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Title: Pupil-tracking-based determination of visual acuity

Purpose: The measurement of visual acuity (VA) is an essential tool in daily clinical practice. Standard procedures are based on question-and-answer protocols involving a conscious response from the patient, which is slow and can be difficult or even unfeasible in some cases. The purpose of this work is to develop and test a procedure to measure VA based on subject's fixation changes, which are fairly instinctive and require a lower level of consciousness.

Methods: We developed a custom-made pupil tracking system and software to detect subject's fixation changes in response to stimuli presentation. VA was measured in 5 subjects with a two-alternative (left/right) forced-choice-like protocol using pupil tracking data and, simultaneously, using subject's answers. Stimuli consisted of 0.5-deg-wide maximum-contrast checkerboards 0.5 deg off-center. The experiment consisted of a randomized sequence of 50 2-sec presentations comprising 10 repetitions for 5 square sizes in 0.1 steps of equivalent decimal VA around the smallest square size still rendering the checkerboard visible, which was determined by adjustment prior to the experiment. Between presentations, a central fixation target was turned on for 2 sec. Subjective and pupil-tracking VA estimates were obtained by sigmoid fitting the percentage of correct answers and correct average direction of fixation during stimulus presentation, respectively.

Results: The correlation between measured VAs with both methods was very good ($R=0.988$) with virtually unit slope (1.013). Differences between VA estimates were small but positive in all 5 subjects (0.13 to 0.04 range; 0.07 mean), implying a slight underestimation by the pupil-tracking method, possibly due to the simple decision criterion used to determine whether the subject was fixating on the stimulus (i.e., seeing it).

Conclusions: We developed a pupil tracking-based method reliably providing VA estimates similar to those obtained by a standard subjective method, suppressing the requirement of a subject's decision and answer. This method can be of interest in patients with difficulty to understand and/or perform the subjective task, and, with an optimized protocol, could speed up VA measurement in clinical settings.