VARIOUS OTHER PROCEDURES

CRITICAL FREQUENCY OF FUSION: CLINICAL APPLICATIONS

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IV. Critical Frequency of Fusion: Clinical Applications

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Critical frequency of fusion is the measure of the minimum number of flickers per second necessary for a discontinuous light stimulus to give the sensation of continuity. It is thus a measure of the apparent persistence of a visual sensation produced by a stimulus. It is an old-established observation that disturbances in central or peripheral vision are associated with a lowering of the critical frequency of fusion. To enable the correlation of the critical frequency of fusion with perimetry the apparatus illustrated in Fig. 36 has been constructed; it allows the study of fusion frequency in the field up to 30 degrees. Actually, it is possible to use a less complicated apparatus, for a bulb giving intermittent light at a frequency that can be adjusted will do almost as well.

The interpretation of the measure of critical frequency of fusion in the pathological visual field is not devoid of difficulties. In the healthy subject the rhythm of fusion varies considerably over different parts of the field, depending on the area illuminated, the type and innervation of the photoreceptors, the calibre of the vessels and other factors. Consequently, in a patient with a scotoma, alterations in frequency of fusion may be determined by two factors which may augment or tend to neutralize each other; they are, the area explored and the changes in visual function. To facilitate the interpretation of actual findings we have determined the normal frequencies for different parts of the field. As frequency increases with the size of the test flicker we have established arbitrarily an isofrequency in 26 points of the field by varying the diameter of the test object (Fig. 37). Under conditions of examination in a healthy subject the frequency of fusion therefore varies now by two factors only: the age of the patient, and the width of the pupil. The effect of these factors is shown below.

TABLE I

Average Frequency of Fusion in 50 Normal Subjects

Age (*in years*)	*Fusion frequency* (*flicker/second*)	
	Normal pupil	*Dilated pupil*
20–30	40·2	42·8
30–40	39·2	42·6
40–50	34·4	42·6
50–60	31·8	40·8
60–70	31·6	38·4

(*After Weekers, R., and Roussel, F.* (1948). *Docum. ophthal.*, **2**, 132.)

Observations on Patients

All patients with disturbances in vision show a lowered critical frequency of fusion, generally directly proportional. This is clearly seen in scotomas revealed by perimetry, but is borne out in almost all perimetric defects. Measuring the critical

frequency of fusion is a useful procedure in following the course of an affection, for a lowering in the frequency of fusion corresponds to a worsening of the affection, and the opposite is also true. This applies equally to lesions of diverse origin; it is

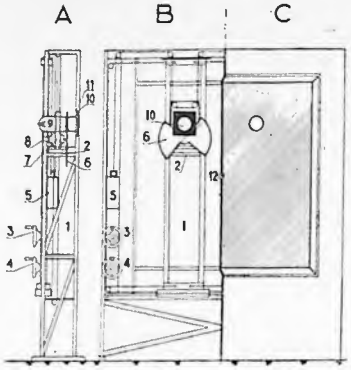

FIG. 36.—Apparatus used for measuring the critical fusion frequency in the visual field. (A) Side view. (B) Face view with the case removed showing the mechanism which ensures displacement of the flicker system in the visual field. (C) Face view with the case in place.

1. Vertical framework ensuring the horizontal displacement of the screen.
2. Platform ensuring elevation and depression of the screen.
3, 4. Crank handles.
5. Counterweights.
6. Revolving shutter.
7. Motor.
8. Speedometer.
9. Light source.
10. Opaque glass screen.
11. Diaphragm.
12. Illuminated point of fixation.

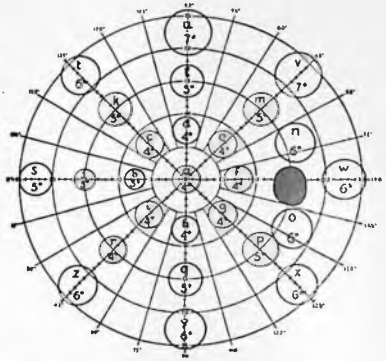

FIG. 37.—Sitings and diameters of test objects giving isofrequency in the normal visual field. Right eye: blacked-out area, blind spot. The sitings have been chosen to fill the visual field as far out as 25 degrees.

The large circles correspond to the areas of low fusion frequency, and the small ones to the areas of high fusion frequency.

(*After Weekers, R., and Roussel, F.* (1948). *Docum. ophthal.*, 2, 132.)

immaterial whether the lesion is choroidal, retinal, or in the optic tract and pathways.

Some special features

Critical frequency of fusion is a more sensitive test than perimetry in certain conditions, such as the following:

(1) *At the beginning of an affection.*—Anomalies in frequency may be present when perimetry reveals no defects.

(2) *As a measure of the extent of the lesion.*—As fusion frequency is a finer test than perimetry, the extent revealed is larger by assessing fusion frequency than by perimetry (Fig. 38).

(3) *During healing.*—Likewise, healing may be shown to be less complete than would be suggested by other methods. This is well seen in the surgical replacement of detached retina. After healing there may yet persist defects in frequency of fusion

(Fig. 39). There may be similar persistent anomalies after recovery from tobacco amblyopia (Fig. 40).

(4) *In unsuspected lesions.*—Occasionally outlying islands of disturbance in such affections as disseminate chorioretinitis may be revealed by tests for fusion frequency when other tests would be negative.

Critical frequency of fusion in vascular affections and in amblyopia ex anopsia

It has been suggested that measuring the critical frequency of fusion is of value in disturbances of retinal circulation; this is not the case. Ophthalmoscopic anomalies precede demonstrable changes in fusion frequency.

In contrast, measuring the critical frequency of fusion is of considerable value in amblyopia ex anopsia. Here frequency of fusion remains normal and, in fact, may be better than normal. Taken together with the poor visual acuity of such patients this strongly suggests that the underlying mechanism of amblyopia is not ocular but cerebral.

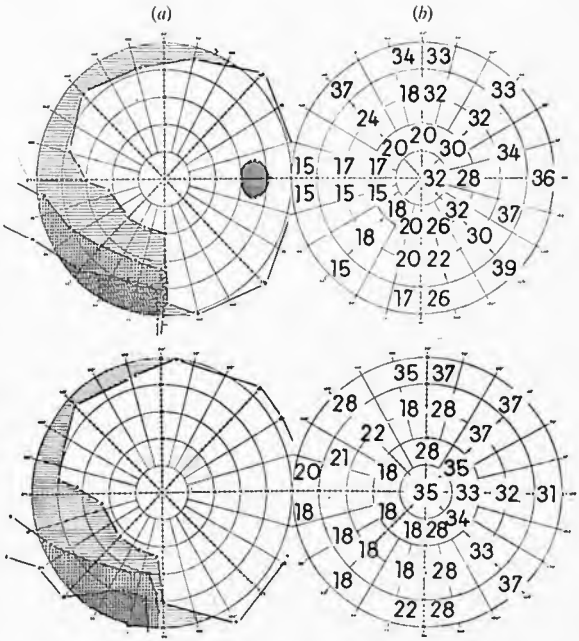

FIG. 38.—Compression of right retrochiasmic optic tract; right intraventricular tumour obliterating the foramen of Monro in a male aged 40 years. Above, right eye; below, left eye. (*a*) Perimetry; homonymous scotoma in the left inferior quadrant, objects 5 and 10/1,000 millimetres (illumination 60 Lux). (*b*) Critical fusion frequency; left homonymous hemianopic reduction. (*After Weekers, R., and Roussel, F.* (1948). *Docum. ophthal.*, 2, 132.)

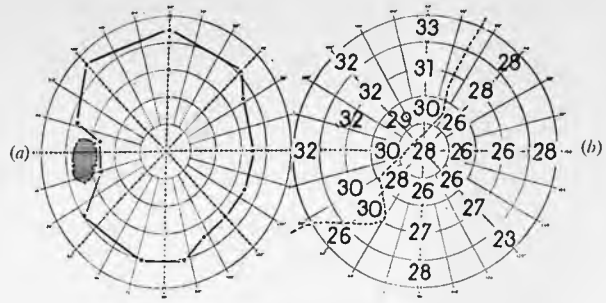

FIG. 39.—Healed retinal detachment in a male aged 55 years. Left eye: healed superior temporal detachment; the detachment had been present for 10 days. Vision at time of test was 5/5. (*a*) Perimetry; object 0·5/1,000 millimetres (illumination 60 Lux). (*b*) Critical fusion frequency; measured 7 months after operation. There is a lowered frequency in the reposed area. Average for originally detached area, 26·6; average for the rest of the retina, 31·0. (*After Weekers, R., and Roussel, F.* (1948). *Docum. ophthal.*, 2, 132.)

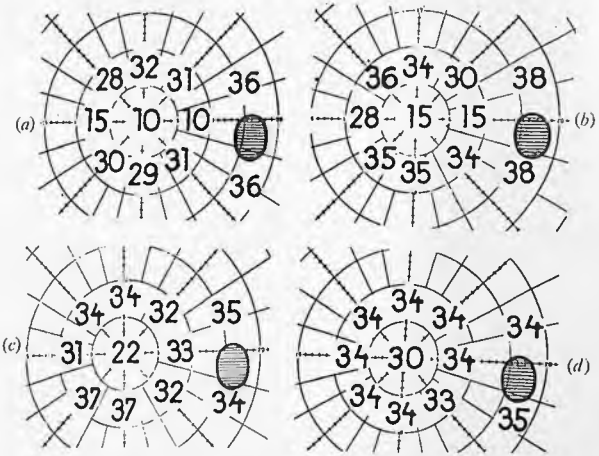

FIG. 40.—Tobacco amblyopia in a male aged 61 years. Right eye. (*a*) Vision was 1/10 and a centro-caecal scotoma was revealed by test objects 5 and 10/1,000 millimetres white. Marked decline of critical frequency of fusion. (*b*) Ten weeks later. The scotoma was still readily revealed with test objects 0·5 and 1/1,000 millimetres, though vision was now 8/10. Critical frequency of fusion was still markedly lowered. (*c*) Three weeks later. Full vision and the scotoma shown only with difficulty with a white test object 0·5/1,000 millimetres; a low critical frequency of fusion was present at the fixation point. (*d*) Ten weeks later. Full vision and no scotoma; there is still reduced critical frequency of fusion at the fixation point. (*After Weekers, R., and Roussel, F.* (1948). *Docum. ophthal.*, 2, 132.)

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