Every Person Has His/Her Own Code to Perceive Images as Sharp

Aug. 26, 2013 (Boston) -- A study by collaborative teams at Schepens Eye Research Institute/Massachusetts Eye and Ear Infirmary and the Institute of Optics, CSIC, Madrid, Spain, has determined for the first time the visual internal code for blur, which an individual employs to perceive the images as sharp. The study, published in the PLOS ONE journal, demonstrates that the magnitude and orientation of the optical blur match that of the retinal image projected by the individual's own optical system.

The optical system of the eye, formed by the cornea and crystalline lens, projects the images of the outside world on the retina. The imperfections of these lenses and the misalignment between them produce a degradation of the retinal image. For example, when a light point is observed, the optical system forms a degraded image on the retina, i.e., a blurred, generally asymmetric, irregular spot. The level of blur varies across people. Also, the concept for what is visually clear or blurred depends on everyone's prior visual experience.

These effects are well known for the optical errors that can be corrected with spectacle lenses or standard contact lenses. In this study the team measured the effect of the residual small imperfections (called aberrations) that remain once the best glasses were fitted.

"The study demonstrates that observers consider as less blurred those images that are degraded by imperfections similar to those present in their own eyes, even if the magnitude of optical blur is similar to their own," explains Professor Susana Marcos, from the Institute of Optics, CSIC.

WE DON'T LIKE TO SEE THROUGH THE EYES OF ANOTHER
To determine the blur pattern that each person considers optimal, the research team used a novel measurement method.

The researchers asked a group of normally sighted subjects to evaluate the quality of hundreds of images with the same magnitude of blur (i.e., an automatic system for image blur calculation would consider them as equal), but with variable orientations, corresponding to those measured in 100 different eyes. The images were projected through an adaptive optics system, which corrected the natural optical imperfections of the subject as well as his spectacle correction.

"This way we evaluated only the neural component of perception," said Susana Marcos, Ph.D., of the Institute of Optics, CSIC. "However, whereas all images were optically equivalent, the participants chose those that were blurred through image processing with

imperfections similar to those of their own eyes, and rejected those from others. The truth is that we don't like to see through the eyes of another."

These results represent for the first time the visual internal code for blur in an individual was measured, but they also have clinical implications, as different pathologies and optical corrections, by lenses or surgery can, and do, change the imperfections of the eyes.

“With regard to the small amounts of blur or visual aberrations, we found that each person adapts to their own visual aberration,” explains Eli Peli, O.D., of Schepens Eye Research Institute/Mass. Eye and Ear, who is also an author on the paper.

“Every eye has optical aberrations. Most people are unaware of their own aberration or blur because each person’s brain learns or adjusts to their own optical aberrations, i.e., those specific to each person. If disease or treatment changes these aberrations, the image will be perceived to be blurrier than before even with best correcting glasses or contact lenses.

However, in time it is expected that the brain will readapt to the new imperfections and the spectacle-corrected image will be perceived to be sharp again. Importantly, if novel correction will improve (reduce the imperfections of the eye’s optics) the perception may be normalized again by the adaptation, but visual performance will remain better.”

About Mass. Eye and Ear

Founded in 1824, Massachusetts Eye and Ear Infirmary is an independent specialty hospital providing patient care for disorders of the eye, ear, nose, throat, head and neck. Mass. Eye and Ear is an international leader in Ophthalmology and Otolaryngology research and a teaching partner of Harvard Medical School. In 2011, the Massachusetts Eye and Ear Infirmary and Schepens Eye Research Institute formed the world’s largest and most robust private basic and clinical ophthalmology research enterprise. For more information, call 617-523-7900 or visit http://www.masseyeandear.org/.

Lucie Sawides, Carlos Dorronsoro, Andrew M. Haun, Eli Peli and Susana Marcos. Using Pattern Classification to Measure Adaptation to the Orientation of High Order Aberrations. PLOS ONE.
http://dx.plos.org/10.1371/journal.pone.0070856