Effect of viewing distance on fixation characteristics in typical observers

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Abstract

Purpose : Fixation is the state in which the eyes foveate a target. Previous studies on fixation stability were undertaken at distances of 40cm or greater, and thus have not systematically examined the effect of viewing distance (hence vergence). In some cases of visual impairment, evidence suggests that fixation is more stable while viewing at near. However, the effect of vergence on fixation in typical participants is not known. This study, therefore, explores the stability of fixation with viewing distance, in those without visual impairment.

Methods : Eye position was measured at 1000Hz over 15secs for 10 participants (4 females; mean age, 26.9 years; range, 22–37 years), as they binocularly viewed a 0.5° dot, at 300, 100, 50 and 25cm. Using the last 5secs of data, a bivariate probability density function was used to determine the accuracy and precision with which participants fixated. The isocontour surrounding the gaze positions with the highest 68% probability density were selected for further analysis. Accuracy was computed as the vector from the target position to the centroid of the 68% isocontour, while precision was quantified using the isocontour area and shape, as well as the orientation of its major axis. A repeated measures ANOVA was used to compare the effect of distance. Where Mauchly's test indicated assumption of sphericity was violated, the Greenhouse-Geisser correction was used.

Results : There was no significant main effect of viewing distance on mean accuracy ($F_{1.690,15.208}$ = 0.935, p = 0.399, η^2 = 0.047), contour area ($F_{3,27}$ = 0.293, p = 0.830, η^2 = 0.022) or shape ($F_{3,27}$ = 0.641, p = 0.595, η^2 = 0.048). Between participants, the orientation of the isocontour major axis was similar at all viewing distances (Rayleigh test; $p<0.05$), except for the left eye at 100cm (mean = 34.66°; 95CI ±55.5°; p = 0.06) and

at 300cm (mean = -41.23°; 95CI ±72.35°; p = 0.12), respectively. Within participants, the orientation of the isocontour major axis was similar at all viewing distances in 7 out of the 10 participants (Rayleigh test; p <0.05).

Conclusions : We found no evidence that distance, and therefore convergence, influences the stability of fixation. We conclude that fixation may not have to be more precise for successful near work. The results suggest that, in a typical classroom for example, where viewing distance varies, the ability of typical students to fixate adequately is unaffected.

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