THE CRITICAL ROLE OF **NEUROPLASTICITY** IN VISION SHARPNESS

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Drs. Goldberg, Waring, Yeu, and Cunningham are consultants to GlassesOff.

As eye care physicians, the most common condition we see in our patients is age-related deterioration of vision. Not only is presbyopia extremely common, affecting approximately 100 million Americans and more than 1 billion people globally,[1] it is often one of the most disruptive conditions experienced by middle-aged adults. While previous generations considered reading glasses an inevitable part of the aging process, today's patients are far less accepting of having to wear reading glasses and are actively seeking alternative solutions.

Just recently, there has been a major increase in the number of alternative solutions to reading glasses. These options may include surgical procedures, such as lens replacement surgery, monovision, or corneal inlays. All of these solutions have been proven to modify or improve the images captured by the eye, but none of them address the critical importance of the second half of vision—how the brain processes the images received from the optic nerve. Through perceptual training and neuroplasticity, the brain's ability to process images can be enhanced.

With the increasing awareness of the role of neuroplasticity in vision, there have been numerous digital software programs and applications made available to patients and consumers, with the goal of enhancing vision through perceptual learning. I met with some of the leading eye care professionals to discuss their experience with and the evidence behind one such technology, the GlassesOff app.

– Damien F. Goldberg, MD

What is perceptual learning? And how does it relate to neuroplasticity?

Dr. Goldberg: George, in the eye care community, you are considered somewhat of an expert in the field of neuroplasticity. Can you briefly explain what neuroplasticity is and how it relates to vision?

George O. Waring IV, MD, FACS: Simply put, when the brain adapts and creates new neural pathways during the learning process, we call this neuroplasticity. As practitioners, we are gaining a deeper understanding that patient satisfaction with vision is not just based on optical correction, but also on the brain's ability to accommodate for these optical changes or corrections through perceptual learning. Perceptual learning exercises stimulate the visual cortex—the image processing center of the brain—creating new neuronal pathways and literally augment the brain's ability to process images. Numerous studies have demonstrated that perceptual learning exercises can enhance vision performance including visual acuity, contrast sensitivity, stereo-acuity, processing speed, and reading speed.[2-5]

How do we talk to patients about perceptual training?

Dr. Goldberg: How would you explain the benefits of perceptual training to patients?

Dr. Waring: I like to explain to patients that the optic nerve of the eye is just an extension of the brain. Like a camera, the eye captures images and sends signals through the optic nerve to the brain. Then, like a computer, the brain processes the images in the visual cortex. The benefit of perceptual training is that the brain learns to be more efficient in accurately identifying and processing visual stimuli. As practitioners, it's important to know that in situations where there is a high signal-to-noise ratio such as crowding, poor lighting, or blurred images, the benefits of perceptual learning can sometimes be even more pronounced in improving vision performance. Decades of research have shown that perceptual learning exercises can enhance visual cortex function, resulting in numerous

benefits that go beyond what we as eye care physicians and surgeons can accomplish through traditional treatments.[2,6-9]

Dr. Goldberg: Derek, how do you explain to a patient what GlassesOff is and how it works?

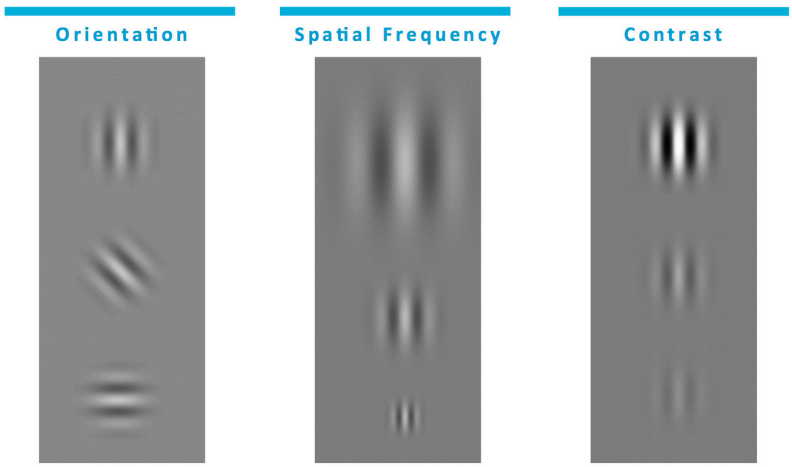

Figure 1: GlassesOff uses Gabor patches to challenge visual tasks such as orientation, spatial frequency, and contrast.

Derek N. Cunningham, OD: For my patients who want to get rid of their reading glasses, I tell them that their vision quality is determined by both their eyes' ability to capture images and their brain's ability to interpret these images. So while there are contact lenses or surgical options available to improve the image capturing ability, there is a mobile app available today that can help them reduce dependence on their reading glasses and improve their near vision sharpness by exercising the brain. It works through a series of intuitive exercises that stimulate the image processing center of the brain **(FIGURE 1)**. This helps the brain process images more efficiently and results in patients being able to see more clearly.

For maximum benefit, the company recommends the app be used 10 to 12 minutes, 3 times a week, for 2 to 3 months.

Dr. Goldberg: Is the app affordable for most patients?

Dr. Cunningham: I believe it is very affordable and easy to access for most of our patients. The app is available on iTunes or GooglePlay for about $10/month or $25 for a 3-month subscription. In my opinion, it's a complimentary solution to what we do as eye care physicians that does not require a significant investment of time or money by patients.

Dr. Goldberg: Liz, are there data to support the near vision benefits of GlassesOff? Can patients really get rid of their reading glasses?

Elizabeth Yeu, MD: Yes. The company has decades of research and published data

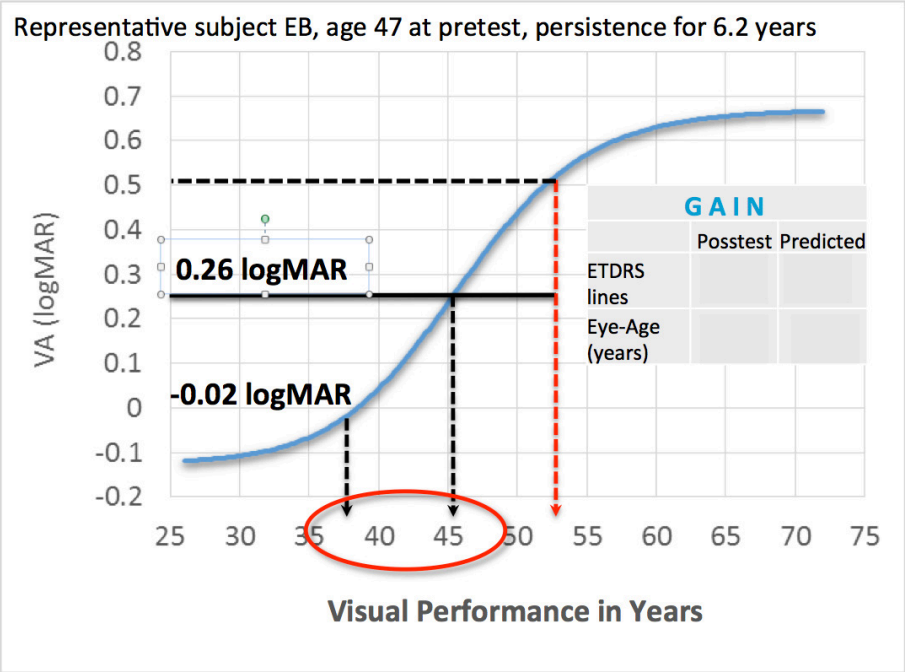

Figure 2: A representative subject from the Berkeley study gained 0.28 logMAR of visual performance, despite an expected age-related decline of >0.2 logMAR (2 EDTRS lines).

to support the science behind perceptual learning technologies, such as GlassesOff. Specifically, there is substantial evidence regarding the positive impact that perceptual training using Gabor patches has on augmenting neuroplasticity to improve overall vision.

One of the landmark studies was conducted at UC Berkeley in users dependent on reading glasses.[10] By the end of the study, over 90% of the participants who completed the GlassesOff 3-month program were able to read standard font without glasses. That's huge! The participants experienced an improvement not only in their visual acuity, but in their contrast sensitivity, their image processing speed, and their reading speed **(FIGURE 2)**.[2]

Dr. Goldberg: Derek, would you recommend GlassesOff to someone who doesn't currently wear reading glasses?

Dr. Cunningham: Absolutely. Multiple studies have been conducted in individuals who have what we would consider perfect vision, who still benefitted from perceptual learning exercises. One such study includes a group of Israeli Airforce pilots that used the GlassesOff technology for three months.[3] The pilots showed a 35% improvement in visual acuity ($P<0.001$) and a 24% improvement in image processing speed ($P=0.001$). The participants also experienced improvements in contrast sensitivity, stereo acuity, and even depth perception.

Another recent study tested visual speed by presenting visual stimuli to young patients with 20/20 vision.[4] Prior to using the GlassesOff app, the subjects took 205 milliseconds to correctly identify the images. After completing the 3-month GlassesOff program, the

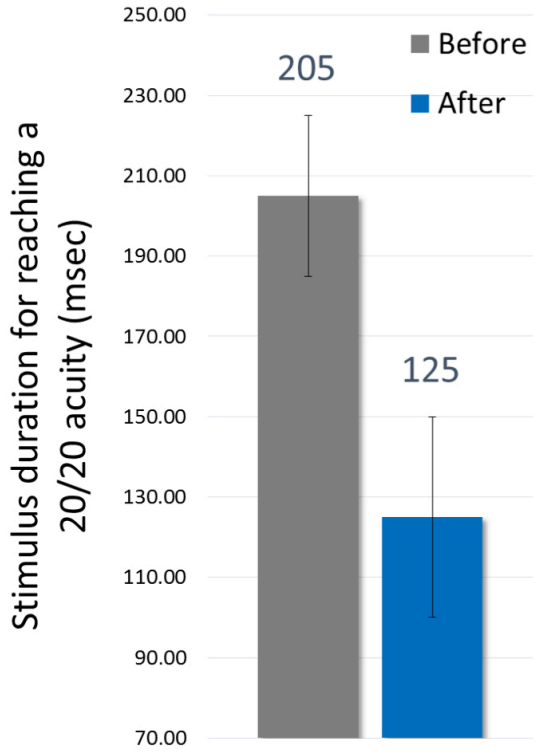

Figure 3: Young subjects with initially perfect vision saw a 40% improvement in visual processing speed after 3 months of performing the perceptual learning challenges in the GlassesOff app.

study group was able to clearly identify the images within 125 milliseconds, a 40% improvement in processing speed **(FIGURE 3)**.

These studies demonstrate that perceptual learning can not only improve vision, but also vision performance related functions, such as processing speed, stimuli recognition, and reaction times.

Dr. Yeu: I can personally testify to some of these outcomes. I have 20/20 near vision, and I do not need reading glasses. However, I really wanted to understand the GlassesOff app prior to recommending it to my patients, so I started using it.

I noticed a shocking improvement in my reading speed. My husband and I like to read together, especially newspaper articles. We usually read alongside each other on the same screen. I do not read as fast as he does, and he has to wait for me. After 4 to 5 weeks of using the app, I realized I was finishing the article at the same time as he was, and that has never happened before. I was very impressed, because I knew my vision was considered "perfect," and so I was not expecting to experience any personal benefits from using the app.

Who can benefit from perceptual training in our practices?

Dr. Goldberg: Can you describe a specific type of patient or cases in which you feel improving neuroplasticity would be an advantage?

Dr. Cunningham: Where I practice, we have worked with athletes for many years to improve their ability to process and respond to visual information faster, as well as pick up more detail

with greater clarity and speed. Along with athletes, we can all benefit from faster recognition times, whether we are driving, or in visual tasks that used to be easy for us but have become a little more difficult, such as reading an e-mail or text. Perceptual training technologies such as GlassesOff can provide noticeable results for a wide range of individuals.

Dr. Waring: Perceptual learning is synergistic and complimentary to many of the things we do as eye care physicians. As a surgeon, my job is to help the eye's ability to capture images clearly. Technologies such as GlassesOff then work to improve the brain's ability to process those images. A lot of patients come to us for surgery, but we also have a number of patients who are not interested in surgical options based on lifestyle or candidacy. We can now introduce them to scientifically proven techniques that may reduce their dependence on reading glasses. The perceptual vision training from GlassesOff can literally be conducted in the palm of their hand

Dr. Yeu: I agree with George. Once I gained a good understanding of the GlassesOff technology, I thought this could help many of the adults I see in my practice. This includes the 40-year old man who just started using reading glasses or the post-operative cataract patient; they can all benefit.

For example, I had a woman who had multifocal lens replacement. She needed both her distance and near vision corrected. After surgery, she had excellent distance vision but was not happy with her reading vision. I recommended she use the GlassesOff app, and after completing the 3-month training program on her iPhone, she was reading at the J1 line. Her reading vision is better than 20/20.

Dr. Cunningham: My colleagues bring up a good point that perceptual learning technologies can help a broad range of patients. Today's business professionals spend 8, 10, or even 12 or more hours a day at their computers or mobile devices. This causes a significant strain on the eyes. It is now common for adults in their late 30s to present with symptoms such as eye fatigue, headaches, and even some blurriness when reading onscreen text. This kind of strain can significantly slow down their reading speed and productivity. Perceptual learning challenges can counteract some of these symptoms.

Can patients be held accountable for their vision performance?

Dr. Goldberg: It sounds like we all agree that perceptual training exercises can improve

vision regardless of a patients' baseline. As physicians, can we incorporate GlassesOff into our practices and, to some extent, hold our patients accountable for their visual performance?

Dr. Cunningham: I think we can, Damien. Allowing patients to participate in their own therapy is very valuable. Patients want to feel like they are doing something to address their visual issues, and this app allows them to go home, actively participate, track their scores, and see the results. Involving the patient in the process of regaining their vision independence helps build the relationship between doctor and patient, and it rewards them for their own effort.

Dr. Waring: I agree. I believe perceptual learning can make a significant impact in what we do and what we can offer to our patients. It is the first tool available in a widespread format making it accessible to anyone interested in improving their vision. The convenience of having the GlassesOff app on your mobile device means you can perform the perceptual training exercises anytime you have a few free minutes without distractions. This user-friendly app helps patients achieve optimal results and is not burdensome at all.

Dr. Goldberg: This is just the beginning of new technology applications in visual performance. I thank everyone for sharing their knowledge and experiences with us. ▪

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