Visual Motion – An Omitted Component of Optometry

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What Do These Have in Common?

- Eye Movements
- Accommodation
- Binocularity
- Suppression
- Visual Fields
- DVAT
- Visual Fields
- Central/Peripheral Vision
- Visual Localization
- Stereopsis
- Peri and Extrapersonal Space
- Dizziness
- Visual Motion Sensitivity
- Color Testing

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VISUAL MOTION

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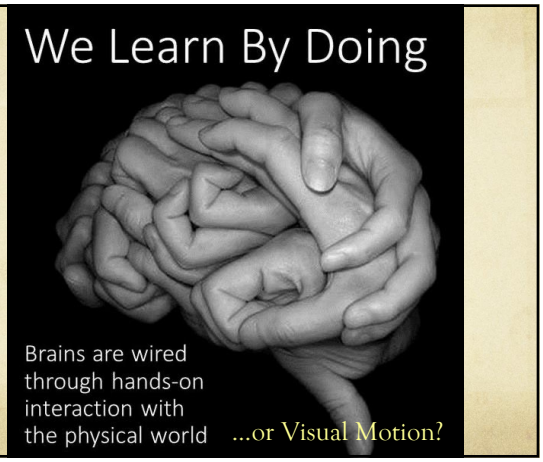
We Learn By Doing



Brains are wired through hands-on interaction with the physical world

...or Visual Motion?

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Visual Motion

- How does your brain deal with it?
  - Filtering and Anticipation
- Central / Peripheral – Visual Spatial Awareness
- Optometric Toolbox – lenses, prism, selective occlusion, tints/filters and vision therapy/rehab
- Fusion – fast(motion) vs. slow(disparity)
- Visual Motion Sensitivity

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Value of Brain Processing

- Anticipation – are you in the present or future
  - Visual motion is what you use
- Filtering – subcortical(motion)/cortical (selective attention)
  - Eliminates being over stimulated
- Central/Peripheral (CP) vs. Visual Spatial Awareness (VSA)

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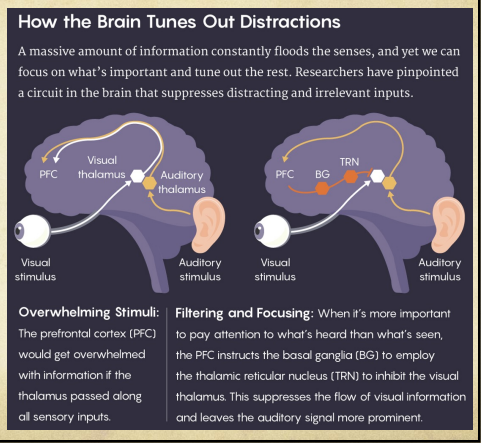
Sub-Cortical and Cortical Pathways



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Central/Peripheral vs. Visual Spatial Awareness Binocular Motion Parallax

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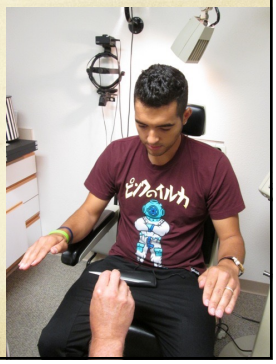
Visual Spatial Awareness



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Brock String

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Magno/Parvo Considerations

- P-pathway accounts for 91% in fovea, 45% periphery, suppress Parvo?
- 10% of ganglion cells in optic nerve are magno
- M-pathway is represented in and the DENSITY IS GREATEST in the fovea, but only 5% of cells
- *Since M cells (and P cells) are concentrated most densely centrally, one would expect a M pathway defect to be expressed most strongly centrally (relate to Cook's work on periphery)

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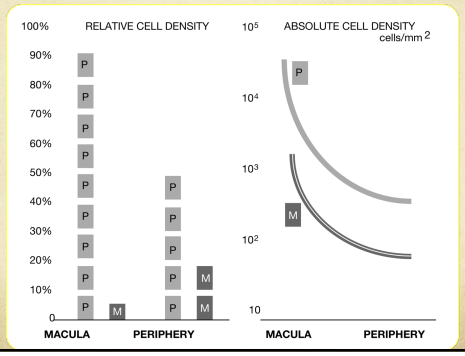
M/P Pathways – Dacey - 1994



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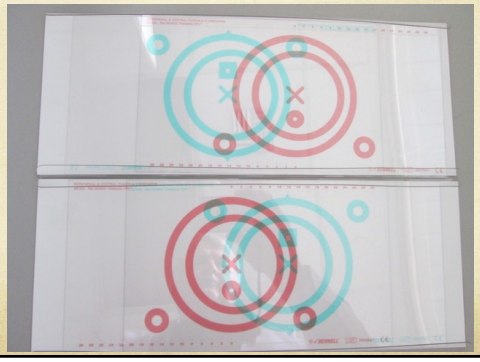
Can you simultaneously fuse BO/BI



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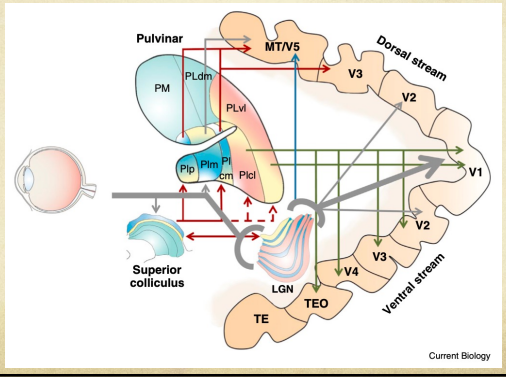
Visual Motion Pathways



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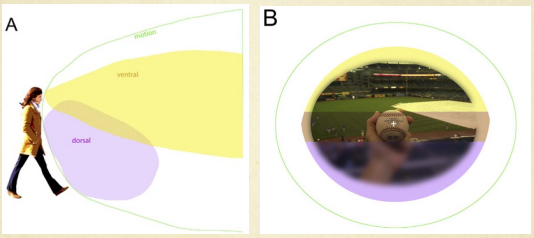
Spatial Considerations of Dorsal and Ventral with Motion (Preattentive)



Gilaie-Dotan, Sharon
Neuropsychologia 2016, 89, p. 378-392

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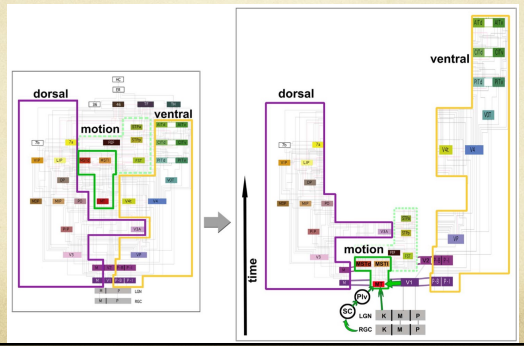
Revised Visual Hierarchy

Original – anatomic based Updated – latency based



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Train in London – direction ?

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"Vision is the deriving of meaning and directing of action as triggered by a selected band of radiant energy."

Robert Kraskin, OD

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"Vision is the art of seeing (using) things invisible."

Jonathan Swift

- *Anticipation
  - If we did not, we'd miss a lot, visual motion
- *Filtering out information
  - Subconscious vs. conscious pathways

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"It is impossible to be in the present, you have to be in the future to interact with the present."

Jam Ghajar, MD

Neuroscientist. 2009 June ; 15(3): 232–242. doi:10.1177/1073858408326429.

The Predictive Brain State: Asynchrony in Disorders of Attention?

Jamshid Ghajar and **Richard B. Ivry**

The Predictive Brain State: Timing Deficiency in Traumatic Brain Injury?

Jamshid Ghajar, MD, PhD, Richard B. Ivry, PhD, and the Cognitive and Neurobiological Research Consortium

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Visual – Vestibular Interaction

- Arousal - rotational, linear is calming
- Myelination – at birth visual and vestibular
- Arousal
- Bilateral input, Cerebellar interaction
- Balance – Dizziness (visual motion, vestibular)
- Four Circles – Where am I, Where is it

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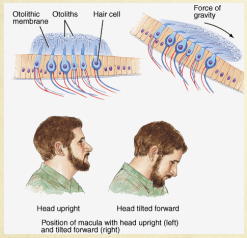
Sensors of the Inner Ear Visual Connections with Eyes

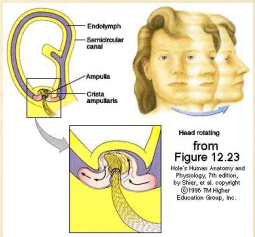
Otolith Organs



Linear Accelerometers

Go to ALL Eye Muscles

Semicircular Canals



Angular Accelerometers

Go to PAIRS of Eye Muscles

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Optometric Toolbox

- *Lenses – accommodation, motion increases magnification which increases VOR gain, effects upon peripheral visual input
- Prism – binocular, spatial aspects include apex magnification and base minification thus VOR gain, spatial - not just periphery
- Selective Occlusion – Decrease proximal vergence thus peripheral and spatial aspects (x,y,z axes), increases motor localization with less emphasis upon stereopsis, vision is motor
- Tints/Filters – Blue magnification, red minification, and cone disparities-central/peripheral relationships of space, PS/S balance
- Vision therapy/rehabilitation – accommodation, binocular, fixation, spatial and others

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Lenses

- Compensatory vs. therapeutic considerations
- Not related solely to the accommodative convergence model
- Why are glasses rejected, especially with large changes, progressive bifocals (MF IOL)
- Relative plus increases VOR gain from magnification thus stabilizing imagery (in mTBI and dizziness, VMS)
- *Magnification increases VOR gain…see Len Press
- What happens with lens in place, what happens after lens removed. Possible habituation

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Lens Aberrations - Magnification

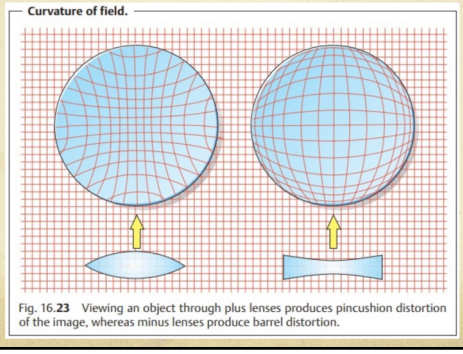

Fig. 16.23 Viewing an object through plus lenses produces pincushion distortion of the image, whereas minus lenses produce barrel distortion.

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Prism

- Compensatory vs. therapeutic considerations
- Binocular considerations
- Postural/gait implications – head upright, rotation
- Unilateral Spatial Inattention / Visual Field Loss
- AEL vs. VMSS
- *VOR gain – apex magnifies, base minifies
  - Base In provides increased VOR gain to VSA
  - Base Down provides increased VOR gain superiorly

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Abnormal Egocentric Localization

- Motor – Hemiplegia
- Vestibular – Unilateral hypofunction
- Cervical – Cervical Joint Proprioception Test (JPE)
- Visual – strabismus, eccentric fixation, amblyopia, EOM paresis, gaze palsy, smooth pursuit neck torsion test

  VMSS ? What is the symptom vs. cause
- Combinations

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AEL or VMSS

Initial Testing

Post 10X RL Doll's Eye

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Brain Injury 2009;23(6):566-76

Modifying postural adaptation following a CVA through prismatic shift of visuo-spatial egocenter

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Abstract

Objective: To demonstrate that Visual Midline Shift Syndrome (VMSS) following a cerebrovascular accident (CVA) can be corrected with yoked prisms.

Research design: This randomized study describes how the use of yoked prisms affects visual midline and documents the influence of yoked prisms on improving postural orientation.

Methods and procedures: Evaluation of VMSS and its correlation with postural lean during ambulation were studied in 30 post-CVA subjects and 30 controls.

Experimental interventions: Yoked prisms were used to treat VMSS by correcting posture and balance.

Outcomes and results: Over 50% of post-CVA subjects showed positive visual midline shift ($p < 0.001$; 95% confidence interval [CI], 0.660.93 for right CVAs and $p = 0.001$; 95% CI, 0.61–0.93 for left CVAs). A statistically significant proportion of those with a positive shift showed a decrease in shift utilizing yoked prisms ($p < 0.001$; 95% CI, 0.73–0.97 for right CVAs and $p = 0.001$; 95% CI, 0.07–0.39 for left CVAs). Additionally, over 50% of CVA subjects developed lean or drift away from hemiparesis and many subjects showed increased weight-bearing on the hemiparetic side with yoked prisms.

Conclusions: Yoked prisms are an effective means of treating VMSS in this population and may be useful in other neurological syndromes with visuo-spatial involvement.

- Secondary to "prismatic shift of visuo-spatial egocenter" or is it from a change in "visual motion and vestibular processing"

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What Happens with 10 PD BR Eyes Closed ?

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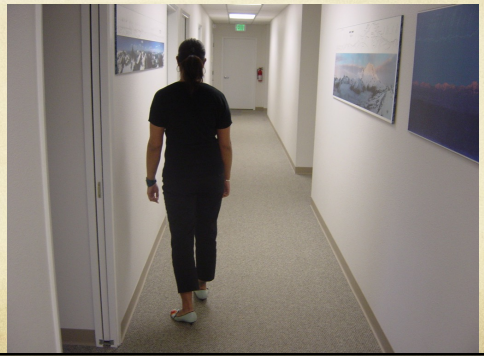
Visually goes straight into wall



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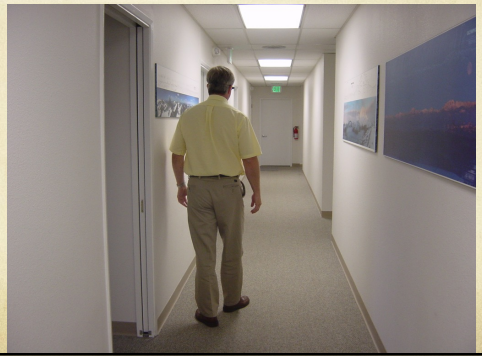
Goes toward wall, motor corrects



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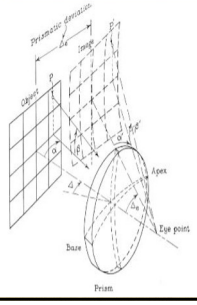
Magnification to Apex Increasing VOR Gain

Asymmetric LInear Magnification



Looking at this from the frontal plane aspect:

Perceived non-linear spatial expansion of the image (whole world) from the base to the apex.

Asymmetric Linear Magnification

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Selective Occlusion

- Binasal/nasal and Spot applications
- Modification of nasal vs. temporal inputs
  - Nasal retina for localization, temporal for stereopsis
- Benefits of binasal for promoting N-T monocular motion tracking
- Benefits in some acquired types (CN6) to recover full range of movement vs. compensatory prism

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Potential Effects of Binasal

- Decrease or eliminate diplopia/confusion that is secondary to strabismus
- Effects upon visual spatial awareness/suppression
- Modify fixation preference
- Promote alternation between eyes
- Decrease Anomalous Correspondence
- Promote abducting eye to lead localization
- Eliminate cross fixation patterns

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Potential Effects of Binasal

- Improve abduction (adduction - bitemporal)
- Effects upon contracture/atrophy
- Improve N-T tracking (motion processing) – changing cross fixatino pattern in infantile esotropia
- Modify Central/Peripheral relationships
  - Decrease central confusion, increase visual spatial awareness
  - VEP amplitudes increase and symptoms decrease
- Amblyopia prevention and treatment
- Eliminates proximal vergence, removes near visual input

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mTBI and Post Trauma Vision Syndrome

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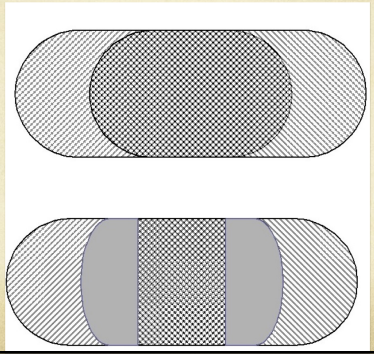
How Might Binasal Occlusion Help



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Width of Binasal - Overview

- Effects on alternation/fusion-C/P
- Effects on sensory/motor, asymmetry
- Smaller Width
  - Larger field of view, increase sensory
  - Less emphasis of extending motor to lead
- Larger Width
  - Smaller field of view, sensory penalization
  - More emphasis of extending motor to lead

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Tint / Filters

- Size and Motion Changes – blue magnifies, red minifies
  - *Magnification increases VOR gain
- Change color relationships between central and peripheral retina
  - Blue tint blocks red end (centrally 8/13 cones)
  - Amber tint blocks green end (centrally 4/13 cones)
  - Yellow tint blocks blue end (centrally 1/13 cones)
- Why does blue seem to be most common color…

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Benefits of Foundational Tools

- Lenses – Magnification of periphery (VSA)
- Prism – Magnification of apex (BI affects VSA)
- Selective Occlusion
  - Binasal – emphasis of outward VSA, removes proximal vergence
  - Spot – remove central, maintain periphery (VSA)
- Tints/Filters – Magnification with blue

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REHAB – EOM Considerations

- Fixation – central attention with motion monitoring maintenance of fixation
- Pursuits – anticipation, importance of peripheral input, slow vs. faster, midline saccadic intrusion
- Saccades – localization, anticipation, motion of self and target
- OKR – based upon peripheral visual input (iPhone), development of N-T monocular processing in infantile esotropia, amblyopia

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We cannot omit the importance of visual motion in our evaluation and management of vision.

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Thank you for allowing me to share today!

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