
VISION

GAZE STABILITY

The vestibulo-ocular reflex (VOR) helps keep the eyes still during head motion.

ARTICLE

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Vision Challenges with Vestibular Disorders

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A common complaint for people with vestibular disorders is that they have difficulty with their vision. They may experience 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 during head motion (*oscillopsia*) or have double vision (*diplopia*). When they hold their heads still, these visual instability problems might resolve.

Many people with vestibular disorders consult an eye care professional due to their visual symptoms. The typical eye examination is done while the patient's head is resting against a head rest, thereby reducing the head motion, which may mask the visual symptoms. With a vestibular disorder, the eyes may not be the primary cause of the problem; therefore the typical eye exam will not identify any eye pathology or routine optical problems that would explain the patient's reported symptoms.

Visual acuity issues and/or functional visual skills deficits, such as focusing, eye tracking and fixation and eye teaming coordination, may often trigger or exacerbate vestibular symptoms. Therefore, it is recommended that these patients consult with an optometrist who specializes in Neuro-optometric Rehabilitation. The neuro-optometric evaluation specifically assesses the visual, ocular motor and focusing skills important for stabilizing the sensory motor components of the vestibulo-ocular reflex (or "VOR").

HOW DO VESTIBULAR DISORDERS AFFECT VISION?

The vestibular system and the visual system coordinate with each other through brain pathways in order to control visual fixation. The 'ear to eye' connection is known as the *vestibulo-ocular reflex (VOR)*. The VOR has a critical role of keeping the eyes still during head motion. This is known as gaze stability. The VOR also sends a signal down to the postural muscles of the trunk/arms/legs, which is crucial for maintaining balance.

Another way to explain this is to consider the video camera. Video cameras have motion stabilizing equipment built into them. This equipment stabilizes the visual world in order to capture a clear visual scene even though natural motions of the hand holding the video camera



NYSTAGMUS IS A REFLEXIVE MOTION WHERE THE EYES APPEAR TO JERK ONE DIRECTION (FAST) AND THEN SLOWLY RESET IN THE OPPOSITE DIRECTION.

would otherwise blur the image. In the case of a deficient VOR, the eyes move during head motion, when they should instead be still.

HOW DOES THE VESTIBULO-OCULAR REFLEX WORK?

The inner ear includes a unique type of sensory hair cell that responds to head motion. When the head rotates, the hair cells move and this triggers the firing rate in the vestibular (inner ear) nerve, which sends this signal to the brain, eye, and postural muscles. In the absence of motion, both inner ears are still sending a signal to the brain, and the amount of signal from the left and right ears should be similar. Normally, this signal becomes asymmetric when the head rotates to one side. For example, when the head turns toward the right the firing rate from the right vestibular nerve increases while the firing rate from the left vestibular nerve decreases. The difference in firing rate is interpreted by the brain as a rotation (or motion) of the head and is used to provide stability to the eyes and postural muscles (i.e. balance) during head motion. Therefore if the vestibular system is not working properly in 1 ear (or both), then the brain does not receive correct information about head motion from the vestibular nerves, and this results in symptoms such as vertigo, imbalance, or oscillopsia.

IMPACTS OF A DISRUPTED VESTIBULO-OCULAR REFLEX

A disrupted or impaired VOR can result in abnormal vestibular *nystagmus*, a reflexive motion of the eyes that includes a fast and slow rotation; the eyes will appear to jerk one direction (fast) and then slowly reset in the opposite direction. Patients with a disrupted VOR commonly experience vertigo due to the asymmetry in firing rate between the left and right ear. They may also experience oscillopsia

during head motion, where objects in the visual world appear to bounce/move because the VOR is not able to keep the eyes still during head motion and the objects therefore do not remain fixed on the same point of the retina. Imbalance is also commonly experienced by those with a VOR deficit.

Interestingly, some patients 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. Sometimes these symptoms of visual supersensitivity are related to an unrecognized migraine disorder¹, and treatment aimed at migraine prevention may be effective. Other times, an abnormal vestibular system and migraine are the coupled culprits.

Reading text on a printed page can be difficult for people with an impaired VOR, because the small head motion destabilizes gaze. The result is words and letters that appear to oscillate and shift.

Reading text on a computer monitor may be a problem due to the 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 head movements—even those as small as are produced by a pulse.

People with vestibular disorders may also have an illusion of motion in their peripheral vision. A damaged VOR can also cause nystagmus to worsen when the person looks to the right or left. In this case, looking over the shoulder while backing up a car may be difficult.

Peripheral vision distortions may especially be problematic for a person who wears Progressive Add Lenses (PAL) and or bifocals and has substituted eye rotation instead of head motion in order to minimize those distortions. Although eye-glasses produce clear and consistent vision straight ahead, lens aberrations such as visual field



curvature and distortion reduce visual clarity when a person looks through the side of a lens. 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.

Individuals with vestibular disorders often experience a visual dependence, where the brain becomes extremely reliant on vision to maintain balance. However, as a result of a VOR defect, this may lead to symptoms when a person's visual field is overwhelmed (e.g., busy patterns on wallpaper) or lacks a point of fixation (e.g. darkness, wide open spaces). Typical comments from such patients include:

- *I cannot be in a crowd of people nor in wide-open spaces; both situations make me feel disoriented and panicky.*
- *I often take a cart in a grocery store even when I'm shopping for only one item.*
- *I've become so frustrated I would rather just stay home.*

EVALUATION



The diagnosis of a vestibular disorder relies on a combination of careful history of the problem, physical examination, and laboratory tests. The laboratory tests involve evaluation of the vestibular system based on eye movements. For example, electronystagmography (ENG) is a battery of tests to measure brain and vestibular originated eye movements. Included in the test battery is measuring nystagmus that may occur when the head is placed in certain positions, or when one ear is stimulated with warm (or separately cold) water or air, known as the caloric test. The eye movements are recorded using small electrodes placed on the skin around the eyes or with a video camera mounted to a goggle frame (known as

video-nystagmography or VNG). Rotation testing employs the same electrodes or goggles to measure the relationship between the velocity of the head and eyes during whole body rotation.

Other tests measure function from the vestibular system by exposing the subject to a clicking noise, known as the vestibular evoked myogenic potential (VEMP) test.

The vestibular function tests are administered and interpreted by trained specialists. Factors such as age,² medications,^{3 (P. 51)} or systemic processes such as depression⁴, migraine⁵, or sleep deprivation^{6, 7}, and even alertness can modify the VOR.

TREATMENT

The first approach to resolving most of the vision problems affecting visual-vestibular symptoms is to eliminate any ocular or functional visual problems such as eye fixation and eye movement, focusing, and binocular teaming problems. An evaluation by an optometrist (OD) is necessary to diagnose and treat these problems. Depending on the vestibular diagnosis, treatment may involve vestibular physical therapy, surgery, medication, or other strategies (i.e. diet modification).

Vestibular physical therapy incorporates exercises with the goal to improve gaze and gait instability, reduce head motion-induced dizziness, reduce fall risk, and improve fitness.

Optometric therapies (Neuro-optometric Rehabilitation) are an important component of treatment—especially if an underlying focusing, ocular mal-alignment, visual acuity, or visual processing problem is suspected in addition to the vestibular disorder. Such optometric therapies may involve the use of corrective lenses including prisms and spectacles, phototherapy (light therapy), and therapy to enhance vision and functional visual skills such as fixation, eye movement, focusing, and eye teaming ability.

GLASSES AND CONTACT LENSES

Wearing glasses alters the size of the visual world, increasing images for farsighted people and reducing images for nearsighted people. The altered visual image causes the brain to adjust the amount of eye movement during a related head movement. If a person needs correction for both distance and reading, using bifocals, trifocals, or progressive lenses (PAL) will create extra work for the brain,



which can overtax its ability to adjust to the different levels of magnification. In this case, it is recommended that a person may want to consider having two pairs of single-vision glasses—one each for near and far viewing. Regardless, even with a single power lens, adjustment will be more difficult if the glasses are not fit properly (i.e. they slide down the nose).

A person with a vestibular disorder who wears glasses may also consider switching to lenses with a small lens diameter to reduce visual aberrations, which may limit the vertigo and dizziness. Another helpful alternative is to switch from glasses to contact lenses. Unlike glasses, where the distance between the eye and the lens can vary, contacts are worn directly over the cornea of the eye, preventing image distortion with correct size and position.

COPING STRATEGIES



To facilitate the recovery process, certain strategies can be adopted to improve tolerance:

- When outside, use high quality sunglasses to reduce glare from sunshine.
- Minimize visual distractions in the peripheral vision by using glacier glasses (sunglasses with side visors).
- Focus attention on a large object a short distance away while walking toward it.
- Use a cane to increase touch cues.
- Ensure home or office lighting is consistent from room to room.
- Many people report increased sensitivity to fluorescent lights. If this is a problem, consider using a small incandescent desk light.
- Reduce home décor that involves a complicated (i.e. 'busy') patterns. This might include replacing wallpaper, substituting light-filtering curtains for mini-blinds, and replacing or removing highly patterned carpets.

FINAL THOUGHT

Vestibular disorders can be disabling and thus tempt those affected to stay home and avoid head motion or visual stimulation. However, this will undermine the brain's ability to make adjustments and recover. Most vestibular disorders can be treated with options that offer significant relief.

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