Peripheral Visual Cortical Influence on Central Ventilation

Ron Hruska, MPA, PT
AAPMD Collaboration Cures
September 25, 2021

Overview

Cortical visual satisfaction of balanced peripheral optic flow enhances physiologic related trust of appendage influence on chest wall and respiratory neuro-mechanics.

The human body, as a pump, decompresses and compresses air and fluid pressure, through binocular balance. Allocation of spatial attention by the cortical hemispheres can be impacted by visual perception, homeostatic location, forward locomotor movement and hemispheric pulmonary function.

Addressing what one references (visual processing), and where one simultaneously moves (spatial processing), often requires a sense of upright stability that can only be provided by an optometrist and health care movement specialist working together.

Lateralized over representation of ambient space, ground for extraocular muscle related stabilization and visual acuity sensitiveness all can, and often do, influence biased breathing behavior patterns.

Central Ventilation and Global Autonomics

The flow of the 6,000 liters or air a day the average adult moves in the lungs to extract oxygen, depends on the orientation we place our neck in, with sensory information about the local environment our central nervous system receives.

Our central nervous system regulates our central ventilation system.

A central ventilation system can be defined as a centrally located ventilator specifically designed to provide controlled, continuous, low-level movement of air in and out the home (body) for general ventilation. It contributes to healthy indoor (lung) air for everyone (everything) in the home (body), and protects the home (body) from mold and mildew (inflammation and airway hyper or hypo responsiveness).

Airway smooth muscle is the primary effector cell responsible for controlling airway caliber and resistance to the entire tracheobronchial tree. The autonomic nervous system is the principal regulator of the airway smooth muscle tone and consists of three separate neural pathways:

1. **Parasympathetic innervation (The predominant contractile innervation of airway smooth muscle. Cholinergic in nature. The primary relaxant innervation of the airways is comprised of noncholinergic or nitric oxide synthase and vasoactive intestinal peptide-containing parasympathetic nerves.)**

2. **Sympathetic-adrenergic nerve innervation, causing airway smooth muscle relaxation (play a much smaller role in directly regulating smooth muscle tone in human airways.)**

3. **Nonadrenergic, noncholinergic innervation that increases airway hyperresponsiveness. Sympathetic noradrenergic nerve fibers are reflexively activated by distension of the main pulmonary artery or proximal airway segments (cervical trachea, larynx, pharynx). The responses to low arterial Po2 are due to activation of carotid and/or aortic arterial chemoreceptors and involve both the sympathetic chain and the vagus nerve.**

Therefore, our ventilation is regulated by airway smooth muscle.

Airway smooth muscle is the critical modulating bronchomotor tone of the precontracted airways.

The vagus nerve is initiated at the core of the brain and travels to the depths of the gut. It affects:

1. Eye movement,
2. Facial expressions,
3. Tone of voice,
4. Heart rate,
5. Heart rate variability,
6. Ventilation,
7. Inflammatory responses, and
8. Digestion

Although afferent nerves within the vagus innervate virtually all visceral organs, nearly 20% terminate within the airway and lungs.

[Mazzone SB and Undem BJ. Vagal afferent innervation of the airways in health and disease. Physiol Rev. 2016 Jul; 96(3):975-1024.]

Through neuroception, the vagal nerve is continuously assessing the safety of our physical, physiologic, and psychologic state and situation, as well as the mood, position or state others are in that one interacts with.

The vagal nerve is a relay messenger.

What happens in Vagus, does not stay in Vagus.

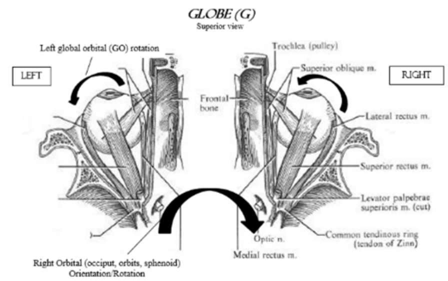
One of the most powerful doorways to successful homeostatic balance is messages that go through the eyes to the retinas.

Our twelve extraocular muscles are crucial not only for our ability to focus our vision, but they are also essential for our survival, since the evolutions of our species has depended upon our eyes to detect danger.

The extraocular eye muscles contain nerve endings that are the source of the oculocardiac reflex, a very powerful parasympathetic <u>body</u> reflex.

The oculocardiac reflex directly affects the vagus nerve which runs from the brain directly down the spinal cord of the neck to the heart and the stomach.

When the neck is twisted or imbalanced, anatomically, the oculocardiac reflex communicates to the vagus nerve that we are in danger, thus initiates an immediate signal to speed up heart rate, increase blood pressure and tense up the body, including the extraocular muscles, more.



Adapted from Pansky B, House EL. 1975. Review of Gross Anatomy. 3rd Ed. New York, NY: Macmillan. p. 107.

Alteration of cervical postural function is just one of these alterations, that influences both binocular (using both eyes) function, requires biocular (an optical system, i.e. cortex, in which the optical components are shared by both of the viewer's eyes) cortical processing that modulates both eye ciliary and airway smooth muscle. This cortical processing becomes engrained and patterned.

Overview of Eyes and Proprioception

Proprioceptive input from the neck muscles, which are highly connected and correlated with central ventilation, has access to mechanisms which are used in the calculation of the direction of gaze. As a result, the motor output of the gaze system seems to be modified in such a way that the eye position is shifted.

This would imply a functional sensory coupling between eye and neck position, and that the proprioceptive messages originating in neck muscles are processed together with visual information and eye muscle proprioceptive information in determining gaze direction.

[Lennerstrand and Han]

A mismatch between the neck proprioceptive input from the two sides, or from the back and the front, of the neck may influence the gaze control system and trigger both a sensory response, perceived as an illusory movement of the fixation target, and a compensatory motor response, which under conditions of head and body fixation would result in oculomotor activation deviation of the eyes, on a 'deviated' body, neck and head.

The human proprioceptive system has four overlapping major functions:

1. Posture and ventilation/body movement is mediated by proprioception through the afferent information it receives from all sensory receptors, and by the efferent information it sends to the extrapyramidal motor tracts.

2. By integrating and modulating the information that comes from sensory receptors, including the retinas, the proprioceptive system informs the brain about the relative position of the sensory organs, the relation between each body segment, and the relative position of the body and chest walls in the surrounding environment. This is referred to as "Egocentric Spatial Localization".

[Alves da Siva O. and Alves da Silva T. The eyes and proprioception. Vision Development and Rehabilitation. June 2019;5(2).]

Alves da Silva also concluded that in studying the patient's 'oculomotricity' it was possible to identify a pattern of eye dysfunction in patients who had "Postural Deficiency Syndrome or Proprioceptive Dysfunction Syndrome.

3. Proprioceptive information known to be transmitted in the multisensorial deep layers of the superior colliculus in the midbrain is believed to have a role in modulating multisensory integration.

   This modulation has consequences in motor behavior affecting respiration, ventilation and breathing patterning and higher cognitive functions.

4. Postural asymmetry influences version movement of the binocular system. Those with postural asymmetry favoring right limb support exhibited a pseudoscotoma only on levoversion or rotation of both eyes to the left.

   [Martins Da Cunha H and Alves Da Silva O. Postural deficiency syndrome. Its importance in ophthalmology. J Fr Opthalmol. 1986;9.]

[Scotoma is a scintillating partial alteration in the field of vision that is almost spiral-shaped, with distortion of shapes but otherwise melting into the background similarly to the physiological blind spot, as may be cause by cortical spreading depression.]

Visual System PRI Considerations for Balanced Upright Cortical Function

***See attached handouts**

Thank you!

Ron Hruska, MPA, PT
Hruska.Ron@posturalrestoration.com

Visual System PRI Considerations for Balanced Upright Cortical Function

- Right eye more functionally dominant, or at least equal to the left eye's dominance, for focal, distant vision
    - This may reflect a relative increased need for less hyperopic, or more myopic, optical compensation on the right side vs. the left
    - This may reflect a relative increased need for less inversion, or more eversion, calcaneal compensation on the right side vs. the left.

- Astigmatic correction that does not exceed what the physical development of the eye dictates.
    - This would ideally vary with given tasks as an appropriate response and not require compensatory lenses for near vision when sitting or distance when standing.

- Left peripheral visual field active more than, or equally to, the right peripheral visual field in standing or during forward progression or walking.

- Binocular alignment would be accurate at distance, meaning no misalignment tendencies, and the visual system could withstand a slight increase in divergence (relaxation of medial rectus, activation of lateral rectus) or convergence (relaxation of lateral rectus, activation of medial rectus) without sacrificing clarity, single vision, or associated limited neck rotation when standing.

- Flexibility of the visual system is maintained so that the response to the task is appropriate. The visual system does not "lock" itself into any given response so tightly that it is unable to change to the next stimulus without effort, such as forward and backward movement of the optometrist when in standing.

PRI Terminology Related to Vision

Functional Cortical Dominance

- This refers to the eye that the brain predominately uses for functional upright activity
- This eye will be the one most strongly associated with the patient's habitual pattern of centering their body in space
- Not all patients exhibit a strong preference, or strong dominance
- This may not be the same eye classically determined as the "dominate" eye, which is typically done by a sighting task

Neutral

- B Cervical Lateral Flexion (C Lat Flex)
- B Humeral Glenoid Internal Rotation (HG IR)
- B Cervical Axial Rotation (C Axial Rot)

Grounded

- B Straight Leg Raise (SLR); 70°-90°
- B Sense of big toe, medial arch and heel
- Standing Sensory Shift without losing B sense of big toes, medial arches or heels

Centering

- A PRI visual perceptual concept that reflects ability to capitalize ascending support and balance through appropriate compensatory neurological patterning from the visual-vestibular centers
- Occurs in lateralized upright position

Space

- Personal Space – an arms-length around you
- Peri-Personal Space – from border of personal space to distances up to 10 feet
- Extra Personal Space – beyond 10 feet out
- Space 'appears' compressed when excessive visual convergence takes place looking at any target distance- usually this tendency occurs with movement that is patterned around extension

The following patients need to be seen by a COVD or Neuro-optometrist before PRI visual concepts are considered:

- Strabismus (eye turn), with or without surgery history
- Double vision and/or vertical ocular muscle imbalance
- Degenerative/damaged cornea, such as keratoconus, trauma history
- Retinal disease, such as macular degeneration
- Optic nerve disease, such as glaucoma
- Visual field loss

GUIDELINES AND CONSIDERATIONS FOR OPTOMETRISTS WHO ARE INTEGRATING WITH PRI PRACTITIONERS

Astigmatism

- If the patient has astigmatism, ≤1.00, and the axes are between 180-100 on the right eye, and/or 080-180 on the left eye: have the optometrist trial the **spherical equivalent** prescription to see if this improves their pattern and allows them to become neutral.
- The spherical equivalent is defined as the spherical power whose focal point coincides with the circle of least confusion of a sphero-cylindrical lens.
    - For example, with a spectacle correction of -3.00 + 1.00 x 180, the spherical equivalent = -3.00 + ½(+1.00D) = -3.00D + 0.50D = 2.50D spherical equivalent. (Reference: https://webeye.ophth.uiowa.edu/eyeforum/video/Refraction/Intro-Optics-Refract-Errors/index.htm)
- If the astigmatism is >1.00, and axes of astigmatism are in range above, it is easiest on the patient to have both contacts and glasses before integrating PRI visual concepts. Example: Training eyewear can be utilized over their contact lenses which results in less blur while the training eyewear is on. High amounts of astigmatism are very hard to "over-ride" in glasses without significantly blurring the patient's vision.

Bifocal Glasses

- **Progressives = No-Line Bifocals**
  Power is not consistent throughout lens, either vertically or horizontally. To make a lens have different powers in top vs. bottom, astigmatism is *induced* in the lens nasal and temporal to the area in the patient's straight-ahead line of sight. This astigmatism is variable throughout the lens, both in amount and axis, and cannot be specified. It is a product of lens manufacturing to get the "progressive" change in power.
- **Lined or Round Segment Bifocals**
  Less problematic than a progressive, but for patients who habitually look down while walking may negatively influence their pattern.
    - ➢ In either of these situations, trial the distance portion of the prescription (without the bifocal) <u>for upright function</u>.

Bifocal or Monovision Contacts—The Way to Avoid "Reading Glasses"

- Bifocal contacts have the potential to complicate programs because the patient is looking through different powers in each eye at the same time. These have an unpredictable effect and vary with the patient.

- Monovision means that patients elect to have one eye, their optometrically dominant eye, corrected for distance viewing, and the other eye corrected for near viewing. This allows them to "switch" between the 2 eyes, primarily using input from one for far away and the other for up close. This is one of the most significant limiting factors we have encountered for patients; we have come across several patients who improve dramatically in both objective and subjective findings just by having them get out of their monovision modality.

- Modified monovision is a hybrid of the above two modes of contact correction. Since it still means that there are circumstances the patient is "switching" between their two eyes, it again could be a significant limiting factor.

    - You need to have the patient ask their doctor if they are wearing any of these modes of correction. It is difficult to determine this simply by looking at their prescription.

    - In all of these situations, the best recommendation is to have the patient obtain contacts that give both eyes the best possible distance vision and assess if this changes their postural pattern. This does mean they will need reading glasses.

    - They will almost *always* need to do this prior to any PRI visual perception lens intervention, even if it does not change their objective or subjective findings.

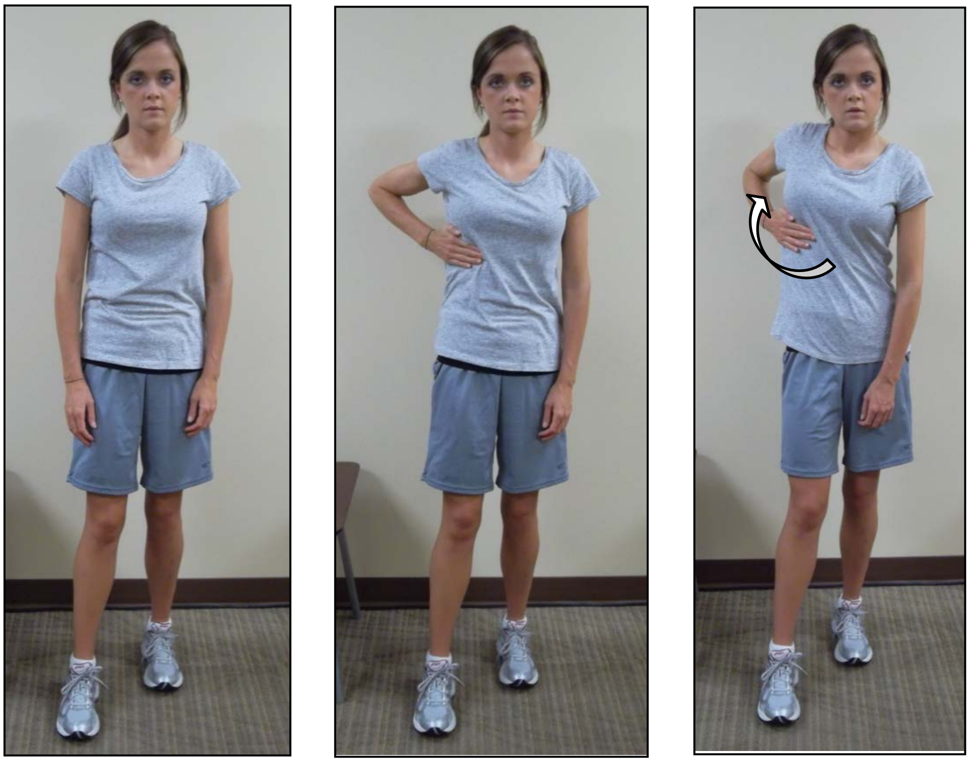
General Guidelines

- Ask the patient to work with their optometrist to get the best corrected vision in both eyes if they have one eye that does not see as well as the other for distance without correction. This may be in glasses or contacts; it is up to the discretion of the optometrist. <u>Getting the brain to use both eyes as "equally" as possible is always the goal.</u>

- Each patient (their brain!) responds differently to a lens change and it's impossible to predict what the outcome will be to any lens change.

- Consider using one of the three left centering with right thoracic rotation respiratory techniques to determine which final prescription to prescribe if acuity that has been established to get the brain to use both eyes equally is hard to substantiate by the patient. Which final prescription allows the patient to breathe and move more easily, and stay more relaxed, with one or all of these three standing PRI techniques?

Standing Left Centering with Right Thoracic Rotation, Right Rib Sensory Awareness, and Inhalation Focus

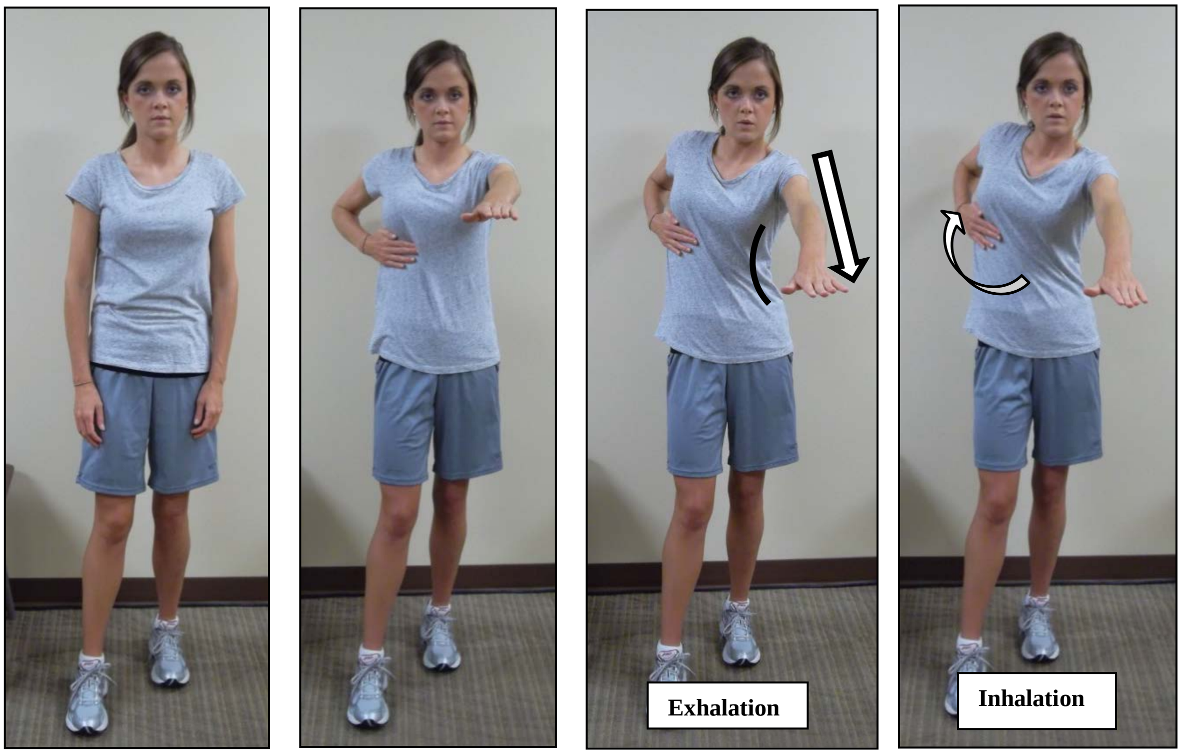


1. Stand with right foot forward and left foot back. Bring your left hip back feeling your weight shift back to your left foot and heel. Your pelvis should orient slightly to the left. Find, feel, and be aware of your left heel throughout the exercise.
2. Place your right hand on your lower rib cage while your left hand stays at your side. Relax and exhale fully through your mouth.
3. Continue to keep the left heel grounded as you inhale through your nose, feeling the right ribs move up and back as your trunk slightly rotates to the right. Continue to keep left heel grounded.
4. Exhale through your mouth as you relax to the starting position. Repeat for 4-5 breaths emphasizing right rib motion with each inhalation.
5. Relax and repeat 4 more times.

Standing Left Centering with Right Thoracic Rotation, Left Rib Sensory Awareness, and Exhalation Focus

1. Stand with right foot forward and left foot back. Bring your left hip back feeling your weight shift back to your left foot and heel. Your pelvis should orient slightly to the left. Find, feel, and be aware of your left heel throughout the exercise.
2. Place your right hand on your lower rib cage and place your left hand straight out in front of you.
3. Breathe in through your nose. Exhale through your mouth as you reach forward with your left arm feeling your left ribs move down and in and your trunk slightly side bend to the left. Keep left heel awareness and grounding throughout the exercise.
4. Return to the starting position and inhale gently through your nose. Repeat 4-5 times feeling and emphasizing left rib movement with each exhalation.
5. Relax and repeat 4 more times.

STANDING LEFT CENTERING WITH RIGHT THORACIC ROTATION, BILATERAL RIB SENSORY AWARENESS AND INHALATION AND EXHALATION INTEGRATION



1. Stand with right foot forward and left foot back. Bring your left hip back feeling your weight shift back to your left foot and heel. Your pelvis should orient slightly to the left. Find, feel, and be aware of your left heel throughout the exercise.
2. Find and feel your left heel grounded on the floor.
3. Place your right hand on your lower rib cage and place your left hand straight out in front of you.
4. Breathe in through your nose. Exhale through your mouth as you reach forward with your left arm feeling your left ribs move down and in and your trunk slightly side bend to the left. Keep left heel awareness and grounding throughout the exercise.
5. Inhale through your nose as you feel right ribs move up and back as the right chest wall expands and the upper trunk rotates slightly to the right.
6. Relax to the starting position. Repeat 4-5 times feeling and emphasizing left rib movement with each exhalation and right rib movement with each inhalation.
7. Relax and repeat 4 more times.

Option: You could start with the inhalation phase feeling right ribs move up and back followed by full exhalation with left arm reach feeling left ribs move down and in. Then relax to starting position.