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## Impact of the Aberrations of Progressive Power Lenses on Visual Acuity

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### Abstract

**Purpose:** To evaluate how the aberrations present at different locations of progressive power lenses (PPL), used during normal viewing, affect visual performance.

**Methods:** A Hartmann-Shack wave-front sensor was used to measure ophthalmic progressive power lenses isolated or in combination with the eye. An additional channel in the experimental setup allowed to perform visual testing under controlled optical conditions. We measured the wave-front aberrations at six relevant locations across a PPL (plano lens, 2D power addition). These aberration maps were coupled with the aberrations of three normal eyes. In order to evaluate the optical quality, three optical parameters were computed from the aberrations: RMS (root-mean square), Strehl ratio and the logarithm of the volume of the point spread function (Log\_Vol\_PSF). Both high and low contrast visual acuity (VA) were measured in green light when the subjects looked through the selected locations of the PPL. All measurements were obtained for 3 and 4.5-mm pupil diameters.

**Results:** Small amounts of astigmatism, coma and trefoil (around 0.05 microns each one, for 4.5-mm pupil diameter) were found in areas of the corridor of the PPL. In other peripheral locations, astigmatism increases while other aberrations remained within the same small values as in the corridor. Both optical and visual quality parameters when the eyes looked through the corridor areas of the PPL were similar to those of the naked eye. High and low contrast VA expressed as MAR ranged between 0.6-1.0 and 1.2-1.9 arcmin respectively, while in the naked eyes these ranges were 0.6-1.1 and 1.3-1.8 arcmin. Outside the corridor, the optical quality of the eye plus lens decreased, mainly due to the astigmatism of the lens. However, even for these peripheral locations, visual acuity remained relatively stable. For example, high contrast VA at locations 3 and 6 mm from the corridor were 0.7-1.3 and 0.8-1.7 arcmin respectively.

**Conclusions:** The small amounts of astigmatism and higher order aberrations, mainly coma and trefoil,

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that are present in the central (corridor) areas of progressive lenses appear to have a limited impact on VA. In these locations, aberration coupling between eye and PPL can even yield slightly better VA than in the naked eye. However, at peripheral areas of the lens larger amounts of astigmatism moderately reduce visual acuity.

**Keywords:** physiological optics • visual acuity • astigmatism



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