The aberrations of the human optical system's components appear to compensate for each other, and this phenomenon is markedly different in myopic and hyperopic eyes, reported Spanish researchers at the annual meeting of the Association for Research in Vision and Ophthalmology (ARVO).

The cornea and internal media can be more aberrated than the total eye and the opposing aberrations can compensate for each other in young eyes. The mechanism of this compensation is not well understood, commented Antonio Benito MD, University of Murcia, Spain.

To determine if this compensation is an active or passive effect, Dr Benito studied 57 myopes and 16 hyperopes with vision ranging from -9.0 D to +8.0 D. He used a prototype Hartmann-Shack wavefront sensor, ray-tracing and corneal topography to measure total and corneal wavefront aberrations.

In every eye, the distance from the corneal vertex to the pupil centre was estimated. That distance is related to kappa angle, which is highly dependent on the subject's refractive error; he noted.

In myopes, the average RMS error of the whole eye was lower than that of its components, indicating still better compensation, he reported.

Dr Benito and his colleagues also examined how well the eye's components compensated for each particular aberrational term. They found that spherical aberration was similarly well compensated for in both groups. Overall, the aberration was positive for the cornea (mean: 0.19 microns) and negative for the lens (mean: -0.14 microns).

However, the internal components compensated significantly better for horizontal coma of the cornea in hyperopes than in myopes. The average values for corneal/internal aberrations were 0.09/-0.1 microns in myopes versus 0.25/-0.3 microns in hyperopes. Thus it appears that the lateral coma is responsible for the major compensation in the hyperopes, he said.

The average distance from the corneal vertex to the pupil centre was also higher in hyperopes (0.26 mm) than in myopes (0.7 mm). The horizontal decentration of the pupil correlated with both corneal and internal horizontal coma.

Dr Benito explained that these findings imply a simple, passive model to explain compensation. If the kappa angle is small, the dominant term is spherical aberration (positive for cornea, negative for internal and compensated). As angle kappa increases, the components tilt in the same direction, also induce coma with the same magnitude but opposite sign, which is again compensated.

"This is a self-correcting mechanism, with the lens and cornea displacement cancelling each other," he said.

In a related study, Norberto Lopez-Gil PhD and his group, "Ciencias de la Visión", also from the University of Murcia together with another researcher from the University Paris-Sud 11, examined the relationship of accommodative ability, age, and wavefront error differences to try and develop a more realistic age-related model for the accommodation mechanism.

The team measured accommodation using a new Imagine-Eyes Irx3 aberrometer (Figure 1) on 70 eyes of 40 healthy volunteers aged 20 to 60 years. Patients were divided into four age groups: 20-30 years, 30-40 years, 40-50 years, and 50-60 years. All had astigmatism of less than 1.25 D.

The volunteers were presented with an image at far point (0 D), which was then moved automatically up to 20 cm (5.0 D) by 0.5 D steps, with the wavefront measured after each step using infrared light. The changes in different aberrations were represented as a function of accommodation.

The study showed a very large variation among subjects, but no clear relationships between accommodation, age, and wavefront error. In the case of higher-order aberrations, there were large variations, but no pattern.

Coma did show a tendency to decrease in the young group at higher accommodation however it was more stable in the middle group and increased in the older group. There was a similar finding for trefoil. The same basic tendencies were found if the accommodation was limited to just between 0.0 D and 1.0 D.

"You get a clear decrease in spherical aberrations as a function of accommodation in the young group. We saw no clear tendency for the middle-aged group, and a clear tendency to increase in the old group," Dr Lopez-Gil said. Asked about seeing a change in spherical aberration in people 50-60 whose lenses probably aren't doing much of anything during accommodation, Dr Lopez-Gil wasn't sure how to explain the findings.

"We are not totally sure about the interpretation of that," he said.