differ even in primary generalized epilepsy (implying different convulsive thresholds for the two hemispheres).

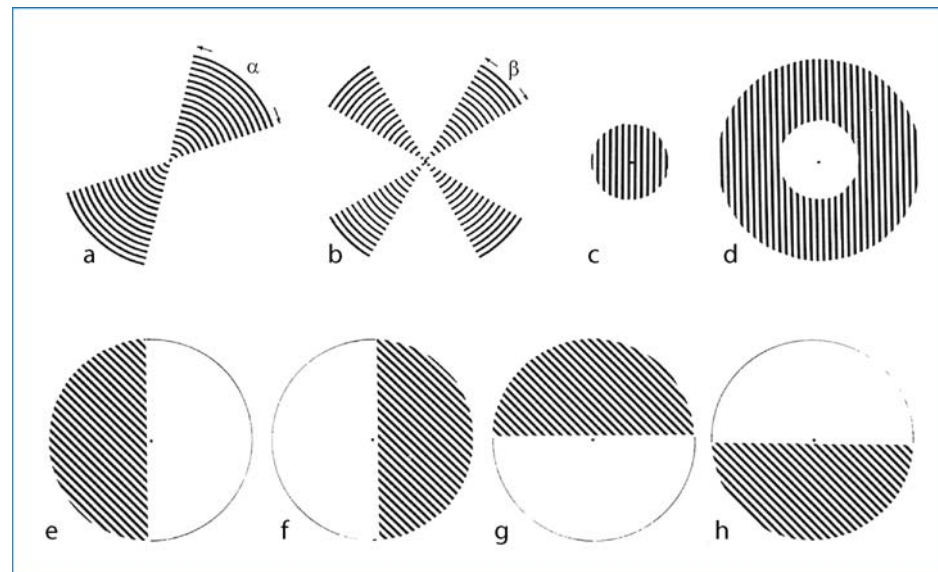
not because the response is synchronized – drifting patterns are not epileptogenic, but are aversive for individuals with migraine (Wilkins 1995).

### Prognosis

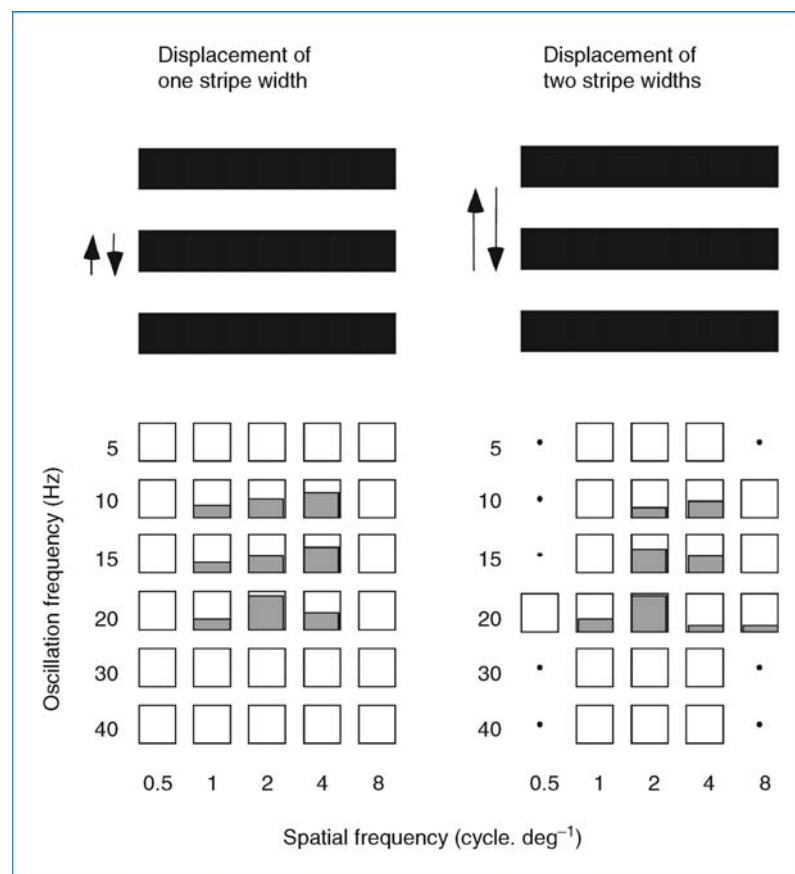
The prognosis is as for photosensitive epilepsy; 75% of patients retain their susceptibility to patterns for life, but some lose their sensitivity after their 20s (Harding and Jeavons 1994).

### Management

The management is as for photosensitive epilepsy. Appropriately tinted glasses can be an effective treatment. Blue glasses have been shown to reduce seizures in some cases. There are



**Figure 209-3.** Schematics of individual patterns, including those that provided the data for Fig. 209-2 showing the central fixation point. For patterns **a** and **b** the size of the pattern was adjusted by varying the number of sectors or the sector angles  $\alpha$  and  $\beta$ . The remaining patterns were varied in size by manipulating their outer radius, which ranged from 3 to  $24^\circ$  (Wilkins 1995)



**Figure 209-4.** Squares are filled in proportion to the number of patients with photosensitive epilepsy exhibiting a photoparoxysmal response to vibrating gratings of various spatial and temporal frequencies. (Patients sensitive to stationary gratings were excluded.) The effects of spatial and temporal frequency are independent. Within the range shown, amplitude of vibration has no effect (Wilkins 1995)

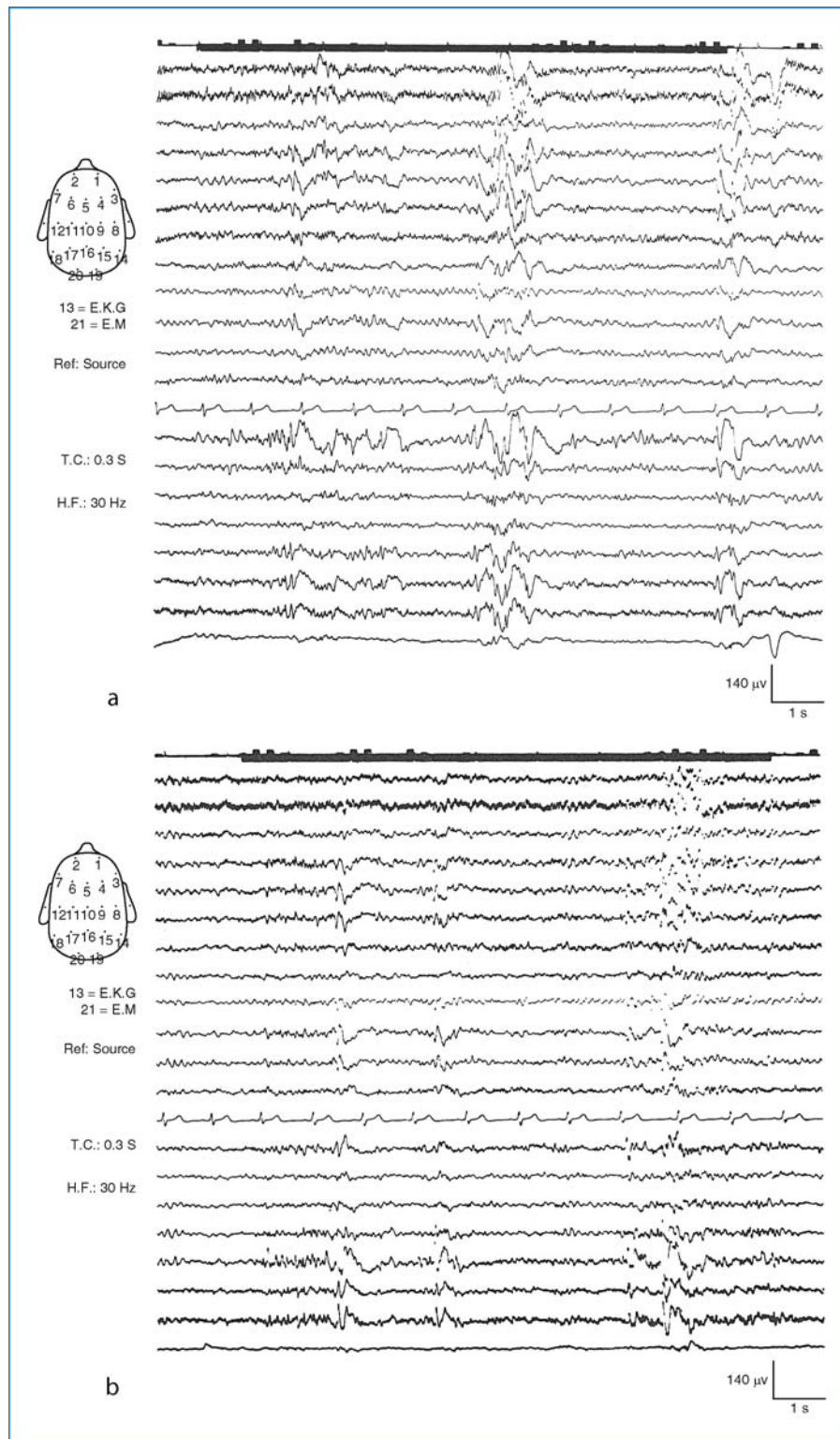
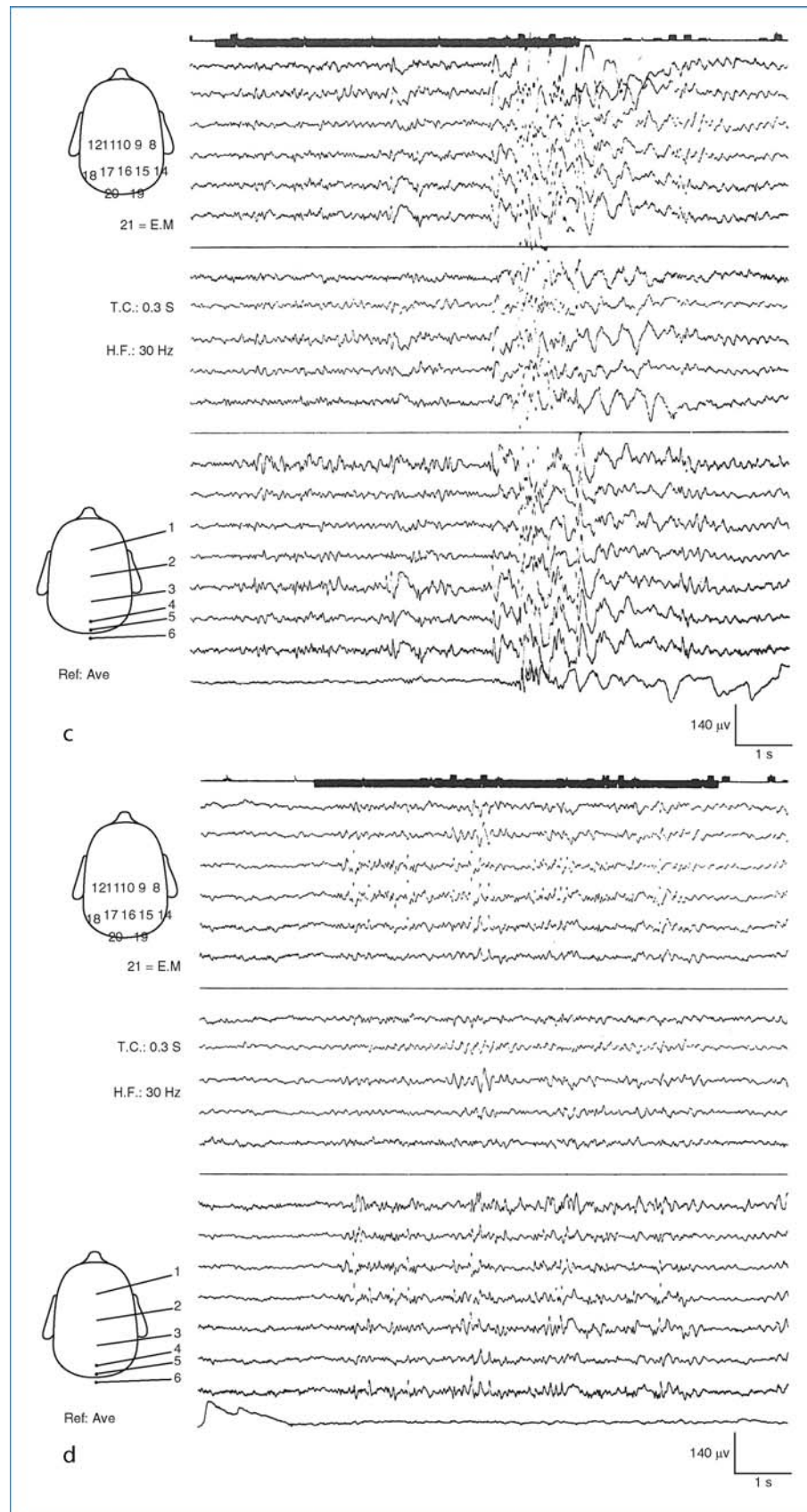


Figure 209-5. (continued)



**Figure 209-5.** An EEG of a patient with pattern-sensitive epilepsy during presentation of patterns in the (a) left, (b) right, (c) upper and (d) lower visual fields (Fig. 209-3e-h). The scalp topography of the spikes follows that of the underlying visual cortex receiving stimulation (Wilkins 1995)

also initial indications that an individually chosen colour can offer a more acceptable and effective treatment. Where there is an awareness of symptoms, an appropriate color can be selected subjectively using the Intuitive Colorimeter. If physical means of protection are insufficient, the drugs of choice are sodium valproate or lamotrigine.

### Declaration of Interest

The British Medical Research Council owns the rights to the *Intuitive Colorimeter*. The author receives from the Council a proportion of the royalties on sales in the form of an Award to Inventors.

### Cross-References

- ▶ Fixation-Off Sensitivity
- ▶ Focal Seizures with Visual Hallucinations

- ▶ Idiopathic Photosensitive Occipital Lobe Epilepsy
- ▶ Occipital Lobe Epilepsies
- ▶ Pathophysiology of Neocortical Epileptic Seizures
- ▶ Pathophysiology of Reflex Epileptic Seizures
- ▶ Photosensitivity, Epileptic Seizures and Epileptic Syndromes
- ▶ Primary Reading Epilepsy
- ▶ Reflex Epileptic Seizures
- ▶ Reflex Seizures and Reflex Epilepsies: Overview
- ▶ Valproate

### References

- Harding GFA, Jeavons PM (1994) Photosensitive epilepsy: new and expanded edition. Cambridge University Press, Cambridge
- Wilkins AJ (1995) Visual stress. Oxford University Press, Oxford