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Eye-hand reference frames misalign after central field loss

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Footnotes

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Abstract

Purpose: When central vision is lost and a preferred retinal locus (PRL) develops in the periphery, typical eye-hand coordination may be disrupted. In cases of AMD, reach initiation is delayed (Timberlake et al., 2011) and saccades can be misdirected (Renninger et al., 2012). This work examines the degree to which the reach trajectory is affected by central field loss (CFL).

Methods: Subjects with CFL and age-matched controls performed a rapid reach to a high contrast dot on a touch sensitive screen. The dot can occur in 1 of 8 locations surrounding fixation at varying distances. Subjects received negative feedback if reach time or touch endpoint error criteria was violated. Reach time limits were determined for each subject during practice trials. **Accepted**

decline. Eye and hand movement trajectories were tracked (SR Eyelink 1000 and Polhemus Liberty Motion Tracker) and touch endpoints were collected (ELO Touchscreen). Viewing was binocular, with tracking of the dominant/better eye. Monocular scotoma and PRL locations were measured with microperimetry. The foveal pit was localized relative to the scotoma and PRL utilizing optical coherence tomography (OCT/SLO by Optos). Reach trajectories were analyzed for initiation time, peak velocity, total duration, tortuosity and directional bias. Accuracy and precision of endpoint errors were also analyzed.

Results: Reach initiation was delayed relative to age-matched healthy controls, yet overall trajectories were smooth and exhibited age-appropriate dynamics. Eye movements tended to bring the fixational PRL close to the target before onset of reach initiation. Directionality of the reach toward the target exhibited more variability in CFL subjects, yet endpoint precision was not worse than predicted given PRL eccentricity (i.e., visual acuity). In several cases, PRL landing was notably biased off of the target in a direction that pulled the non-functioning fovea closer to the target, suggesting incomplete re-referencing of eye-hand coordination to the PRL.

Conclusions: In many cases of CFL, fixation is re-referenced to the PRL. This “remapping” does not always extend completely to the hand, resulting in an offset between PRL and reach endpoints. The misalignment between the eye and hand may pose a problem for dexterity, especially when moving under time pressure. Rehabilitation that targets eye-hand realignment may provide a benefit.

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