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Push and pull get eyes to work together

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Researchers appear to have found a better way to correct sensory eye dominance, a condition in which an imbalance between the eyes compromises fine depth perception. The key is a push-pull training method in which the weak eye is made to work while vision in the strong eye is actively suppressed, according to a report published online on October 14 in *Current Biology*.

"After a 10-day training period, we found our participants' sensory eye dominance is significantly reduced as the two eyes become more balanced," said Teng Leng Ooi of Pennsylvania College of Optometry at Salus University. "As a consequence, their depth perception also improves significantly."

Most people have excellent three-dimensional depth perception because their two eyes work together as an even team, explained Ooi and her colleagues Zijiang He and graduate student Jingping Xu of the University of Louisville. That's why it is easier to thread a needle with two eyes opened than with one eye closed.

"By using the visual images from both eyes, the brain can construct a 3D visual world that enables us to precisely judge the depth of objects," He said. For that to work optimally, the two eyes have to contribute equally. If one eye becomes stronger, depth perception degrades. In the extreme, that imbalance is similar to amblyopia, more commonly known as lazy eye, a condition that affects two to three percent of children in the United States.

If the imbalance of amblyopia goes uncorrected early, the weak eye can become severely suppressed. Treatments today aim to correct the problem by covering up the stronger eye part of the time, making the weaker one do all the work, a treatment that follows the logic of "use it or lose it."

But, the researchers report, that "push-only" training strategy doesn't work very well in adults with sensory eye dominance, whose neural wiring is less flexible. They now show in a study supported by the National Eye Institute that what does work is an alternative method in which the two eyes are exposed to different patterns in a way that ensures that only the images presented to the weak eye are perceived.

The method is based on Ooi and He's earlier work in which they studied how the brain determines which eye's image is perceived when the two eyes receive very different images, for example, horizontal grating in one eye and vertical grating in the other eye.

"Typically, such a stimulation results in one alternately perceiving the image in each eye," He said. "At one moment, the left eye's image is seen, and the next moment, the right eye's image is seen, and so on. It is as if the two eyes compete for perception."

Ooi and He found that when the two eyes are forced to compete in that way, they could tilt the competition for perception in favor of one eye by attracting a form of visual attention to it. This is done by cueing one eye before the competition begins. In the new method, this simply means that a square frame is presented to the weaker eye before the competitive images appear.

The researchers say that they don't yet understand exactly how this push-pull training method works to readjust the balance between the eyes. "Possibly, by causing the strong eye to be suppressed at all times during

the training, we reduce the inhibitory hold of the strong eye on the weak eye," Ooi said. Further behavioral and neurophysiological studies are needed to explore the mechanism.

The new push-pull strategy could be used to reduce sensory eye dominance, which could be especially important in those for whom fine depth perception is critical for their vocations, including dentists, surgeons, machinists, and athletes. The researchers also expect that it can be adapted for treating children with amblyopia.

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