A SPEED-OF-PERCEPTION MEASUREMENT APPARATUS*

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THIS instrument (Fig. 1), originally called the Accommodation Tachometer, was built to our request in 1950 at the Royal Air Force Technical Research and Development Section, from the design of Mr. Palmer. The parent idea is not original (Robertson, 1935; Ferree and Rand, 1936), but the apparatus

FIG. 1.—Exterior of apparatus showing position of patient and operator.

FIG. 2.—Interior of apparatus showing position of mirrors and electronic timing device.

appears to be so. It was desirable that the machine should be portable so that it could be used in a decompression chamber and in a passenger-carrying aircraft.

Apparatus

By means of ten reflecting mirrors (Fig. 2), the far object is seen at a distance of 22 feet, whilst the near object is viewed directly at a distance of 2 feet.

Since candidates with an

* Received for publication January 27, 1953.

uncorrected vision of 6/6, 6/9 and 6/12 were to be the subjects of this investigation, the letters used for the distant objects were made comparable with those of the Snellen chart. The near object letters were made equal in both size and contrast (which conformed to that given by a black letter on a bright background) to the near type equivalent of Snellen's 6/6 line.

Formerly, separate slides were made, but in order to maintain the patient's attention and to keep his eyes focused on the near object, or relaxed for the distant object, it was found necessary to be able to change the target smoothly and easily. The letters were therefore

FIG. 3.—Letters used for distance test, photographed on a 35 mm. film strip.

photographed on a 35-mm. film strip (Fig. 3). A light metal carrier was constructed to hold the appropriate letter in the target area and to enable the operator to slide different letters into position (Fig. 4). For experimental and demonstration purposes, targets of a

FIG. 4.—Metal carrier holding a near-object letter in the target area.

FIG. 5.—Photographic representation of an altimeter. The settings can be altered by means of the perspex wheel shown on the right.

more practical nature were also constructed. To provide realism a photographic representation of an altimeter (Fig. 5) and an illuminated runway (Fig. 6) were chosen; the boundary lights of the latter roughly subtend the same inside angle as the letter A on the 6/12 line of the Snellen chart. By means of perspex wheels the altimeter settings can be altered as in an aeroplane coming in to land, and the runway can be moved so that it appears to be inclined to one side or other of the vertical. In the original machine, spring-loaded shutters were used to measure the interval of time taken by a subject to adjust his convergence and accommodation.

FIG. 6.—Illuminated runway in diagrammatic form, showing perspex cog-wheels controlling its position.

For many years it has been known that a measurement of the speed rather than of the power of accommodation can afford clinical evidence of the performance of a function which is mainly connected with the relaxation and contraction of the focusing apparatus of the human eye (Robertson, 1936). In the adjustment of vision from near to far, and in the reverse direction, very many factors are involved. The duration and size of the stimulus, the intensity of the light, the size of the pupil and the area of the retina receiving the stimulus will all influence the speed of perception. Natural ability and concentration will again cause individual variations (Strughold, 1949). Although the various factors involved, such as the latent period of the retina and cortex (Adrian and Matthews, 1927, 1928), can and have been separately studied, practical considerations in relation to pilots would point to the total time taken to perceive a near or distant object as being of greater

importance, particularly in these days when the speed of flight is associated with that of sound.

The convergence accommodation power is known to be affected by certain drugs and by conditions involving great physical and mental strain. During the late war an attempt was made to assess the onset of operational fatigue in aircrews by means of repeated clinical examinations. Among a number of tests for ocular function, the deterioration in the convergence accommodation power was found to afford some evidence of fatigue, and it was suggested "that tests of accommodation were sensitive indicators of the re-actions of men to the exceptional stress of their environment at that time" (Reid, 1949).

It seems that a precise measurement of the speed of perception might more nearly reflect the loss of nervous tone and the onset of fatigue than any other short term clinical method.

Since, at the present time, there are no operational tours on which the same aircrew may be exposed night after night to the peculiar dangers of war, the apparatus was used during night operational exercises held by the R.A.F. Sqn.-Ldr. M. F. P. Marshall, who undertook this particular investigation, found that although increasing fatigue adversely influenced the speed of perception, the finer degrees were difficult to measure.

At his suggestion, an electronic timing device (Figs 2 and 7) was fitted. Data supplied

FIG. 7.—Control panel of electronic timing device.

A—Switch controlling illumination of near and distant objects: (1) Green bulb indicating near position. (2) Red bulb indicating distant position.

B—Press-button actuating electronic timing device.

C { Time control (sec.).

D {

by the General Electric Company Research Laboratory shows that the incandescence time of 230v. 40w. lamps is of the order of 0.04 sec. and that the nigrescence time is 0.02 sec. The target is thus visible for approximately 0.02 sec. shorter than is indicated. The settings range from 2 to 0.25 sec. in intervals of 0.1 sec.

Method of Use

The near and distant objects are first shown to the candidate. By means of the electronic device the distant object is then illuminated and the time during which the near target will be visible is selected. When the button is pressed the near target is exposed for the given interval of time after which the distant object automatically comes into view.

An exposure of 0.8 sec. is first selected and this is reduced by 0.2 sec. until the candidate is unable to recognize the near letter. A second attempt is then allowed at the same speed. If the candidate fails again, his speed of perception (distant to near) is recorded as the fastest time in which he could just recognize the near letter. If on the second attempt he calls the near letter correctly he is then tested on an exposure speed 0.2 sec. less.

Between each attempt the letter in the near target, and afterwards the letter in the distant target, is altered. This prevents any prefixation in space to the near position. The whole procedure is then reversed and the speed of perception is measured from near to far.

In order to record on this apparatus the average speed of perception of different age

FIG. 8.—Average perception time for different age groups.

FIG. 9.—Speed of perception related to maximum power of accommodation in young adults.

FIG. 10.—Speed of perception related to muscle balance (measured on Maddox rod at 6 m.).

groups both from near to far and *vice versa* nearly 1,000 men were examined by Ft.-Lieut. J. H. de Graeve (Fig. 8). His findings compare very closely with those in the 628 men examined by Robertson.

Some work has also been carried out on subjects with refractive errors which can be completely or partially overcome without the aid of glasses, and on those who have varying degrees of eso- or exophoria. These findings differ from those of Robertson.

Up to the present, it has been found that, excluding the progressive deterioration of increasing age, hypermetropes are slower than emmetropes (in the far to near test) (Fig. 9) and that the trend of those with an esophoria of 3 pupil diameters and over is in the reverse direction (Fig. 10).

The apparatus is to be taken up in a Shackleton aircraft of the R.A.F. in the near future to assess the effect of long operational flights in modern machines upon the speed of perception. It will also be used in the decompression chamber when the effects of anoxia at different altitudes will be investigated.

Discussion

The practical importance of such measurements lies in the physiological make-up of man. The rate of nerve and muscle conduction and the chain reactions which take place at the lower perceptual levels cannot, in the main, be increased by practice.

In mechanical function, however, the 20th century has seen the birth, growth, and mounting performance of mechanisms, the speed of which has already out-distanced that of sound. Although the perception time (using the term in its broadest sense) varies considerably in different individuals, it is chiefly at the higher levels of recognition and discrimination that this occurs. This time can be reduced by practice, as was demonstrated in aircraft recognition during the recent war, but cannot, it seems, keep pace with modern requirements. To what extent can physiological and perceptual processes continue to direct the velocity of modern machines, particularly at the speed of supersonic flight? To-day this question is more than academic, and it is hoped that the R.A.F. Perception Tachometer will be able to furnish practical data on present problems.

In individual and national conflicts, from the time of Hannibal to the desert battles of Wavell and Rommel, speed has been an important factor. To human minds the lure of speed is magnetic. Each age has its Atalanta, variously disguised. Adventurous men still accept her challenge, though the price of failure is too often the same as in ancient days. Undeterred by the fate of former suitors, they will maintain that with the apple of their creative minds they can, like Hippomenes, snatch the victory—at least in their time. An apparatus of this type may perhaps help to assess their chances of success.

I wish to record my thanks to Sqn. Off. Gwilt and to those officers already mentioned, without whose help the work outlined above could not have been completed.

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