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## Depth of Focus for Different Aberration Patterns Using an Adaptive-Optics Vision Simulator

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### Abstract

**Purpose:** To use an adaptive optics vision simulator (AOVS) to explore the impact of different aberration patterns on subjective depth of focus (DOF) determined using through-focus reading acuity. These tests will also be used to examine the suitability of optical metrics for predicting subjective DOF.

**Methods:** An AOVS was constructed that allows us to simultaneously manipulate the effective ocular wavefront aberration and measure the resulting visual performance through different object vergences. Simulator testing was performed in white light on 3 subjects with a 4.8 mm pupil and paralyzed accommodation. DOF was determined in each subject for 6 cases of aberration: 1) the subject's natural aberration pattern; 2) all aberrations corrected; 3) positive spherical aberration of 0.22 µm, 4) negative spherical aberration of 0.22 µm; 5) vertical coma of 0.22µm; and 6) astigmatism at 45° of 0.22µm. Reading acuity was determined for each of the 6 cases at best focus. Subsequently, subjective DOF was evaluated for these cases by determining the positive and negative defocus range for which the subject had acceptable reading acuity for a letter size twice that of their peak acuity. The ocular wavefront aberration was recorded at each focus position and used to determine MTF for corresponding spatial frequencies as well as MTF volume and encircled energy, thus enabling a comparison of objective DOF and subjective DOF.

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**Results:** Correcting all of the monochromatic aberrations of the eye decreased DOF. Differences in DOF were measured for the 4 different cases with similar RMS values. A comparison of optical DOF and subjective DOF showed similar trends for the 6 cases, but MTF volume is not a strong predictor of subjectively determined DOF using reading acuity. MTF values at the selected letter sizes are better optical predictors of DOF.

**Conclusions:** Using an AOVS it was determined that inducing different types of higher-order aberration patterns results in different measured values of subjectively measured DOF. An AOVS is a powerful tool that can be used to investigate the optical factors that contribute to subjective DOF.

**Keywords:** aberrations • optical properties • refractive surgery: optical quality



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