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Fixation and perception

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Boyce and West [3] have recently recorded eye-position while subjects were instructed to fixate successively the apices of the two Müller–Lyer figures. Provided that the two figures were simultaneously present in the visual field, the separation of the mean fixation points during observation of the underestimated figure was found to be significantly less than the corresponding distance recorded during inspection of the overestimated one. Boyce and West conclude that they have demonstrated an effect of perception upon fixation.

A very similar experiment was performed by Delabarre in 1897 and is described in his preliminary note " A Method of Recording Eye Movements " [4]. Delabarre's apparatus, though relatively primitive, and his results, though never reported in detail, were very comparable to those of Boyce and West. Initially he employed an optical-lever system, recording directly on to a photographic plate, but difficulties with the plate led him to settle on a mechanical method. Delabarre [4, 5] considered that he had shown an effect of fixation upon perception.

Effects of both duration and locus of fixation upon perception, and in particular upon the magnitude of the geometrical illusions, have been reported [9, 12, 15, 17], and it is probable that causality is present in both directions, but the persistence of the classical distortions in after-images, and with tachistoscopic or stabilized presentation [10, 13], renders implausible a primary explanation of the geometrical illusions in terms of eye-movement or eye-position. There remains the third possibility that the fixational effect is causally independent of the perceptual distortion.

Boyce and West themselves considered the hypothesis that the fixation control mechanism seeks the position at which maximum information may be secured, and attempted by their second experiment to exclude this possibility. They state, without discussion, that the Müller–Lyer illusion is destroyed when each figure is observed alone. Repeating their measurements with only the fixated figure present in the visual field they found that there was now no difference in the distances between the mean fixation points. This second finding would seem strong evidence against any hypothesis proposing the independence of the perceptual and fixational anomalies.

Yet the suggestion that the perceptual target differs from the geometrical target only when the second figure is present is a curious and unsubstantiated one. How far, spatially and temporally, may the second figure be removed

before interaction ceases and the illusion is abolished? Must the subject, during fixation, make continual comparison between the two figures? The illusion certainly persists when one of the figures is separately compared with a single plane line [1, 8]; and, if one figure is fixated in a tachistoscope and the second is then presented in the adjacent visual field, no change is observed in the length of the fixated figure. To demonstrate conclusively that the distortion of visual space is present in the absence of any form of comparison stimulus would be difficult, but the assumption that it is abolished has far too little empirical foundation to sustain a further hypothesis.

Although the large inter-subject differences are unexplained, it is particularly strange that with only a single figure present in the visual field two of the three subjects show, for both figures, a significantly lower mean separation than they generated when fixating the underestimated figure in the presence of the over-estimated; thus, in the postulated absence of illusion, the separations are now further from the veridical value. Unless this discrepancy is accounted for, no weight can be placed on the absence of a significant difference in the second experiment. Indeed, owing to the possibility of a ceiling effect [16], it is generally illegitimate to argue from the absence of a significant difference under a second condition if the values obtained under this condition lie outside the range of those secured under the first condition.

Thus the possibility of causal independence has not been satisfactorily eliminated. An alternative hypothesis to that of the 'maximum information position', discussed by Boyce and West, would propose that the adjacent fins, and probably more distant elements of the configuration, themselves elicit fixation reflexes and thereby introduce directional biases in the excursions from the desired fixation point and consequent displacements of the mean recorded eye-position.

Whereas there has been considerable investigation of the effects upon fixation of several parameters of symmetrical test-objects [2, 14], the especially interesting effects of asymmetric, extra-foveal, or extra-macular stimuli have not been systematically examined. Although Delabarre [5], McAllister [11], and Dodge [6] all considered this problem, and although such effects constituted a classical objection to the after-image methods of observing eye-movements, there remains remarkably little information concerning the influence on fixation of the position, luminance, contrast, size, wavelength, flicker and movement of stimuli elsewhere in the visual field. The relative influence of such stimuli on involuntary eye-movements during fixation might prove a useful indication of their attentional properties.

Gaader [7] has demonstrated that during observation of a pattern asymmetrically distributed about the fixation point the average saccade has a direction opposite to that of the pattern: the very strong suggestion is that drift is predominantly towards the pattern. It is not impossible that this phenomenon, which is of an appropriate order of magnitude, will account for the results secured by Boyce and West: at the very least its influence must be controlled.

Such an explanation would differ from that of the 'maximum information position' in supposing that mean recorded eye-position does not coincide with the preferred or optimal locus or area: the latter is not displaced, but the excursions from it are determined both by the immediately adjacent obliques and by more distant segments of both figures.

Judd [8], in 1905, employing several variants of the Müller–Lyer figures performed essentially the same experiment, and denied the result reported earlier by Delabarre and now by Boyce and West. Although his figures were considerably larger than those of Boyce and West, the discrepancy may be verbal, since Judd, rather than recording mean position, defined fixations displaced from the required position as lapses from fixation. At the least, he demonstrated a very marked tendency for fixations to occur within the angle of the underestimated figure.

" The way in which fixation works up into the angles of a Müller–Lyer illusion, when the illusion is most strongly seen, seems to indicate not so much the motor organisation of the visual processes as rather the obvious fact that, in spite of intent and introspective assurance, the real object whose partial prefixational perception occasions the eye movement is something other than the exact point of intersection of the lines " [6].

It is uncertain whether the result of Boyce and West's second experiment as well as their primary finding may be explained by the phenomenon described by Gaader: a stimulus elsewhere in the visual field is now absent, but the four quadrants were not equipollent in Gaader's experiment, and we have data on only a single eye.

In Boyce and West's third experiment (cf. 8) geometry and perception varied concomitantly and consequently these results are subject to the difficulties considered earlier.

The intimate association of perception and fixation during inspection of the Müller–Lyer figure has yet again been demonstrated and has been measured more accurately than before, but the character and direction of the causal relation remain open to conjecture.

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