

NeuroLASIK

Can surgeons improve LASIK outcomes by training the visual cortex?

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NeuroVision (NeuroVision, Inc., Singapore) is a technology that theoretically optimizes the visual processing by training the brain to see well. Neurons in the visual cortex analyze images; they respond to parameters such as orientation, spatial frequency (size), and contrast. Visual processing involves interneural interactions affecting both neural excitation and inhibition. Neural interactions determine the sensitivity for visual contrast at each spatial frequency (termed *contrast sensitivity function*).

Essentially, the brain pools responses across many neurons to average out the noisy activity of single cells and, theoretically, improve the signal-to-noise ratio and visual acuity. Alternatively, by choosing the appropriate stimulus conditions, the noise of individual neurons is brought under experimental control. In addition, through the controlled computer-modulated stimulus, contrast sensitivity at low levels is increased dramatically.

HOW IT WORKS

The software-based, interactive NeuroVision system continuously adapts to individual visual abilities. Each patient undergoes a baseline examination that is customized to his “neural inefficiencies.” As he undergoes the NeuroVision treatment, it is modified to his specific response. NeuroVision probes specific neuronal interactions to reduce noise, increase signal strength, and thus improve contrast sensitivity function. The system compensates for blurred input from the retina by enhancing neural processing.

The NeuroVision technology is a noninvasive, patient-specific, perceptual learning program that is based on visual stimulation. The technology facilitates neural connections at the cortical level through a computerized visual training regimen using Gabor patches to improve contrast sensitivity and visual acuity.

NeuroVision encompasses a lateral masking technique to tailor an individual computerized training regimen by using various parameters of the stimulus (Gabor) such as spatial frequencies, the spatial arrangement of the Gabor patches, contrast level, orientation (local and global), tasks order, context, the duration of exposure, etc. It reportedly improves neuronal efficiency and induces improvement of an

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eye’s contrast sensitivity function by reducing the noise-to-signal ratio of neural activity in the primary visual cortex.

As visual perception depends on both the optical input received from the eye and the neural processing of that input in the visual cortex, NeuroVision technology improves quality of vision (contrast sensitivity and visual acuity) by enhancing neural processing in the primary visual cortex.

TREATMENT FLOW

At the clinic, the patient’s examination includes an evaluation of contrast sensitivity and UCVA at distance and near. The information gathered is entered into the system’s database. Then, the patient undergoes a computerized analysis with Gabor patches. These patches are widely used in the field of visual neuroscience to describe the shape of receptive fields of neurons in the primary visual cortex and represent the most effective stimulation. In theory, they map out the patient’s neural inefficiencies, and this information is also entered into the database. The NeuroVision software measures the contrast threshold of a Gabor target with the presence of flankers (ie, Gabor patches on either side of a target Gabor) (Figure 1). After exposure to two short, successive visual displays, the patient identifies which display contains three Gabors.

Next, the patient downloads the NeuroVision software on his computer. Sitting 5 feet from the computer screen in a quiet dark room, he uses visual stimuli to reprogram his brain so that his vision is sharper. Patients are monitored via an Internet database. They complete 20 sessions of 20 minutes each over the course of 4 to 8 weeks.

STUDIES

There are years of data supporting the use of the NeuroVision system internationally^{1,2} (D. Tan, MD;

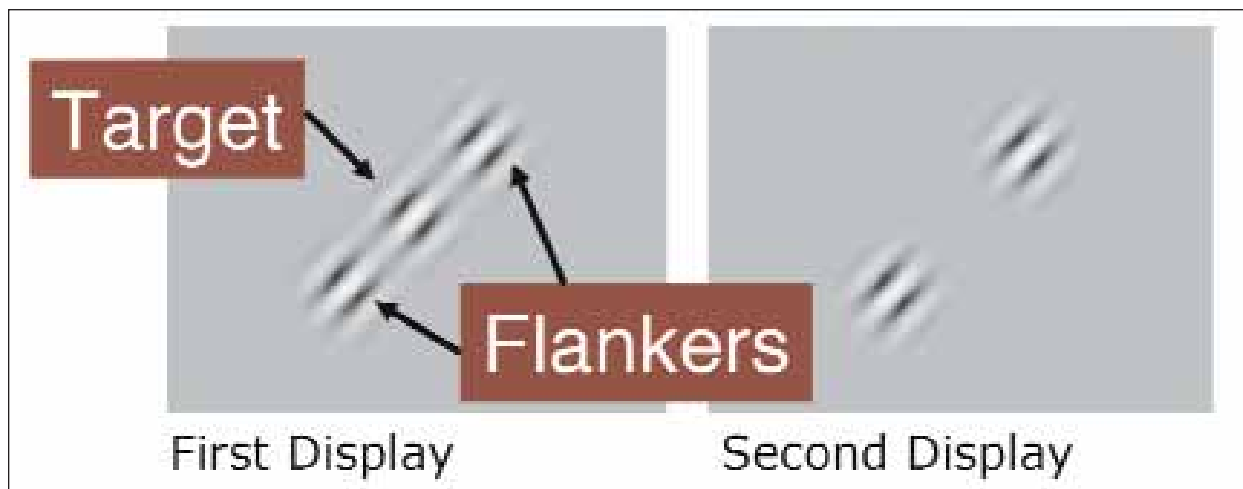


Figure 1. The NeuroVision software measures the contrast threshold of a Gabor target with the presence of flankers. The patient is exposed to two short displays in succession, and the patient identifies which display contains three Gabors.

A. Fong, MD, unpublished data, 2007; D. Tan, MD, unpublished data, 2007). These studies showed that the majority of patients gained two lines of visual acuity and experienced an improvement of 100% at all frequencies of contrast sensitivity. The treatment groups included mild myopes, emerging presbyopes, postoperative refractive surgery patients, and amblyopes.

Nevertheless, we were skeptical about the international results. Using the appropriate controls, we conducted a study of low myopes and achieved similar results to the international studies. A majority of our patients gained two lines of visual acuity and a 100% improvement in contrast sensitivity.

Our next investigation was a two-site study of 60 patients who had undergone LASIK with the Ladarvision 4000 (Alcon Laboratories, Inc., Fort Worth, TX). Half of the patients received the NeuroVision treatment (the NeuroLASIK group), and the other half underwent a control “sham” treatment (eg, a video game). We have added 10 patients for a total of 70 in the study and are using the Allegretto Wave excimer laser system (Advanced Medical Optics, Inc., Santa Ana, CA). Thus far, we have approximately 26 patients total who have completed the treatment. Our protocol is to perform refractive surgery, wait 1 month, have patients undergo the NeuroVision or the control treatment for 2 months, and then analyze the results.

In the NeuroLASIK group, after undergoing refractive surgery and NeuroVision, eyes with worse than 20/20 vision gained two lines of UCVA versus 0.45 lines in the control group. One month after LASIK, 75% of patients in the NeuroLASIK group achieved a UCVA of better than 20/20 before undergoing retraining of their visual cortex. This percentage jumped to 96% after patients completed the

NeuroVision portion of the NeuroLASIK treatment. The UCVA in the control group also improved slightly, results we considered normal due to the 2-month healing time. We will follow all enrolled patients for 1 year to see if their visual improvement is maintained.

IN SUMMARY

NeuroVision appears to increase the likelihood that patients will achieve a UCVA of 20/20 or better at 3 months postoperatively. Many of our patients had a visual acuity of 20/12.5 or better 3 months after LASIK. Those whose uncorrected vision was worse than 20/20 before NeuroVision gained two lines of vision on average. Our patients have noticed the improvement in their vision, and they have found the NeuroVision software easy to use at home. Further study of the technology, such as functional imaging, is needed. ■

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