VESTIBULAR DISORDERS ASSOCIATION

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Vision Challenges with Vestibular Disorders

By the Vestibular Disorders Association

A common complaint for people with vestibular disorders is that they have difficulty with their vision. They have problems focusing on an object or perceive that objects are moving from side to side or revolving around them (*vertigo*). They may see their visual field jiggle or bounce (*oscillopsia*) or have double vision (*diplopia*). When they hold their heads still, the problems disappear. The optometrist, who conducts eye exams while a patient's head is securely braced against a head rest, is often unaware that a vestibular problem exists. When the optometrist then explains the normal results of the exam, such patients may become disgruntled or frustrated because the test results don't reflect the symptoms that they experience in the course of daily life.

Why do vestibular disorders affect vision?

The vestibular system sends motor control signals via the nervous system to the muscles of the eyes with an automatic function called the *vestibulo-ocular reflex* (VOR). The VOR is a crucial part of maintaining balance and clear vision, controlling eye positions so that when the head moves, gaze remains stable. Another way of explaining this is to compare the vision system to photography. The camera (the eyes) must be held steady by the photographer (the VOR) in order to produce clear pictures. However, if the photographer is unable to hold the camera steady, the resulting pictures will be blurry or perhaps have double exposures, even though the camera itself is in perfect working order. A malfunctioning vestibular system changes the once skilled photographer into an unskilled one. People with a chronic vestibular disorder must learn to adapt to this newly unpredictable visual world—a challenge that only increases in complexity if they also require glasses or other visual correction.

How does the vestibulo-ocular reflex work?

When the head is motionless, the number of impulses transmitted from the vestibular organs on the right side is equal to the number of impulses from the left side. When the head turns toward the right, the number of impulses transmitted through the nervous system from the right ear increases and the number from the left ear decreases. The difference in impulses sent from each side controls eye movements to stabilize the gaze during active head motions.

There is a predictable ratio between the amount of head movement and the amount of eye movement required for a

stable gaze. When the head rotates at a certain angle and speed, the eyes rotate at the same speed (*gain*) but in the opposite direction (*phase*). The sensory information provided by both ears is normally symmetrical. Signals coming from the left ear correspond with the information provided by the right ear. Thus, if the vestibular organs in one or both ears are not working properly, the brain receives conflicting signals about movement, resulting in the sensation of vertigo.

Impacts of a disrupted vestibulo-ocular reflex

A disrupted or impaired VOR can result in abnormal *nystagmus*, an excessive to-and-fro movement of the eyes, and oscillopsia, where objects appear to bounce because they do not remain fixed on the same point on the retina. A person with a vestibular disorder may also experience photosensitivity (discomfort with bright light) and other vision problems such as: intense discomfort with flickering lights, particularly fluorescent, sodium, or mercury vapor lights; moving objects; rows of similar objects, such as in grocery store aisles or lines of text on a page; or busy, high contrast patterns, such as polka dots or sunlight filtering through mini-blinds. Environments with a combination of fluorescent lighting and busy patterns or moving objects are especially problematic which is why shopping in large stores may be very difficult. Even environments with subdued décor can be fatiguing if frequent head movements are required, such as when a person converses with others at work or at a social gathering.

Reading text on a printed page presents a special challenge for people with an impaired VOR. The bouncing and shifting words and letters require more effort to process (see Figure 1), which is why children with an undiagnosed vestibular disorder are sometimes mistakenly thought to be dyslexic.

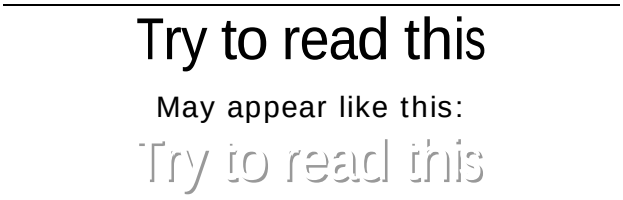


Figure 1. For people with oscillopsia, tracking printed words on a page can require a great deal of effort because of the distortion produced by even small head movements.

Reading text on a computer monitor can be even more problematic because of a heightened sensitivity to screen flickering or scrolling pages of text. Many people with an impaired VOR resort to manually bracing their head to reduce reading problems, such as by cupping their chin in their hand, in an effort to prevent tiny movements—even those as small as are produced by a pulse.

People with vestibular disorders face particular challenges with peripheral vision, which works to integrate visual information with vestibular functions and is vital for maintaining a sense of balance

and orientation. A damaged VOR may result in peripheral visual flickers that may be mistakenly perceived as movement, such as the illusion of a bird flying quickly past. In addition, nystagmus is more pronounced when a person looks to the far right or left, so actions such as looking over the shoulder while backing up a car can be especially uncomfortable.

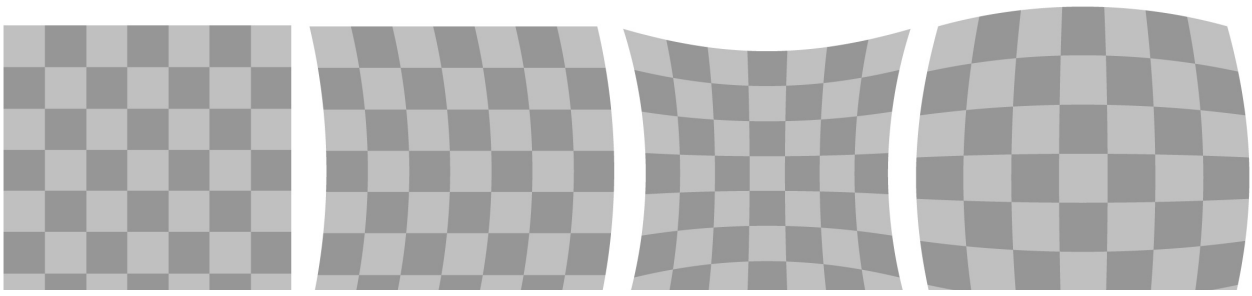
Peripheral vision distortions are especially problematic for a person who wears glasses and has adapted to a vestibular disorder by minimizing head movements and relying instead on moving the eyes. Although eyeglasses produce clear and consistent vision straight ahead, lens aberrations such as visual field curvature and distortion reduce vision clarity when a person looks through the side of a lens (Figure 2). Thus, if a person with glasses moves the eyes rather than the head to scan, objects viewed to the side will appear to distort and move. Certain shapes of windshields in cars or vans may cause similar peripheral distortion at their edges.

Ironically, a person with a vestibular disorder may experience a phenomenon called *visual dependence*, where the brain suppresses vestibular input and becomes extremely reliant on vision to maintain balance. However, because of the impaired VOR, disorientation and symptoms of panic can occur in situations where movement of objects near the person may be mistaken for self-movement. These symptoms may also occur when a person's visual field is overwhelmed (e.g., in a room wallpapered with busy patterns) or lacks a point of fixation (e.g., in intense darkness, wide open spaces, or as experienced with snow blindness).

Evaluation

The diagnosis of a vestibular disorder relies on a combination of careful inspection of the history of the problem, physical examination, and tests. Because vision is so closely linked to the vestibular system, many of these diagnostic tests involve evaluation of the gain, phase, and symmetry of eye movements that occur with vestibular stimulation.

Figure 2 (below). Projection of a flat object (A) onto a curved surface causes straight lines to appear curved (B) as the power (curvature) of a lens increases, so does the



correct farsightedness cause pincushion-type distortion (C) and glasses that correct nearsightedness cause a barrel-like distortion (D).

For example, electronystagmography (ENG) tests measure nystagmus that occurs when the head is positioned in certain ways while a person tracks a moving object, or when the ear on one side is stimulated with warm or cold water or air (the caloric test). During these tests, eye movements are recorded using small electrodes placed on the skin around the eyes or with an infrared video camera mounted on goggles (known as videonystagmography or VNG). Rotation testing employs the same electrodes or goggles to measure the relationship between the speed of head movement and eye movements while the head is rotated.

It is important to note that these and other tests employed to evaluate vision and vestibular disorders must be administered and interpreted by trained specialists. Factors such as age,[1] medications,[2(p. 51)] or systemic processes such as depression,[3] migraine,[4] or sleep deprivation[5,6] can modify the VOR. Such factors must be incorporated into the testing process and interpretation of the results by physicians such as otolaryngologists/ENTs, otologists, neurotologists, otoneurologists, and ophthalmologists.

Treatment

The first approach to resolving vision problems resulting from a vestibular disorder is to treat the vestibular disorder. Depending on the specific vestibular disorder diagnosis, treatment may involve surgery, physical therapy, medication, or other strategies. When a chronic vestibular disorder does not resolve with treatment, specialized vestibular rehabilitation exercises may still be useful in helping with the related impacts on vision. Vestibular rehabilitation is an exercise-based program that includes coordinating eye and head movements, stimulating the symptoms of dizziness in order to desensitize the vestibular system, improving balance and walking ability, and improving fitness.

Optometric therapies may also be part of treatment—especially if an underlying focusing, ocular alignment, visual acuity, or visual processing problem is suspected in addition to the VOR problem caused by the vestibular disorder. Such optometric rehabilitation treatment may involve the use of corrective lenses, including prisms and spectacles, phototherapy (light therapy), and therapy to help sharpen vision skills or develop the eye muscles involved in focusing, such as exercises that have a person cover one eye while reading.

Glasses and contact lenses

With glasses, the type of vision correction alters the size of the visual world, growing larger for farsighted people and shrinking for nearsighted people. This change forces the brain to recalculate the ratio between head and

eye movement, which is a fairly simple adjustment to make with lenses that have only one optical power. If a person needs correction for both distance and reading, using bifocals, trifocals, or progressive lenses will create extra work for a brain already overtaxed by negotiating a vestibular disorder because multiple levels of magnification in the same lens require the brain to calculate and adjust to multiple eye-head movement ratios. Such a person may want to consider having two pairs of single-vision glasses—one for each task. Regardless, even with a single power lens, adjustment will be more difficult if the glasses are not fit properly such that they tend to slide down the nose and cause the distance between the eye and the lens to vary.

A person with a vestibular disorder who wears glasses may also consider switching to lenses with a small lens diameter to reduce visual aberrations, thus helping to reduce vertigo and dizziness. Another possibly helpful alternative is switching from glasses to contact lenses. Unlike glasses, where the distance between the eye and the lens can vary, contacts are worn directly on the cornea of the eye, allowing objects to appear without distortion and in the correct size and position. In some cases, contact lenses may also help dampen the nystagmus associated with a vestibular disorder. However, a disadvantage of contact lenses is that they can increase a person's sensitivity to light.

Coping strategies

To facilitate the adaptation process, a person can adopt certain strategies to improve tolerating problematic environments: When outside, wearing high quality sunglasses can help a person tolerate glare from sunshine. To minimize visual distractions in their peripheral vision, some people find it helpful to use glacier glasses (sunglasses with side visors). Other adaptations may include fixing attention on a large object a short distance away while walking toward it, using a cane to increase touch cues, and ensuring that home or office lighting is consistent from room to room and doesn't use unshielded bulbs and fluorescent lights. If fluorescent lighting is unavoidable at work, using a small incandescent desk light may help disguise some of the fluorescent light's flickering.

Home décor can be modified to eliminate patterns wherever possible. This might include replacing wallpaper that has a busy pattern, substituting light-filtering curtains for mini-blinds, and replacing or removing highly patterned carpets, which can trick the eye into believing that there is a depression or elevation in the floor where none exists.

Although it may be tempting for people with VOR disturbances to cope by staying at home and avoiding visual stimulation, this can undermine the ability to adapt in the long term.

Additional resources

Some helpful documents available from VEDA:

- The Human Balance System: A Complex Coordination of Central and Peripheral Systems (Pub. S-7)
- Vestibular Rehabilitation: An Effective, Evidence-Based Treatment (Pub. F-7)
- Computer Monitors and Digital Televisions (Pub. F-30)
- Vestibular Injury: Compensation, Decompensation, and Failure to Compensate (Pub. F-26)

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