NEW PROTOTYPE CENTRAL FIELD SCOTOMETER*†

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THIS instrument was designed to overcome some of the features in earlier scotometers giving rise to inconsistencies in the results obtained on testing the central visual field (Gradle and Meyer, 1929).

Inconsistent results may arise from difficulty in maintaining fixation (Evans, 1936; Marx, 1920; Raiford, 1954), environmental distractions (Marx, 1920; Raiford, 1954), lack of standardization of screen illumination (Peter, 1920), or of test objects—especially of contrast between test objects and illumination of the screen against which they are displayed.

FIG. 1.—Operator's view of scotometer.

F = Fixation point.
A and B = Controls.
P = Projector.

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These problems have been overcome in some of the more modern types of bowl perimeter and some of the solutions have been incorporated into the design of the prototype described here.

Description

A back-projection method of displaying test objects has been used, following the example of the Gambs perimeter (Étienne, 1954).

The screen is a flat sheet of Perspex on the rear surface of which (the side facing the operator) are engraved the usual meridians at 15° intervals from 0° to 360° and concentric circles drawn on a tangent scale to represent 1° , 2° , 3° , 4° , 5° , 10° , 15° , and 20° from fixation. The screen is calibrated for use at a distance of 1 metre. The side of the screen facing the subject is sand-blasted and then painted white. The calibrations are not visible to the subject, who is presented with an even white surface with a clearly visible fixation point at its centre.

The fixation object is of 50 per cent. reflectance glass (7.5 mm. diam.) mounted in a brass tube set in a hole drilled through the centre of the screen; it reflects light from the screen illumination source to the eye under test. Because it is only of 50 per cent. reflectance, the glass transmits enough light for the operator to observe the eye under test.

Fig. 1 shows the operator's end of the apparatus; F is the fixation point through which the operator can watch the eye he is investigating, also shown in Fig. 3 (overleaf).

The screen viewing distance of 1 metre is fixed by a cylindrical metal hood 1 metre long extending from just outside the 20° circle on the screen towards the subject; when the eye is at the correct distance from the screen most of the visual field is contained within the hood, so visual distractions are almost entirely eliminated. The hood is shown in Fig. 2.

FIG. 2.—Side view of scotometer.

S = Spotlight.
H = Hatch.

Screen illumination and light for the fixation point derive from the same source, a spotlight (as used in the Keeler operating microscope) mounted on the upper surface of the hood half way along it (Figs 2 and 3 S). This throws a spot of light on a small black dot painted on the white lining; on striking this spot the light is diffused by the lining. When the eye is correctly aligned the fixation point appears as an illuminated disc with a black spot at its centre. Fig. 4 (overleaf) shows a ray diagram of the fixation system. Light from the spotlight S falls on the hood lining at the point marked with a black spot. This light is reflected in the fixation glass "M" back to the eye of the subject "E". An image of the illuminated area is seen by the subject at "I". The observer can watch the eye under test from position "O".

FIG. 3.—Patient's end of scotometer.

H = Hatch.
G = Bell push.
F = Fixation point.
S = Spotlight.
K = Mask.

FIG. 4.—Diagram of fixation system.

S = Spotlight.
M = Fixation glass.
E = Eye of subject.
I = Image of illuminated area.
O = Observer.

The eye is positioned by a sighting device placed between the eye under test and the fixation point (Fig. 3); this is a white disc with a hole through its centre on a pivoted arm, at the subject's end of the apparatus. When alignment is correct the subject sees the fixation point through the hole and the operator sees the disc occluding the eye on looking through the fixation aperture. Once alignment is established the disc is swung out of the way. If alignment is not correct the black dot is seen off centre; if it is grossly incorrect the fixation point is seen as a distorted circle or is not visible at all.

The position of the subject's head is controlled from the operator's end of the apparatus. The controls are shown in Fig. 1; knob A moves the screen and hood assembly laterally, knob B raises and lowers the chin rest; the head and chin rest assembly are shown in Fig. 3. "K" is a mask; it shields the bright area projected by the spotlight from the subject.

Projector

Test objects are projected through the screen from the operator's side. The projector is a modification of that supplied with the Gambs perimeter (Étienne, 1954) (Fig. 1 "P" and Fig. 5).

"X" is a push-button on/off switch. "C" is a colour filter selector ring and "N" selects neutral density filters. There is a further control wheel (not shown in Fig. 5) which selects different sizes of test object. The sizes available in the prototype are 1, 3.5, 7, and 15 mm. in diameter. Each of the diaphragms controlling object size incorporates a neutral density filter. The density of these filters is calculated so that the luminous flux of each test object is the same irrespective of size. The other neutral density filters reduce the illumination of the test objects to 1/2, 1/4, 1/8, and 1/16th intensity. Colours available are white, red, green, blue, and amber.

The projector is held in the hand; when in use it is applied to the screen; when applied correctly the test objects are focused accurately onto the inner surface of the screen.

FIG. 5.—Modified Gambs projector.

X = Switch.
C = Colour filter.
N = Neutral density filter.

Projector

Standardization

The intensity of the screen illumination is controlled by an iris diaphragm incorporated in the spotlight as follows. The apparatus is switched on. The largest test object and 1/8th intensity neutral density filter are applied to the screen with the right hand. There is a hatch (Figs 2 and 3 "H") on the upper aspect of the hood, through which the operator can observe screen and test object. The iris diaphragm on the spotlight is adjusted until the test object is just on the point of vanishing. Standardization is then complete and the hatch may be closed.

Technique of Examination

As the apparatus is mounted on a hydraulic table its height may be adjusted to accommodate the subject comfortably.

The test is best performed in a dimly lit or darkened room; stray environmental light falling on the screen may affect the evenness of illumination. As the level of illumination within the apparatus is about 1 foot candle the subject should adapt to this level for 10 minutes before the test is started.

Each eye is tested in turn, the other being occluded. The alignment procedure should be used before each eye is tested. The best results are obtained when the test object is moved from areas of vision towards blind regions; this gives more consistent results than the reverse technique. Scotomata should be explored by moving the test object as nearly at right-angles to their edges as possible. As in any other apparatus using moving test objects, the rate at which the object is

moved depends upon the subject's response rate (Darley, 1950; Chamlin, 1947; Lloyd, 1947). The subject is asked to press a bell-push (Fig. 3 "G") as soon as he loses sight of the test object; this obviates chin movements which affect steadiness of fixation. The bell-push sounds a buzzer; when this sounds the examiner marks the site of disappearance of the test object on the screen with a wax pencil.

The selection of suitable test objects is based on the visual acuity of the subject (Darley, 1950; Thomasson, 1934). For a subject with a visual acuity of say 6/6 or better, the 3.5 mm. object at full intensity is suitable to start with; when the field has been explored with this, a dimmer or smaller object may be used. The second eye is tested without erasing the marks on the screen from the first test, using different coloured wax pencils for each eye.

When the test is completed, results are recorded on special charts designed for the apparatus. These are of two types, a one-fifth scale chart of the whole central 20° and a 1 : 1 scale chart of the central 5° only; this has a hole punched out of the centre which fits around the edge of the fixation apparatus.

The first chart is used to make a scale drawing of the results which are simply copied from the screen. The second is used for direct tracings of events within the central 5°. Both charts are printed in dense black ink on strong tracing paper, making comparison of successive recordings simple. There is space for recording other information relating to the test.

Results

The apparatus has been in use for 9 months, and sixty normal subjects (107 eyes) have been tested. Only one of the subjects had had a visual field test performed before, and none had a past history of ocular disease. All were investigated under the following conditions: distance correction (if needed) was worn; all subjects had a visual acuity of at least 6/6 in the eyes tested; all subjects were allowed at least 10 minutes to adapt to screen lighting. The same three test objects were used in all cases: 3.5 mm. and 1.0 mm. at full intensity and 1.0 mm. at half intensity. The first two were seen to the limit of the screen by most subjects and in most the isopters were slightly flattened in the vertical meridians.

The third test was seen by all subjects except two, both aged over 60. The remainder saw this test to varying distances out from fixation. The younger the subject the wider the isopter to this test.

Twelve patients with known or suspected field defects, referred from the Oxford Eye Hospital, have also been tested.

The following examples have been selected to illustrate particular points, not because they are of special clinical interest.

Fig. 6 shows a typical normal field to the three standard test objects and illustrates flattening of the isopters in the vertical meridians. Fig. 7 is a composite photograph of tracings of five normal blind spots. Fig. 8 shows direct tracings of the central 5° field in a patient recovering from an embolic occlusion of a cilio-retinal artery; these tests were done one month apart, (a) showing an absolute scotoma to 1 mm. test object extending from below fixation to about 7° and (b) showing that the absolute scotoma has diminished in size and has become patchy and surrounded by a relative scotoma to a 1 mm. test object at half intensity. Fig. 9 is the central 5° field of both eyes in a diabetic patient without retinopathy tested on two occasions 3 weeks apart. Both tests on both eyes have been superimposed; there is a small relative scotoma to a 1 mm. test object at half intensity in each field.

FIG. 6.—Normal 20° field.

FIG. 7.—Composite photograph of tracings of five normal blind spots.

FIG. 8.—Central 5° fields in a patient with ?cilio-retinal artery occlusion, taken at an interval of one month.

FIG. 9.—Central 5° fields in a diabetic without retinopathy. Composite tracings of successive visits at an interval of 3 weeks, from both eyes.

Discussion

The examples given illustrate certain points about the apparatus. Fig. 6 merely shows the general conformation of a normal 20° field. Fig. 7 shows the sensitivity of the apparatus; the angioscotomata are not difficult to plot and, indeed, where subjects showed particularly steady fixation, the angioscotoma revealed itself to such an extent that it became more an endurance test for the subject and examiner than a visual field investigation. Fig. 8 shows the repeatability of the test and that the progress of an extremely small paramacular lesion can be followed accurately. This figure demonstrates the chief fault found in the apparatus so far. It will be seen in (a) that the scotoma is lying principally along the 30° meridian. In (b) it appears to have shifted so that it lies along the 45° meridian. This discrepancy is probably due to head tilt.

Fig. 9 shows scotomata in both eyes that would have been undetectable on a Bjerrum screen. The scotoma in the right eye shows the same type of shift as that in Fig. 8. The left eye scotoma appears to have moved away from fixation at the second test. This may be due to a difference in the speed at which the test object was moved, or to a change in the response rate of the patient (Gradle and Meyer, 1929). In spite of these faults, there can be little doubt that the scotomata shown in Fig. 9 remain unchanged.

The apparent rotation of the field can be obviated by ensuring that the patient's head is not tilted, or by modifying the apparatus slightly. It might be sufficient to use a firm occipital strap; although this apparatus is fitted with one (see Figs 2 and 3) it has not been used.

The Figures show that the apparatus is sensitive and consistent in use. This is probably because it uses controlled illumination and standardized contrast test objects, and because fixation is positive and observable.

The subject has no visual distractions outside the apparatus as nearly all his visual field is enclosed. He cannot see the examiner or any irrelevant part of the apparatus; these factors help to produce accuracy in results.

Conclusion

A new prototype central field scotometer is described which incorporates some of the features of a bowl perimeter. The apparatus operates under conditions of controlled lighting and test object contrast and allows observable fixation. Some examples of results are given that show the design to be successful.

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