Frank Amthor, PhD, is a professor of psychology at UAB, where he holds appointments in the Medical School Department of Neurobiology, the School of Optometry, and the Department of Biomedical Engineering. His research focuses on retinal and central visual processing and neural prostheses, and he is the author of “Neuroscience for Dummies”, now in its second edition. Spinning off the dummies theme, I’ll suggest a construct for lenticular implants as neural prostheses that can provide a platform for neurovisual rehabilitation and neuroadaptation.

A neural prosthesis is defined as an implantable device that improves the functionality of a dysfunctional neurosensory system. Classical examples include cochlear implants, and retinal prostheses such as the Argus II implant. Implantation of devices in the visual system involving the retina or cortex have yielded limited results thus far, certainly relative to the success of cochlear implants. This is due to the comparative complexity of neural processing in the retina and visual cortex. Such is not the case with optical prostheses in more anterior portions of the visual system, specifically corneal inlays and most intraocular lens implants (IOLs).

A device that resides in the middle of this processing continuum is the accommodating IOL, Crystalens being the first one to receive FDA approval in the United States. Unlike its non-movable mono and mutifocal counterparts, accommodating IOLs were initially designed to move fore and aft with changes in accommodative response. At the very least, this qualifies the accommodating IOL as a quasi neuroprosthetic device, intended to simulate nature’s crystalline lens. In other words, the accommodating IOL has neurovisual properties since its ability to restore near focus depends on a well-functioning accommodative neural network.

The challenge of course is that these anticipated axial changes activated by changes in ciliary muscle control are expected to occur within a neural network that has remained relatively dormant for many years prior to cataract surgery. When our practice first began co-managing patients implanted with accommodating IOLs, we encountered complaints about inadequate vision for reading. When we objectively measured the actual accommodative response at near using the Grand Seiko Open View Auto-Refractor, it was clear that these patients rarely exhibited more than one diopter of accommodation.
Dr. Robert Kershner is an ophthalmic surgeon who is a strong proponent of neuro-adaptive rehabilitation. He sees indications for training to begin prior to surgery, and to accelerate the processes of perceptual learning following multifocal IOL implantation. Modeling the possibilities for neuro-adaptive training after the successful approach used in neuro-rehabilitation following acquired brain injury, Kershner observes:

“We surgeons should ask ourselves some questions before we cut. If we can retrain a brain whose optics have changed, how best should it be done? Should we delve into the cortical abilities of our patients? Can manufacturers purposefully design optics to enhance an individual’s interpretation of visual input? The answers to these questions are not simple. Solutions to the problems we face will not be easy. What is certain is that an assessment of our patients’ behavioral, social and psychological needs are at least as important as the measurement of their acuity and A scan.”

In summary, accommodative and pseudo-accommodative mechanisms of IOLs render these lenses as prosthetic tools that require re-integration with the neural network driven by the ciliary muscle, in concert with cortical visual pathways. Ongoing work toward newer lens designs improving depth of focus and reducing the time toward neuro-adaptation may help overcome some of the current limitations. However, as a recent Cochrane Data Base Review demonstrates, there is only moderate-quality evidence that study participants who received accommodative IOLs have anything but small gains in near visual acuity after six months.

Most forms of cataract are a type of age-related lenticular degeneration (ALD), but with a better prognosis for treatment than AMD. Baby Boomers of the 1950s are
heading en masse toward the cataract years, and will have high expectations for optimal visual outcomes post-surgically that takes full advantage of available lens technologies and complementary neuro-rehabilitation. Many would be receptive to neurovisual therapy to maximize visual outcomes if presented with appropriate opportunities. By virtue of our background and training in visual perception, perceptual learning, and neuroplasticity, optometrists engaged in vision therapy and rehabilitation should be at the forefront of these efforts in research and clinical practice.

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