Wavefront custom ablation, what are we missing?

Laurent Castellucci in Anaheim

UNDERSTANDING the central processing of information in the visual system may be the next great hurdle on the road to super vision. Lost amid the hype of wavefront custom ablation is the lack of a strong understanding of the role of neural processing and adaptation on visual acuity, according to Steven E Wilson MD in a debate during the annual AAO conference.

There are a number of limitations to current systems for customised ablation that continue to confound attempts to create "super vision". Most of the limitations involve the accuracy of wavefront measurements, the accuracy of the laser and eyetracker, and the postoperative effects of corneal mechanics. But for Dr Wilson, the main issue lies in the processing of visual data in the central nervous system.

"We only look at the operation of the optical system from the tear film to the retinal surface. We don't get any information about what is happening in the brain," he said.

There is a great deal of plasticity in the visual cortex. Visual pathways are modified by input of data. Early development, during both the neonatal and early childhood periods, is the time of greatest plasticity, but numerous studies have shown the brain continues to be modified and re-sculpted into adulthood.

The question Dr Wilson asks is how much of an effect the processing of raw visual data by the immensely powerful computer that is the brain has on visual acuity.

"There are limitations of objective optical measurements that have long been appreciated since the development of lenses for correcting vision. We have all had the experience of correcting a patient in the office, getting them to be able to see 20/15 but then the patient not accepting the correction in the glasses. We often talk about them just not getting adjusted to it mentally," he pointed out

There is evidence to support neuroadaptation in the literature. For example, an article by Spanish vision scientist Pablo Artal PhD shows that changing the orientation, but not the magnitude of a person's aberrations can result in 20%-40% more blur.

Dr Wilson points out that there are variations in the plasticity of different people's brains. Some people will never even adjust to just a few degrees difference in astigmatism and will abandon a new prescription. That variability may result in some patients thinking they have reduced quality of vision after correcting higher-order aberrations.

"You can't have 20/15 vision with a 20/40 brain," he commented.

The major question is whether or not the visual system already works to correct aberrations. If so, would an adult only accept a certain amount of change after refractive surgery before their ability to re-adapt is overwhelmed? Perhaps only one dioptre out of three dioptres of astigmatism might be necessary and accepted in such a case.

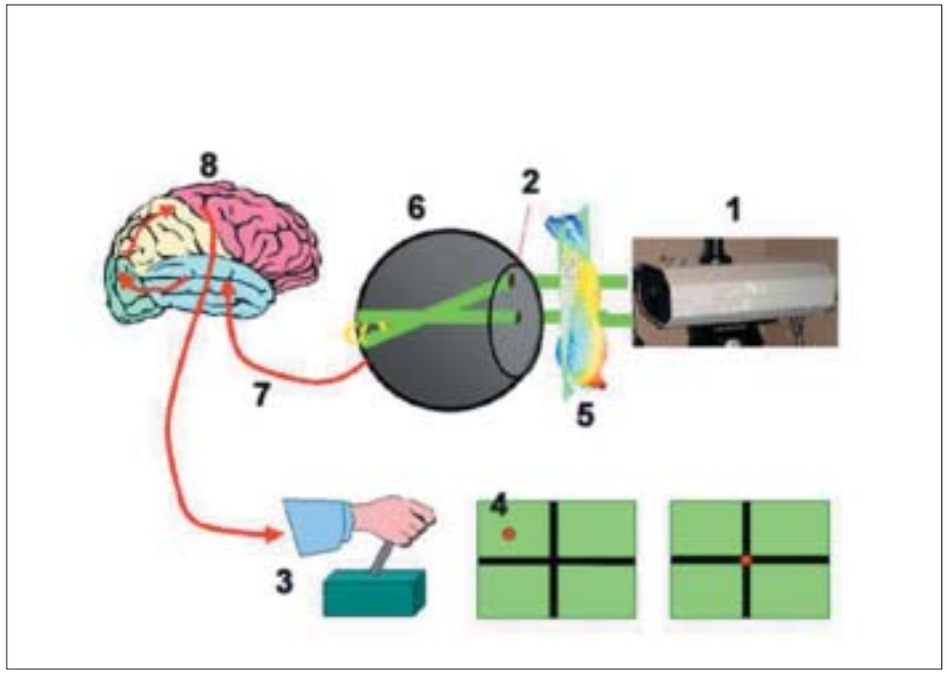
Dr Wilson also notes that there may be many subtle effects and corrections performed by the central nervous system that we don't know about. This may help explain why some people (fighter pilots and professional athletes) who have been identified as having "super vision" sometimes actually have more higher-order aberrations than those with average vision.

Once you introduce the prospect of neural adaptation over time into the equation, it opens up all kinds of additional questions, Dr Wilson says. For instance, will there be better adjustment to correction of some higher-order aberrations than others? Also, do some of the well-known post operative issues with LASIK have to do with limited central nervous system plasticity?

Taking the counterpoint in the debate was Ronald R Krueger MD, who challenged the notion that the brain portion was a real source of limitation of vision in wavefront custom ablation.

The question for Dr Krueger is not are we missing something neurologically, but whether or not wavefront is good enough optically. The FDA-required studies of wavefront custom ablation have consistently shown statistically significant improvement of higher-order aberrations and of contrast sensitivity as compared to conventional ablation. There is also evidence suggests that when an aberration is corrected, not simply altered as in the Artal paper, the results are better.

"Further, evidence demonstrates that the brain does seem to adjust over time, even if it does take a year or two," Dr Krueger said.



Courtesy Ronald Krueger MD

The InterWave system allows the patients to select position of some dots, which shows how the patient is processing input centrally.

Dr Wilson thinks current systems will be better than the one-size fits all approach and that things will only improve if some way of accounting for central nervous system processing is included. Subjective patient input will be critical for this over time.

Currently, the only system that at all takes into account subjective input, even to a limited extent, is the InterWave system at Emory. The InterWave system allows the patients to select position of some dots, which shows how the patient is processing input centrally.

Dr Wilson thinks the future improvements in custom ablation will require complete integration of optical analyses with neural processing in the visual pathways.

Krueger acknowledges that there is room for further improvement. New and better metrics are needed, a better understanding of light scatter, and many other optical improvements before we need to of course some ability to adjust for neural processing. But none of that should stop wavefront from proceeding.

"We are on the right track, but not there yet. But wavefront-guided custom ablations are here to stay," he stressed.

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