Accommodation in virtual reality

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Abstract

Purpose: To investigate how accommodation responses differ between natural viewing conditions and virtual reality environments.

Methods: Monocular accommodative responses (AR) were measured objectively (WAM-5500 and PowerRefII) for 5.00D of accommodation stimulation (AS) in three independent studies. The first study analyzed the effect of the following parameters: stimulation method (real space vs. Badal optometer), field of view (FOV), instrument's proximity, stimuli angular size, and the peripheral interposition of objects in depth. In the second study, the effect of apparent depth on accommodation was analyzed by comparison of the AR when looking to a natural scene with peripheral depth cues and when a photograph of the same scene was displayed through a Badal optometer. The third study analyzed the interactions and main effects on AR of the following parameters: stimulation method, stimulus depth (planar vs volumetric stimulus) and FOV for emmetropes (EMM), late-onset myopes (LOM) and early-onset myopes (EOM).

Results: In the first study, AR showed larger accommodation lags for the Badal Optometer configuration compared to the natural viewing conditions ($Mean_{Diff}$=0.58±0.53D; $p<0.001$). For each of the parameters analyzed, only varying the interposition of objects in depth significantly affected AR ($Mean_{Diff}$=0.29±0.36D; $p<0.05$). In the second study, no significant differences were found between AR for natural scenes compared to the displayed photograph in a Badal Optometer configuration ($Mean_{Diff}$=0.25±0.93D; $p=0.89$). In the third study, a significant interaction was found for the type of stimulation method, stimulus depth and refractive group ($p=0.03$). When controlling for the individual interactions, LOM showed larger lags than EMM and EOM. The most accurate AR was obtained for a FOV between 8º to 10º, and it did not significantly differed among the stimulation methods or stimulus depth used.

Conclusions:

Badal optometers affect AR through a combination of some or all of the studied parameters. AR presented in a Badal optometer configuration may be significantly improved by displaying a realistic image rich in depth cues. Previously reported differences in AR between lens-based compared to natural viewing stimulation methods may be explained by the effect of factors such as the FOV or the depth of the stimulus.