INVOLUNTARY MOVEMENTS OF THE EYE DURING FIXATION AND BLINKING*

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Several authors have investigated recently the small movements of the eyeball which occur during fixation, by recording the movement of a beam of light reflected from the cornea itself (Lord and Wright, 1948), from a small drop of mercury on it (Barlow, 1952), or from a plane mirror on (Ratliff and Riggs, 1950; Ditchburn and Ginsborg, 1953) or attached to (Fender, 1955) a contact lens. These methods have all demonstrated the existence of flicks, originally observed by Adler and Fliegelman (1934), in which the eye rotates through a few minutes of arc in a few hundredths of a second.

We have found that rapid movements of the eye may also be made apparent by viewing a slow running time-base on the face of a cathode-ray oscilloscope. The effect can conveniently be obtained by fixing the gaze on a vertical trace 5 to 10 cm. in length and of spot velocity 50 cm./sec. at a distance of 1 to 2 m. As would be expected, the trace generally has the appearance of a flickering straight line, but from time to time small transient deviations occur. Presumably, movements of the eye cause a displacement of the spot over the retina and the trace appears to be deviated in the opposite direction.

Descriptions of the deviations were obtained from 24 observers. Usually the deviations corresponded to a rapid movement away from the line followed by a slightly slower return (Fig. 1). Their amplitude subtended from 4 to

![Figure 1](http://bjo.bmj.com/)

Fig. 1.—Typical appearance of trace resulting from involuntary movement on fixation. Spot moving downwards.

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30 min. arc at the eye, the great majority being between 10 and 20 min arc. Their duration was between 10 and 30 msec., and they occurred at an average rate of 2 to 40 per min. for the different observers when fixing for periods of 15 to 30 sec. Generally they appeared more frequently on one side of the line than on the other. Their characteristics were independent of the illumination and it did not matter whether the observer fixed a point on the trace or allowed his gaze to wander along it. They occurred more frequently, however, if the observer's concentration was impaired by fatigue.

Similar observations were made with the trace running horizontally. The majority of subjects saw deviations, generally upwards, of 4 min. arc or less; their appearance was distorted by the side-to-side movements which were larger and of velocity comparable with that of the trace. Two observers saw deviations similar in magnitude to the horizontal deviations and three observers saw no vertical deviations.

The duration and magnitude of the deviations are similar to those which would occur as a result of the flicks which have been recorded objectively, and this suggests that the two phenomena are associated. In the case of five subjects, whose eye movements had been previously recorded objectively, it was found that the frequency of the deviations observed subjectively was generally lower than that of the recorded flicks by a factor of two to three. However, observation of random electrical pulses displayed on the base-line showed that the probability of detecting them fell off rapidly when they were reduced to 4 min. arc at the eye. Flicks as small as 2 min. arc have been recorded objectively and this may account for the lower frequencies recorded subjectively.

Allowing that the movements observed by the two methods correspond, it is interesting to note how their form differs. Observed objectively, the eyeball undergoes a more or less constant angular displacement which it maintains for a relatively long time; the trace on the cathode ray tube, on the other hand, suffers only a transient deviation from the baseline. This suggests that a rapid shift of the fixation point over the retina must be associated with the flick.

Separate images of the trace could be seen by the two eyes by placing a prism in front of one of them. The deviations of the two traces appeared identical both in the horizontal and vertical directions. This remained true when a contact lens was inserted into one eye only, thus confirming that the contact lens has no appreciable effect on the movement of the eye during a flick.

Ginsborg (1952), recording the reflection of a beam of light from a contact lens during a blink, concluded that the eyes made an inward and upward movement. The geometry of his apparatus, however, allowed eye movements during blinking to be investigated only when the eyes were initially looking in one fixed direction. These movements can be observed subjectively with the observer looking initially in any direction. The time-base of
a cathode-ray oscilloscope is viewed with one eye only under the conditions described earlier with the head tilted or turned at the required angle. Voluntary blinks and protective blinks, excited by lightly striking the face in the region of the eye with rubber tubing, give similar movements, the latter being more rapid. When the head is turned to the left, the image of the vertical trace deviates to the right on blinking, and vice versa (Fig. 2).

![Fig. 2.—Appearance of trace on blinking, observed with right eye with head turned to left. Spot moving downwards.](image)

This result, obtained with either eye, shows that they rotate towards the primary position at the beginning of the blink. Corresponding movements of the horizontal trace are obtained on blinking when the head is tilted forwards or backwards. There is a position of the eye, looking slightly downwards and about 10° inwards, from which no marked deviation of the trace occurs. Since there is no rotation of the eye up to the time the lids cover the pupil it is probable that the eye takes up this position when the lids are shut.

REFERENCES


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