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# Balance Disorders after Closed Head Injury

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# Outline

- **Ear/Balance System as Shock Organs**
- **Examination of the Balance System**
- **Balance Disorders from CHI/Blast**
  - Ear related disorders
  - Closed Head Injury
  - Other Considerations

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# Background

- 2006 CDC
  - 1.5 million annually with TBI, 80% mild, 2% disability
- Military Population
  - 2-3x higher rates of CHI in peacetime
- TBI common battlefield injury
- DSM IV TR
  - physical symptoms for dx of post-concussive disorder-fatigue, disordered sleep, headaches, and ***vertigo/dizziness***

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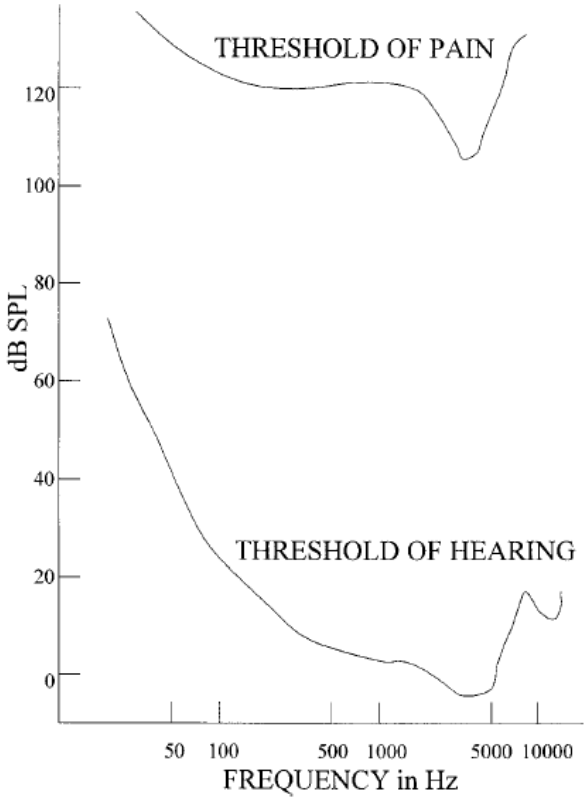
# Ear as Shock Organ

- Ear = mechano-electric transducer
  - 12 Orders of Magnitude
  - 0 dB is one twenty-millionth of Pascal
    - $10^{-8}$ cm movement at the tympanic membrane
- Blast = Pascal's
  - Force transmitted to neuroepithelium
- TM rupture as "pressure sensor"
  - The response of the human ear to blast. Part 1: The effect on the ear drum of a short duration, fast rising pressure wave. Army Weapons Research Establishment/Chemical Defense Establishment Report 1982;No. 04/82.
  - Experimental pressure induced rupture of the tympanic membrane in man. Acta Otolaryngol 1993;113:62-7.



# Balance Disorders related to TBI

- VA/DoD CPG mTBI Management
  - Treatment of somatic complaints should be based upon individual factors and symptom presentation
- Terrio 2009
  - Dizziness/Balance problems common and persistent after mTBI
  - Persistent through deployment 6% dizzy, 15% imbalance
    - In some persisted after deployment
    - For 25-37% new symptoms developed after deployment

    ***Traumatic brain injury screening: preliminary findings in a US Army Brigade Combat Team***. J Head Trauma Rehabil 2009;24:14-23.
- Dizziness/Balance Disorders common from Head Trauma
  - Balance as a vital combat sense
  - Evolves/Changes over time after injury

    ***Blast Exposure vestibular consequences and associated characteristics***
    Otol Neurotol. 2010 Feb;31(2):232-6.
  - Not one disorder

# The Balance “System”

- Ears
  - Linear and angular accelerometers
- Eyes
  - Reflex arcs, fast response, 30ms
- Joints/Muscles
  - Receptors for position, spine reflexes
- CNS
  - Integration of inputs, “perception”

# Balance Examination

- Subset of neurologic exam
  - Reflexes, highly reliable if abnormal
  - Correlate to audiologic tests
  - Exam builds to higher integration abilities
- Ears
  - TM integrity
  - Tuning forks
  - Fistula Test
- Eyes
  - Nystagmus, gaze, smooth pursuit

# Balance Examination

- Evoked Nystagmus-VOR
  - Halpike
  - Halmaygi Head Thrust
  - Post Head Shake
- VSR
  - Rhomberg

# Balance Examination

- Central Integration-Active Motion
  - Dynamic Visual Acuity
  - Museum gait
  - Dynamic Gait Index
    - Good intra-rater reliability
- Screening History
  - Dizziness Handicap Index

*Objective vestibular tests as outcome measures in head injury patients* Laryryngoscope. 2003 Oct;113(10):1746-50

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# Balance Disorders - CHI/Blast

- Ear Related Disorders
- Closed Head Injury Disorders
- Others

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# Otologic Causes: Post Traumatic Dizziness

- Less common, relatively easy to identify
- Standardized History and Physical Examination
  - Limited reliance on specialized testing- Audiogram
  - Hx
    - Duration, frequency, precipitating factors
  - PE
    - Nystagmus, Otoscopy, tuning forks, Hallpike, Rhomberg

# Dizziness after CHI: Blunt

- Classification
  - >400 patients before 2002
- Four Groups
  - Post-traumatic positional vertigo
  - Post-traumatic exertional dizziness
  - Post-traumatic migraine associated dizziness (PTMAD)
  - Post-traumatic spatial disorientation

*Characterizing and Treating Dizziness after Mild Head Trauma*. Otol/Neurotol, 25(2);135-38, 2004.

# Dizziness after CHI: Blunt

- BPPV
  - Hx, position provoked episodic vertigo
  - PE, positive Dix-Halpike with nystagmus
    - Geotropic rotatory-Anterior or Posterior Canal
    - Horizontal beating-Lateral canal
  - All other exams and tests normal

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# Dizziness after CHI: Blunt

- Exertional Dizziness
  - Hx, Dizziness/unsteadiness during or right after exercise, +/- Headache
  - PE, abnormal challenged gait testing
  - Testing-Normal

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# Dizziness after CHI: Blunt

- Migraine Associated Dizziness
  - Hx, Episodic vertigo short and multiple
    - Typical IHC Migraine-not with vertigo
  - PE, abnormal challenged gait, normal static posture
  - Testing, +/- VOR abnormalities, normal Posturography

# Dizziness after CHI: Blunt

- Spatial Disorientation
  - Hx, constant unsteadiness, worse when standing still (present sitting-lying down)
  - PE, abnormal static posture, abnormal challenged gait, abnormal DVA
  - Testing, poor posturography, Abnormal VOR

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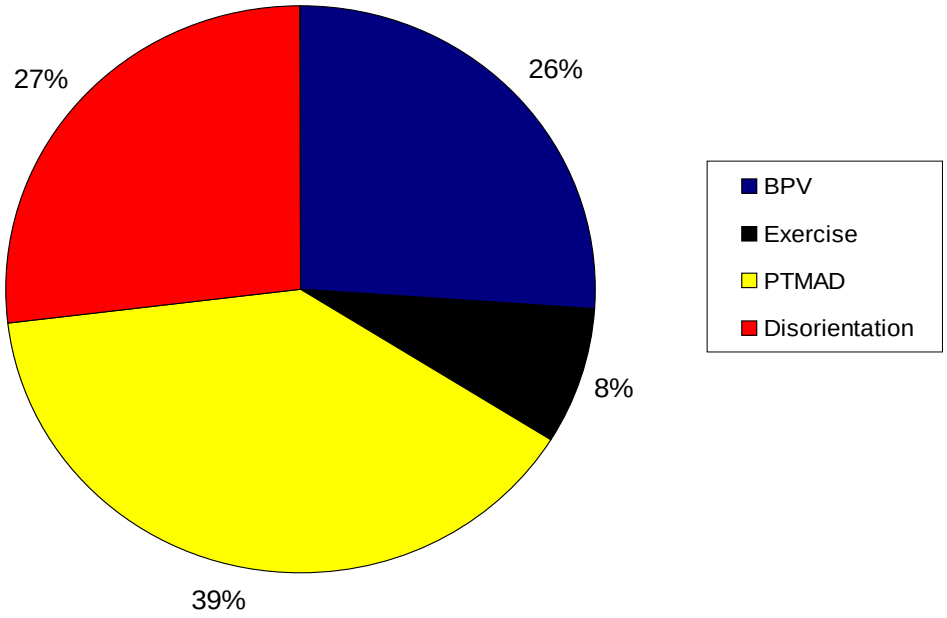
# Dizziness after CHI: Blunt



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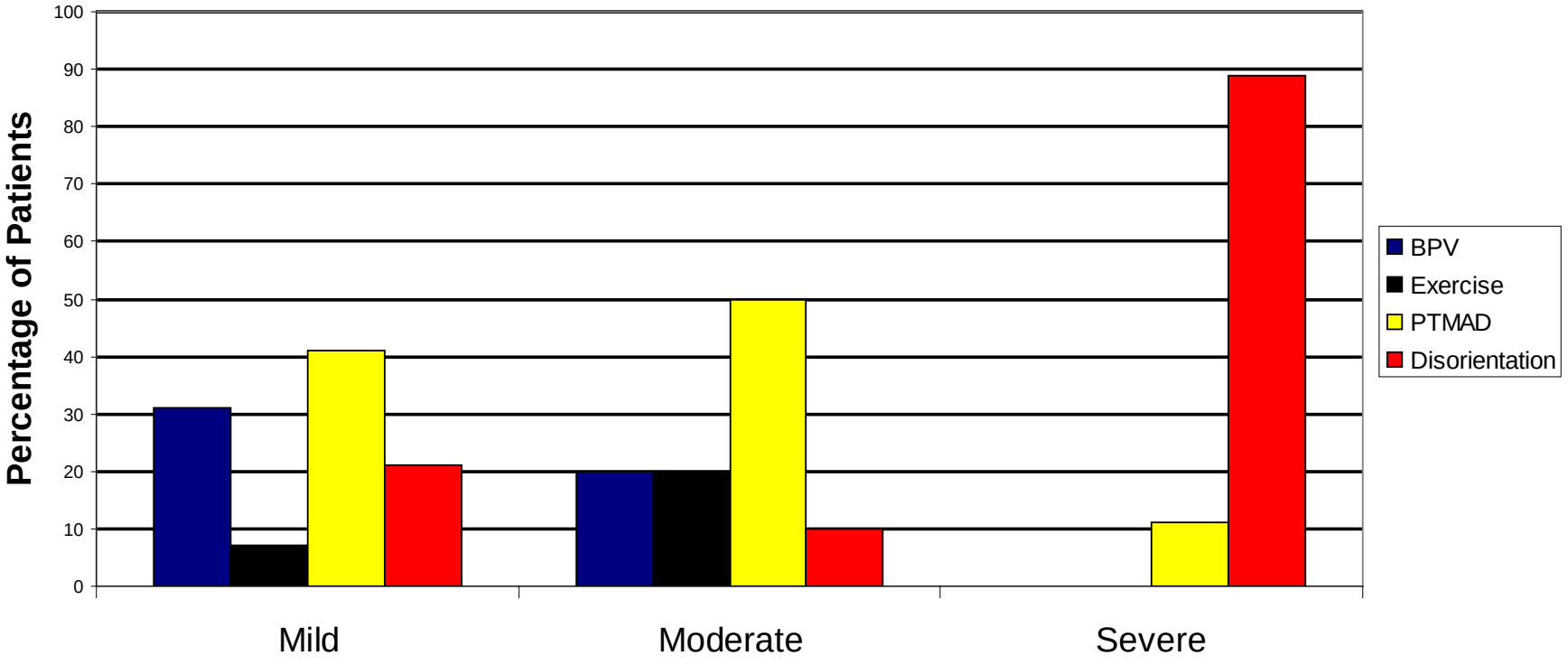
# Dizziness after CHI: Relationship to Severity



# Dizziness after CHI: Blunt

- Treatment
  - BPPV:
    - Canalith repositioning maneuver
  - Exercised Induced Dizziness:
    - Vestibular Rehabilitation
  - MAD:
    - Migraine Prophylactic,
    - Vest Rehab prn
  - Spatial Disorientation:
    - Vestibular Rehab

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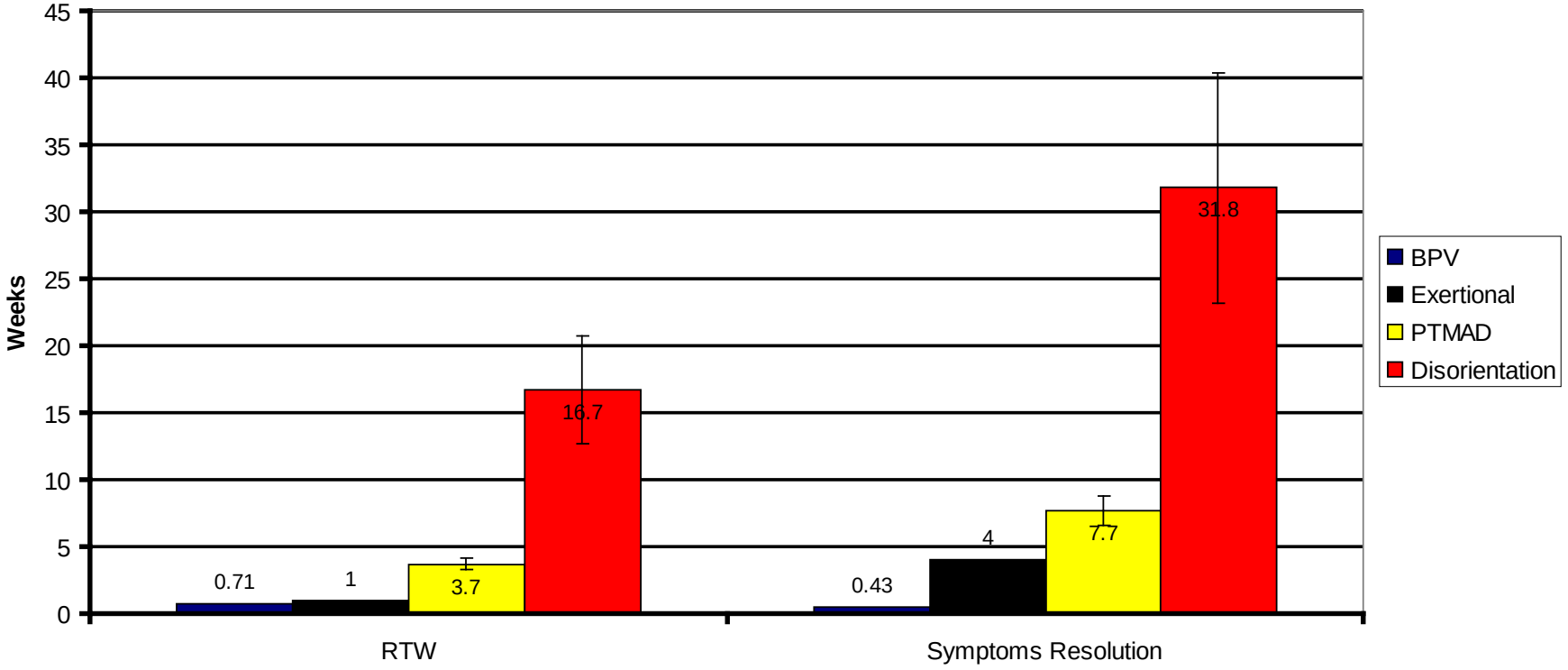
# Dizziness After CHI: Blunt Treatment Response



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# Dizziness after CHI: Blast

- DCOE Meeting May 2009
  - Non-Impact Blast-induced mTBI
    - Variety of scientific data now supports difference from Blunt trauma related mTBI
- Established Dizziness patterns
  - Began changing 2003-2004
  - “new” diagnostic groups for blast

# Dizziness after CHI: Blast

- Classification
  - 200 patients after 2004
- Four Groups
  - Post-traumatic positional vertigo
  - Post Blast Exercised Induced Dizziness
  - Post Blast Dizziness
  - Post Blast Dizziness with vertigo

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# Dizziness after CHI: Blast

- BPPV
- Post Blast Exercised Induced Dizziness
- Post Blast Dizziness
  - Hx, Constant feeling of unsteadiness when standing and walking worse with challenging environments, Constant Headache
  - PE, Abnormalities in challenged gait, tandem Romberg, DVA
  - Testing, Abnormal Posturography, VOR and visual testing
- Post Blast Dizziness with Vertigo
  - As above but also with episodic vertigo

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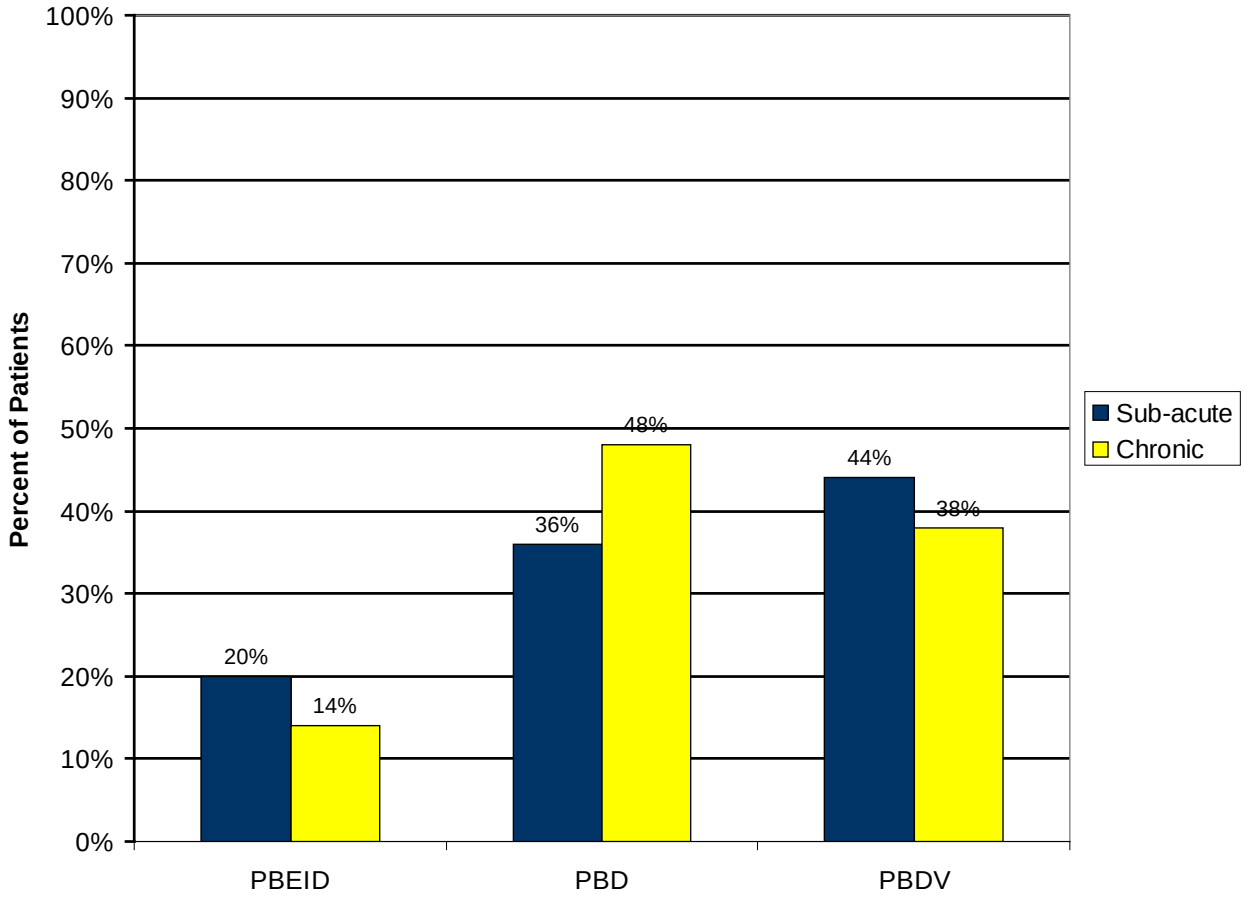
# Dizziness after CHI: Blast



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# Dizziness after CHI: Blast

| Group | Dizziness | Vertigo | Hearing Loss | Headache | PTSD |
|---|---|---|---|---|---|
| Acute | 98%* | 4%* | 33%* | 72% | 2%* |
| Sub-acute | 76% | 47% | 43% | 76% | 20% |
| Chronic | 84% | 36% | 49% | 82% | 44% |

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# Dizziness after CHI: Blast

- Dizziness and headaches are among the dominant symptoms of mTBI seen after blast
- Balance disorders can be classified in sub-acute and chronic blast exposure patients
- Objective vestibular tests tend to worsen over time
- Concurrent PTSD Dx grows at a high rate

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# Chronic Subjective Dizziness

- Common cause of chronic dizziness in civilian populations
- Symptoms are psychological in nature (anxiety, depression)
- Can give abnormal objective testing results

***Chronic dizziness: the interface between psychiatry and neuro-otology***
Curr Opin Neurol. 2006 Feb;19(1):41-8

***Chronic Subjective Dizziness***: Acta Oto-Laryngologica, 2008; 128: 10851088

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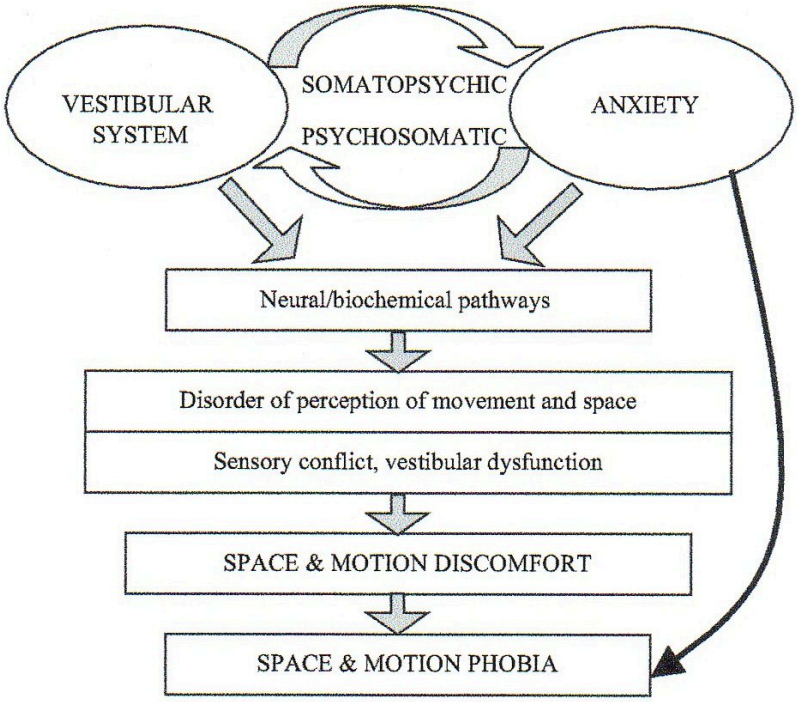
# Chronic Subjective Dizziness

- Links “physiology” with “psychology”
- Balance as Perception
- Underscores need to indentify and treat early before becomes “chronic”



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# Summary

- Balance
  - Critical Sense, disorders common after TBI
- Disorders can be classified
  - Exam, diagnosis, prognosis
- Early evaluation and management may lead to better outcomes