

HEARING ARTICLE

Your Three Balance Systems

The major component regulating your balance is, of course, the vestibular system in your inner ears. The vestibular system consists of the three semicircular canals, the saccule and the utricle. This part of your inner ears continuously senses gravity and both straight and curved movement. Like the cochlea, the vestibular structures contain thousands of tiny hair cells that generate and relay balance signals to your brain.

As you likely know, if something damages the hair cells in your cochlea, you end up with hearing problems. Likewise, if something damages the hair cells in your vestibular system, the result is balance problems.

The second component of your balance system is your eyes (ocular system). Your eyes see both your position in space and movement.

The final component of your balance system goes by the tongue-twisting name of proprioceptive (proh-pree-oh-SEP-tiv) system. Your proprioceptive system uses special pressure sensors in your muscles, tendons and joints to sense gravity and joint position. Most of your proprioceptive sensors are in your feet and leg joints.

As long as these three systems are working properly, you seldom give your ability to keep your balance any thought. However, if one or more of these systems ever fails, it can impose enormous changes on your lifestyle.

These three systems cooperate closely with each other in an interdependent manner to use the strengths of each to the best advantage.

Your Ears and Eyes Work Together

Your vestibular system works together with your eyes in what doctors call the vestibulo-ocular reflex. What this reflex accomplishes is truly incredible. When you walk, your head moves up and down with your body movement. This would make everything you see blurry unless you were absolutely still. However, your vestibulo-ocular reflex normally keeps your eyes clearly focused on your surroundings by instantly and continuously changing your eye position as you move. You think nothing of this. It is totally subconscious and automatic.

However, if your eyes and ears lose this coordination due to vestibular damage, your eye muscles do not receive the proper signals from your brain to automatically adjust for this movement. As a result, your surroundings will appear to move, bounce, jiggle and jump about and your vision will be blurry. This means you will not be able to drive, or even read signs as you walk. Some people can't even recognize the faces of the people they see walking towards them on the sidewalk. The technical name for this condition is oscillopsia (ah-sih-LOP-see-ah).

If you have oscillopsia, just walking can be extremely difficult or even impossible because it is difficult to see and respond to obstacles in your path and to sense the exact location of the floor or ground.

Your vestibulo-ocular reflex is so sensitive that it actually senses the tiny upward and downward motions your head makes each time you breath in and out. It sends this information to your brain. Your brain, in turn, instructs your eye muscles to keep your eyes clearly focused on what you are doing in spite of this movement.

Even more astounding is how incredibly sensitive your vestibulo-ocular reflex is. In fact, it is so incredibly sensitive that it detects the miniscule movement and change in position of your head each time your heart beats and relays this information to your brain. Again, your brain sends messages to your eye muscles to correct for this, all unknown to you. By doing so, it reduces the movement of the image on your retinas thus giving you clear vision so you can read fine print and see fine detail. If you are like most people, you probably never had an inkling that day after day your ears were doing this amazing job for you.

You need your eyes to help you maintain your balance. At the same time, you need your ears (vestibular system) to help you maintain clear vision. Anything that disrupts your vestibulo-ocular reflex directly affects your vision. Therefore, if your vestibular system is damaged, you will likely have fuzzy or blurred vision. You will also likely have difficulty focusing on objects or holding your eyes on a printed page since your hands can't hold a book completely steady. (Each heartbeat not only "jerks" your head, but also "jerks" your hands a tiny bit too.) This makes it difficult or impossible to read smaller print. It can also make it difficult to write. At the same, you will probably have difficulty with depth perception and focusing on or watching moving objects.

In addition, you may feel dizzy, experience nausea or have a sense of moving, particularly at the onset, if you move your eyes, move your head and eyes simultaneously, or watch moving objects. This can make being around traffic, riding in a vehicle, watching TV or watching a movie in a movie theater very unpleasant. You may find moving or flickering lights bother you.

Just the act of focusing your eyes may be difficult and can lead to dizziness and nausea. You may have a tendency to look down because it is harder to focus on more distant objects. Your ability to accurately determine distances may also be disrupted. As a result of your poor depth perception, you may often bump into things.

Your Ears and Proprioceptive System Work Together

Your vestibular system also works together with the muscles of your body via your spinal cord in what doctors call the vestibulo-spinal reflex. This instantaneous reflex allows for continual, coordinated muscle adjustments so you can maintain your balance as you change position.

Normally, your vestibular system sends balance information to those areas of your brain and nervous system involved in the motor control of your muscles. This balance information allows your brain to continuously make little adjustments in muscle activity and body position to allow you to stand upright and maintain your balance.

When you lose this reflex, your vestibular system no longer passes this information on to your brain or it passes faulty information. As a result, your brain does not order the tiny muscle adjustments and you get a condition known as ataxia (ah-TAKS-see-ah). Ataxia is the inability to coordinate your muscles properly such that it affects your gait. As a result, when you walk you may lurch and stagger as if you were drunk (staggering gait) as the other two parts of your balance system try to compensate. You will be unsteady and stumble a lot.

You may try to compensate for this by standing and walking with your legs farther apart than normal in order to give you better control of your balance (wide-based gait). You also may keep looking down while you are walking. Even so, you may lose your balance or stagger when turning quickly (whole body or head only), and need to hold on to walls or furniture when you are walking.

In addition, you may have difficulty walking on slippery, soft or slanted surfaces or on uneven ground. You may have difficulty standing or walking in dim or dark places, at night, or when you have your eyes closed. Even under good lighting conditions, you will still tend to stagger. You may also feel unsteady, have problems standing with your feet together, be uncoordinated and clumsy and overreach when grabbing for objects.

Two Systems Are Necessary to Maintain Balance

When they are working properly, your brain uses the separate signals from your vestibular, ocular and proprioceptive systems to instantly and subconsciously maintain clear vision and to make rapid muscle adjustments to maintain your balance and prevent you from falling.

These three systems are somewhat redundant, so if one stops functioning, you can manage (with difficulty) on the remaining two. However, you cannot maintain your balance with just one system working—you need at least two and preferably all three. Since it is your major balance system, if you lose your vestibular system, your brain has to rely on the other two systems. However, without the critical vestibular information, you will have a lot of trouble maintaining your balance, especially in the dark since darkness effectively eliminates your ocular system leaving you with just your proprioceptive system to help you.

When Damage Whacks Your Balance System

So far we have been looking at how the vestibular system works together with the other two systems and what can happen when the vestibular system totally ceases to function. However, often the vestibular system is just damaged, not totally destroyed. This gives rise to a whole new set of problems.

When your vestibular system dies, it no longer sends any information to your brain, so your brain does the best it can with the information from the other two systems.

However, if your vestibular system is only damaged, it continues to send balance information—wrong information, mind you—but your brain doesn't know this. This confuses your brain and you will experience things such as dizziness and vertigo (VER-tih-goe). If you have vertigo, you may feel that you are spinning around or the room you are in is spinning around you.

Vertigo results from a mismatch of vestibular, ocular, and proprioceptive inputs. When all three are telling your brain the same thing, all is well. However, when your ears tell your brain one thing and your eyes and proprioceptive system tell it another thing, your brain doesn't know who to believe. In this case, your brain's confusion manifests itself as vertigo. Nausea and vomiting often accompany vertigo.

Vestibular side effects generally are worse in the first few weeks after vestibular damage occurs. In time, your brain will begin to rely less and less on vestibular information and more and more on ocular and proprioceptive inputs. As this happens the dizziness and vertigo (with the attendant nausea and vomiting) will tend to go away and you will tend to function as though your vestibular system were

completely dead. However, you will be left with permanent side effects that can alter your lifestyle dramatically.

Other Symptoms of Vestibular Damage

In addition to the host of visual problems, ataxia, dizziness, vertigo, nausea and vomiting, which we have already discussed, damage to the vestibular system can cause a number of other symptoms. Here are some of them.

If your vestibular system is only damaged on one side or damaged worse on one side than the other, you can get a condition called nystagmus (nye-STAG-muss).

Nystagmus refers to abnormal rapid rhythmic back-and-forth side-to-side involuntary eye movements (eye jerking). With nystagmus, both of your eyes drift slowly in one direction and then suddenly jerk in the opposite direction. Your eyes will jerk toward the undamaged (less damaged) side and will drift back towards the (more) damaged side. This abnormal eye movement can also cause vertigo, nausea, vomiting and a host of other visual complaints.

Unlikely as it seems, vestibular damage can cause memory problems. Here is why. When you damage your vestibular system, keeping your balance is now largely a conscious effort, not the automatic effortless procedure it once was. Consequently, those areas of your brain that you once just used for thought and memory, now must constantly work on keeping you balanced. As a result, your memory may suffer. You may grope for words when talking. You may easily forget what is being spoken about during a conversation. You may be easily distracted. You may have difficulty comprehending directions or instructions. You may have trouble concentrating and may feel disoriented at times.

You may also experience fatigue because keeping your balance is now no longer a subconscious event, but something that you must consciously work hard to maintain. All this work makes you tired!

Vestibular damage may also give rise to muscular aches and pains. This is because when your vestibulo-spinal reflex no longer works automatically, you have to consciously control your balance by making your muscles rigid and less relaxed as you strain to keep your balance. In addition, you may get headaches and a stiff/sore neck from trying to hold your head absolutely still so you won't feel dizzy or nauseous.

Finally, damage to your vestibular system can include emotional problems such as anxiety, frustration, anger and depression. Your feelings of self-confidence and self-esteem may plummet. You may feel vaguely uneasy. You may feel that something is wrong or unreal without knowing why.

If you have a damaged vestibular system, you won't necessarily have all of the above symptoms, but you may experience many of them.