Fast automated subjective refraction

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Purpose: To investigate a new method to perform a fast non-cycloplegic refraction that includes the patient's psychophysical response without clinician support.

Methods: Seventy-five healthy subjects were measured twice with the FASR (test-retest) and once with the conventional clinical refraction procedure (CSR). FASR procedure started from the objective refraction (sph, cyl, ax) obtained with an autorefractometer and computed all possible refractions in the interval [(sph-0.50, cyl, ax):(sph+1.50, cyl+1, ax)] in steps of 0.25 D for cylinder and sphere. All the generated refractions were transformed to power vectors and the Euclidean distances with respect the objective refraction were sorted. Then, the root finding bisection algorithm was applied to the Euclidean distances. The algorithm was implemented on a stereoscopic virtual reality system capable of changing sphero-cylindrical refractions according to patient's responses that also has an embedded autorefractometer (Eye and Vision Analyzer, EVA, Davalor Salud Spain). Main outcome measure: spherical equivalent (M) and Jackson cross-cylinder (J_0 and J_{45})

Results: The new proposed method took 4 minutes and 12 seconds (± 99 seconds) and the conventional standard procedure took 12 minutes and 5 seconds (± 316 seconds). The time difference was statistically significant (paired sample t-test, $p<0.01$, $t=-19.71$). The within-subject standard deviations between test-retest (i.e., repeatability) of the new method for the right eye were 0.30, 0.12 and 0.06 D for M, J_0 and J_{45}, respectively. The mean power vector (M, J_0 and J_{45}) differences (±SD) for the right eye between the new method and the conventional procedure were, respectively, 0.08 (±0.36), -0.02 (±0.17) and -0.03 D (±0.09).

Conclusions: The repeatability of the new method and the agreement with conventional subjective refraction are similar to the repeatability and reproducibility of the conventional subjective refraction reported in other studies. While this method presents some limitations that warrant further investigation (e.g., neural response to virtual reality displays), the results of this study show a potential fast, new method of performing subjective refraction without clinician support in a healthy population.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.: According to the most recent estimates from the World Health Organization (WHO), the
uncorrected myopia, hyperopia and astigmatism are the main causes of visual impairment, affecting 43% of the global population. Since the measurement of these variables are some of the most common tests performed by optometrists and ophthalmologists, any improvement in the methodology and instrumentation will have a great impact on the general population.
This study presents a new method to determine the degree of myopia, hyperopia and astigmatism in an automated fast procedure. It takes into account the patient's perception of blur and it is not dependent on clinician skills.