Gaze behavior with myopia management lenses

Poster #4648 - 0483

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Purpose

Myopia management (MM) spectacle lenses have a central clear-zone without defocus or contrast reducing elements, surrounded by peripheral treatment regions with altered image quality. However, natural gaze constantly shifts the line of sight across these peripheral lens zones, moving their effects dynamically over the retina. The current study demonstrates an individual kinematic gaze fingerprint of MM lenses by analyzing head movements.

Methods

Study Procedures

Gaze movements of 10 adult participants (mean age 32±5 years) were recorded in a randomized manner with Pupil Labs neon eye tracker (Pupil Labs, Berlin, Germany) directly after dispensing prescription ZEISS MyoCare (MC), ZEISS MyoEase (ME), and Single Vision spectacle lenses (SV) (ZEISS Vision International GmbH, Germany), fit into Pupil Labs neon's lens holders. Each participant performed 10 trials of a high contrast search task on a computer screen identifying randomly distributed capital letters of size 20 arc min in an alphabetical order. Each trial lasted 1 minute or until task was solved. Average recording time was 8 min per lens. Participants were instructed to move their head and or eyes naturally during the task.

Figure 1. A) Schematic representation of search task. B) Microstructure layout of MyoCare (MC, left) and MyoEase (ME, right). In MC, structures densely cover whole lens periphery. ME shows four rings with larger inter-ring spaces

Measures: Head kinematics were analyzed. Amount of head movement was estimated as the length of the overall head trajectory. Head movement direction frequencies as well as average speed were estimated on sample-to-sample velocity.

Analysis: For up/downward head movement respective half-field of angles (±90°) of head velocities above threshold were summed up. For pairwise comparisons between conditions (MC, ME, SV) Bonferroni-corrected t-tests were performed in MATLAB.

Results

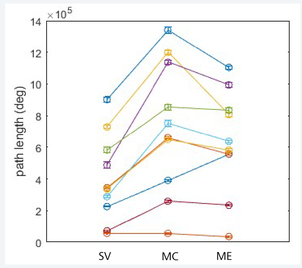

Figure 2 details overall head movement length for each individual with SV, MC and ME respectively, with grouped mean of 402, 729 and 634kdeg with SV, MC and ME respectively; $p < 0.0001$ SV vs. MC, $p < 0.0001$ SV vs. ME, $p = 0.07$ MC vs. ME. *Error bar show standard deviations between trials.*

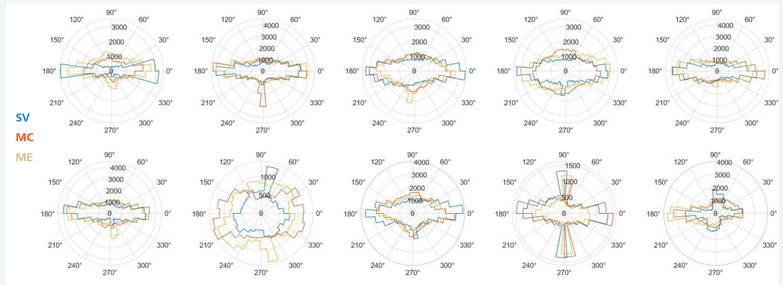

Figure 3. Single subject head movement direction frequency with different lenses in polar representations. SV blue, MC red, ME yellow

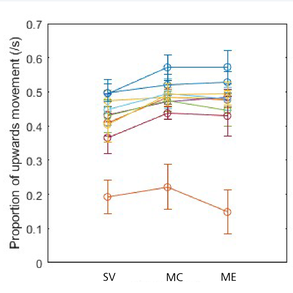

Figure 4. Frequency of upward head movement in individuals with SV, MC and ME. Upward head movements were significantly more frequent in MC compared to SV: 42% in SV, 46.5% in MC, 45.1% in ME; $p < 0.0001$ SV vs. MC, $p < 0.05$ SV vs. ME, $p = 0.17$ MC vs. ME. *Error bars show standard deviations between trials.*

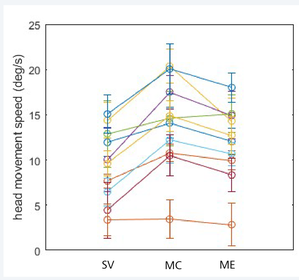

Figure 5. Average head movement speed (HMS) in individuals with SV, MC and ME. HMS differed across the conditions with an average HMS of 9.5, 13.8 and 11.9 deg/sec with SV, MC and ME respectively; $p < 0.0001$ SV vs. MC, $p < 0.01$ SV vs. ME, $p < 0.01$ MC vs. ME. Overall HMS was 11.8±4.7 deg/sec. *Error bars show standard deviations between trials.*

Discussion

- We found that wear of MM spectacles spontaneously increased head movements as compared to SV. This was true for head movement length as well as HMS. In these novice MM lens wearers, this likely represents an effortless, instantaneous adjustment of head movements in response to altered image quality in the lens periphery to maintain good vision (1, 2, 3, 5).
- We found that head movement speed was greater with MC than ME or SV. In ME, the elements to treat myopia progression were limited only the paracentral region (up to 29 mm) whereas in MC they extended over the full lens periphery. Furthermore, the zone in between lens elements was larger (0.5mm in MC to 2.0mm in ME) indicating that the arrangement of the lens elements plays a role.
- Upwards head movements were significantly more frequent in both, MC and ME, compared to SV, where head movements were rare. An increase in head movements while performing the search task with MM spectacles might represent a new type of head movement, which intends to center gaze to look through the clear central zone.

Conclusion

- Novice MM lens wearers instantly changed head movement behavior, likely to maximize phases of clear vision.
- Head movements increased, varied in specific directions and increased in speed with MM spectacle lens.
- Future directions should evaluate how gaze changes during and after long-term adaptation to MM lenses. Studies should compare gaze of adapted and un-adapted MM spectacle lens wearers. Behavior of young spectacle lens wearers is of major interest.

References

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