

Contemporary Concepts in Dysautonomia Following a Brain Injury

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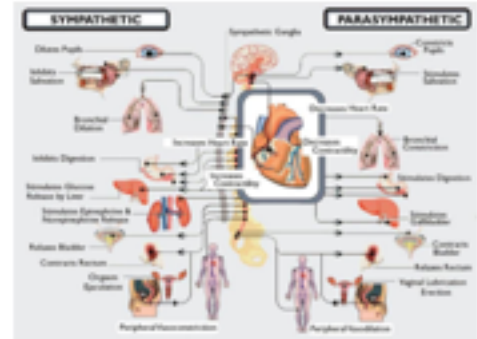
Head Trauma and Dysautonomia

- Estimated 11.4% of POTS patients report onset within 3 months of concussion.
- Up to 70% of adolescents with PCS have postural tachycardia.

(Miranda et al 2018)

Attendee Goals

- Identify ANS disturbance in a range of TBI patients.
- Quantify ANS disturbance
- Localize neural networks associated with dysautonomia
- Integrate treatment strategies that serve the dysautonomic patient after brain injury



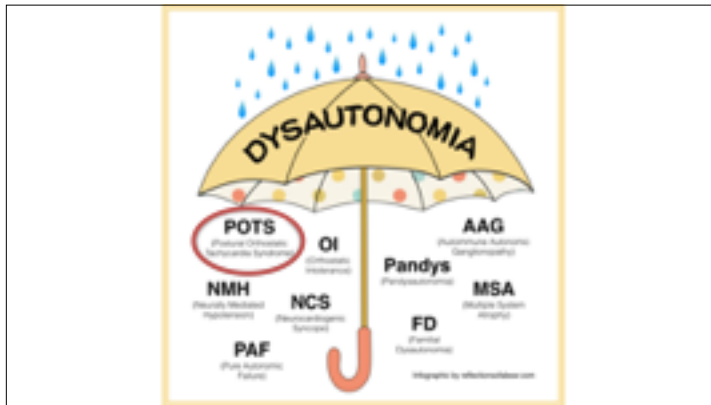
(<https://dysautonomiainternational.org/page.php?id=121>)

Functional goals of ANS

- Self-modulated internal environment
- Energy conversion (digestive) system
- Resource distribution system (waste, nutrients, O2, hormones, etc)
- Portability
 - orthostasis
 - exertion
- Reproduction



Suzanne Blies works on the beam during practice for the senior women's competition at the 2019 U.S. Gymnastics Championships Friday, Aug. 9, 2019, in Kansas City, Mo. (AP Photo/Charlie Riedel)



When the brain is injured we see common autonomic patterns:

- ↑ Heart Rate
- ↑ Blood Pressure
- ↑ Perspiration
- ↑ Pupil Dilation
- ↓ Cranial, GI, Sacral Secretion
- ↓ Central & Peripheral Blood Flow
- ↓ GI Peristalsis
- ↓ Bladder evacuation
- ↓ Sexual Function

<https://dysautonomiainternational.org/page.php?id=121>

Postural Orthostatic Tachycardia Syndrome

Dr. Philip Low

Variants through history

- DaCosta's Syndrome
- Soldier's Heart
- Mitral Valve Prolapse Syndrome
- Neurocirculatory Asthenia
- Chronic Orthostatic Intolerance
- Orthostatic Tachycardia
- Postural Tachycardia Syndrome

(Satish 2006, Masuki et al 2006, Khurana 2006)

POTS- Upon Standing:

Rise in HR more than 30 BPM

HR maintained at 120 BPM+

Orthostatic Symptoms

**Independent of Blood Pressure*

Can you remember your worst hangover?

SYMPTOMS

Syncope Inability to concentrate

Orthostatic Intolerance Excessive Fatigue

Frequent Urination Shortness of Breath

Photophobia Dizziness Migraines

Exercise Intolerance Brain fog Phonophobia

Vertigo Bradycardia Anxiety

Temperature Regulation Problems Palpitations

Mood Swings Insomnia Chest Discomfort

Appetite Disturbance Visual Disturbances

Nausea Tachycardia Low Blood Pressure

Gastrointestinal Problems Tremulousness

Sensory Hypersensitivity Difficulty with recall

<https://www.dysautonomia.org/dysautonomia/symptoms>

Symptoms 1 month after TBI reported the most common symptoms as:

1. fatigue
2. headache
3. dizziness
4. memory trouble
5. trouble sleeping
6. trouble concentrating
7. irritability
8. blurred vision
9. anxiety
10. increased light, and sound sensitivity

(Dikmen et al., 2010)

3 main conditions that we think about when looking at dysautonomia specific to a brain injury.

1. Monosynaptic pathway involvement
2. Polysynaptic pathway
3. Energy expenditure due to inefficiency

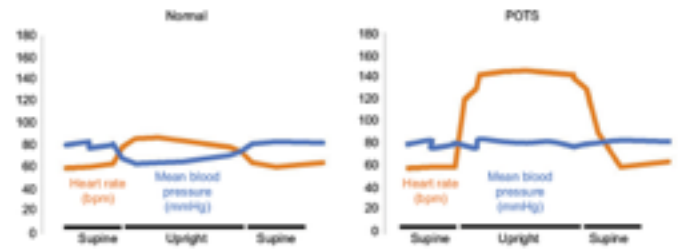
(Beck, 2008)

How is this evaluated clinically in a specialty setting?

Autonomic Testing:

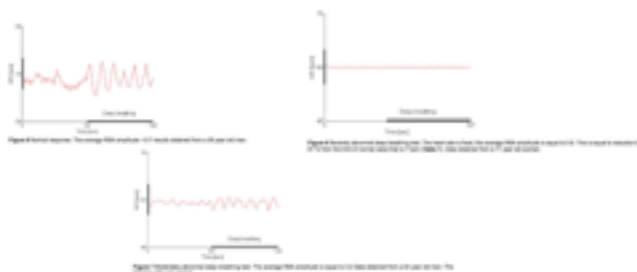
- HRV testing
- Head up Tilt testing
- Valsalva Test
- HR response to standing

Tilt Testing



Webb R, Spurrier AJ, Uno D et al. Postural tachycardia syndrome: current perspectives. *Yonk Health Res Manag* 2018; 35: 1–11.

HRV Deep Breathing



Nosik, Peter. (2011). Quantitative Autonomic Testing. *Journal of visualized experiments* : JOVE. pii. 18.2791/2582.

Valsalva Test

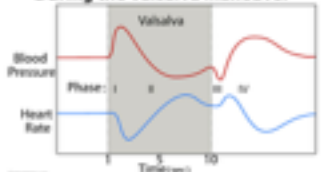
Phase 1. The coast of blowing. The pressure within the chest and abdomen increases and increases intrathoracic pressure. This activates the baroreceptor reflex, which drops heart rate. The increased intrathoracic pressure also reduces the amount of blood that comes into the right atrium (decreased venous return or preload).

Phase 2. Decrease of venous return, lower stroke volume, decrease of central venous pressure and decrease of MAP. Decrease of the vagal activity increasing heart rate. Increase in sympathetic activity, constricting the arteries (TPR). Slight rises of the blood pressure at the end of phase 2 (2S).

Phase 3. Release – the end of the maneuver. Intrathoracic pressure decreases, intrathoracic arteries widen, therefore a brief drop in blood pressure. At the same time, the venous blood fills the heart.

Phase 4. Blood pressure rises again from increased TPR (blood pressure overshoot). This activates the baroreflex, which results in a drop in heart rate (bradycardia). Eventually, both the blood pressure and heart rate normalize.

Blood Pressure and Heart Rate During the Valsalva Maneuver

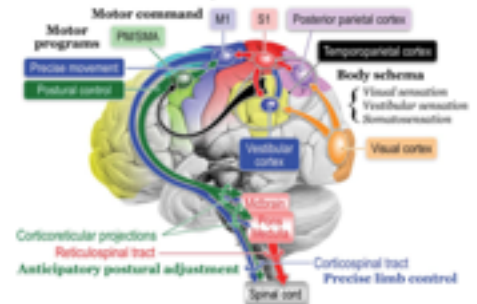


“Body Schema”

- Integrated neural representation of the body (the ‘body schema’) and of the space around the body (‘peripersonal space’)
- This DYNAMIC system is MULTIMODAL involving:
 - Visual System
 - Somatosensory System
 - Vestibular System
- Body part-centered reference frames
- Demonstrates significant plasticity

(Holmes & Spence 2004)

“Body Schema”



Errors in Schema integration cause problems with knowing

1. Where your body parts are in space
2. Where space is in reference to you
3. How to process complex information



Humans are Complex



“The very organ felt to define our humanity, the brain, seems to have been placed in a somewhat precarious position in regards to both vascular perfusion and oxygenation.”

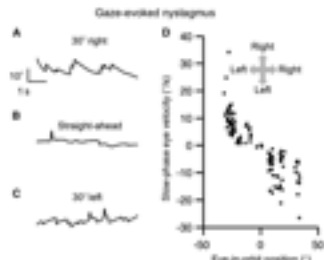
-B. Grubb

21 y/o female with head and neck pain, visual disturbance, brain fog and POTS following head trauma

Clinical Features:

Salient Exam findings:

Figure 1 Gaze-evoked nystagmus of the eyes. (A–C) Example of gaze-evoked nystagmus measured during a 5-s epoch as ...



Brain, 106(4), 105–116. doi:10.1093/brain/106.4.105. Copyright 2003 Blackwell Science Ltd. For personal use only; all rights reserved.

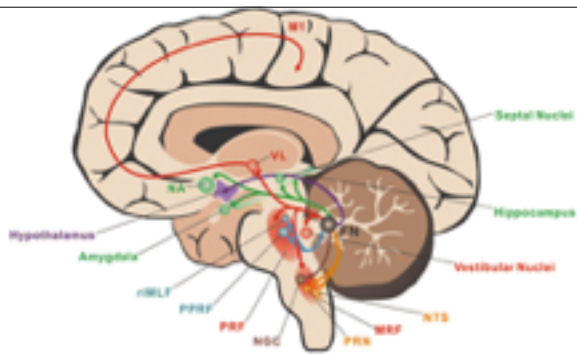
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Figure 4 Neural integrator and its feedback system involving the cerebellum, basal ganglia, thalamus, and neck ...

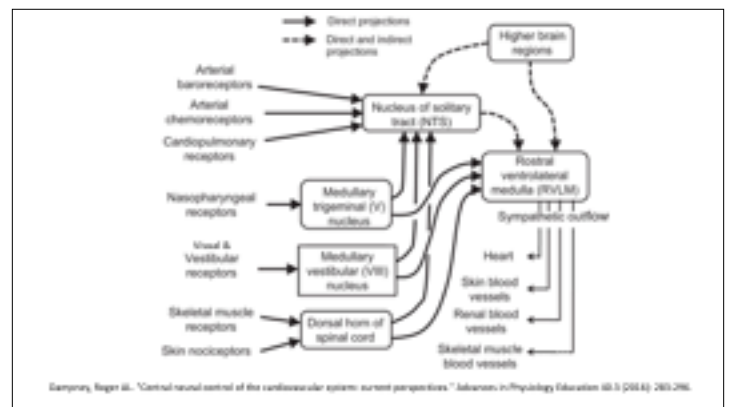
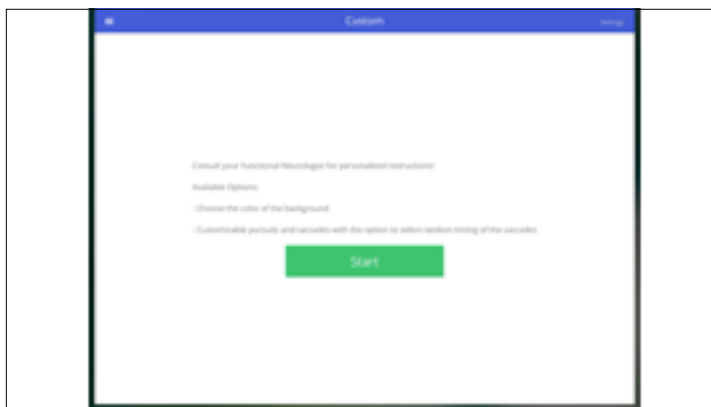
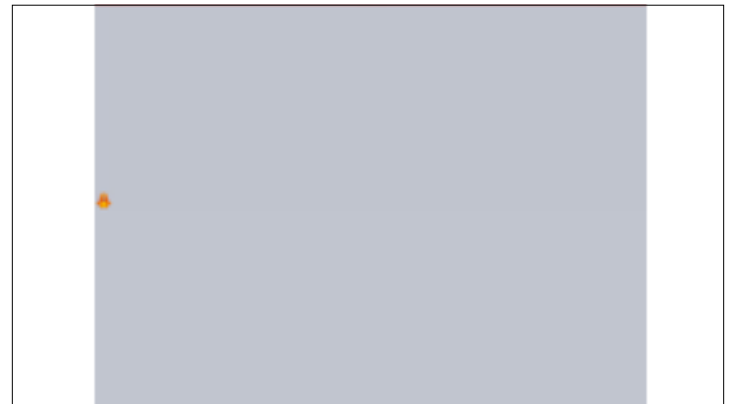


Brain, 106(4), 105–116. doi:10.1093/brain/106.4.105. Copyright 2003 Blackwell Science Ltd. For personal use only; all rights reserved.

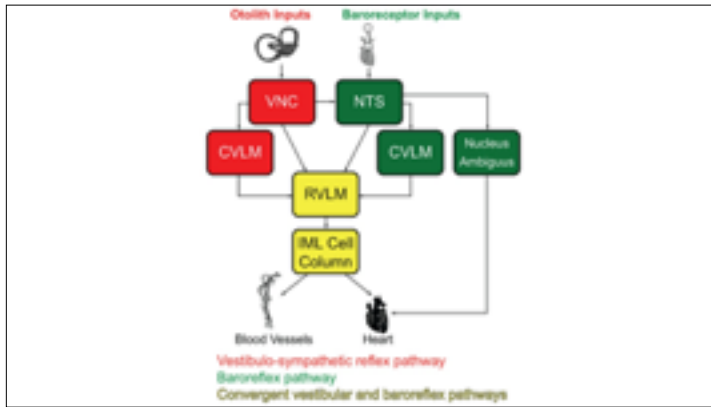
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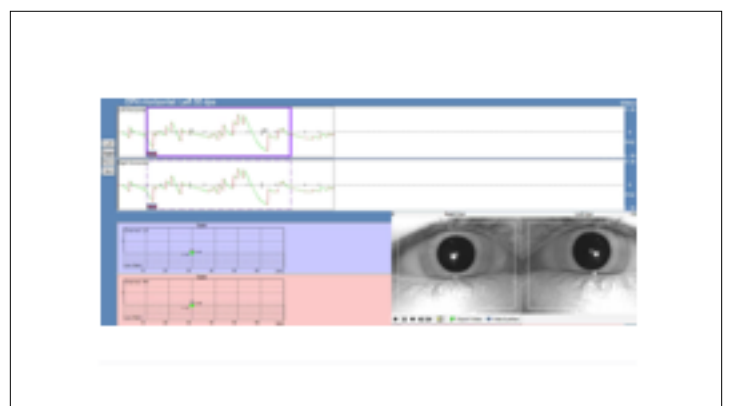
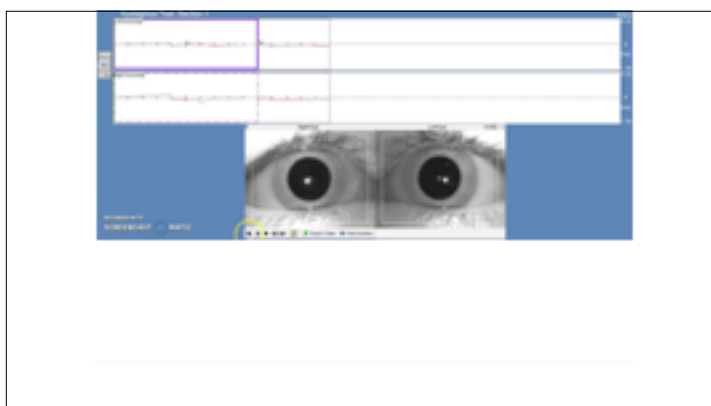
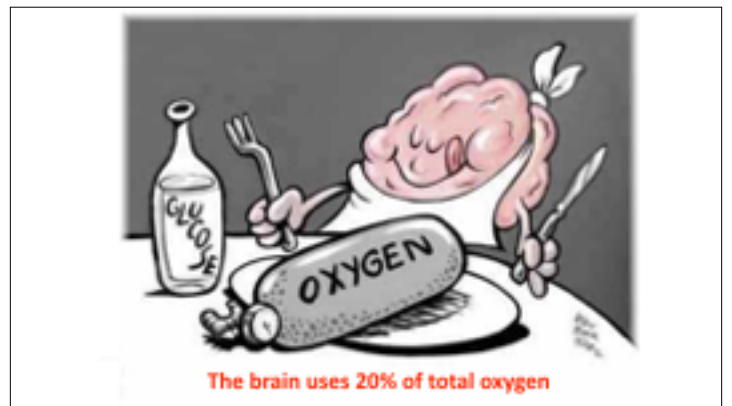
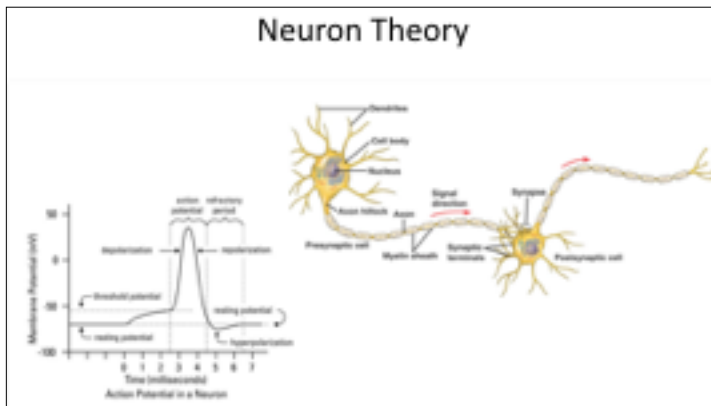
Zhang, XY, Wang, JJ, & Zhu, JN. cerebellum ataxias (2016) 3: 9. <https://doi.org/10.1186/s40673-016-0047-1>

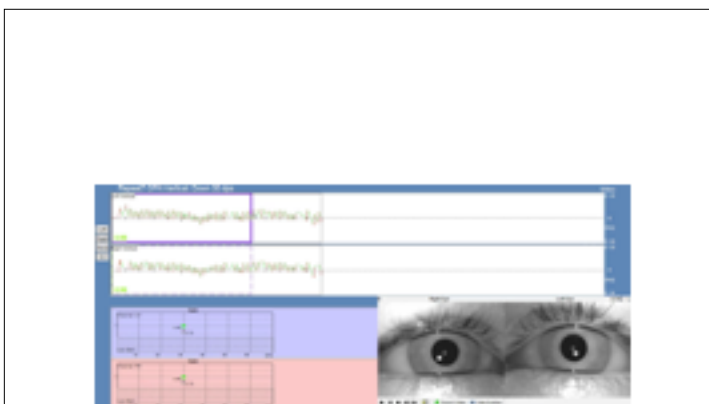
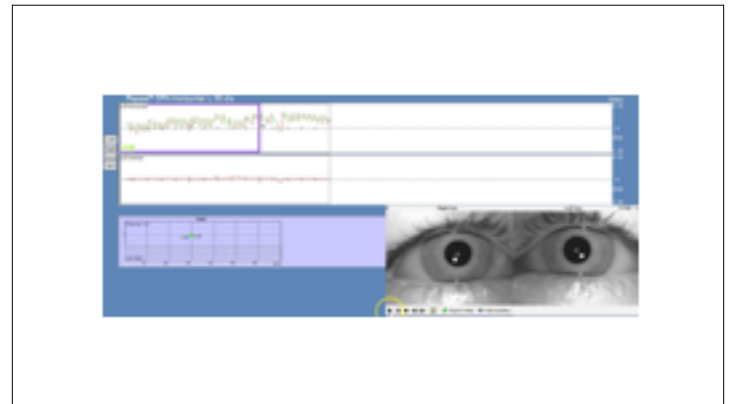
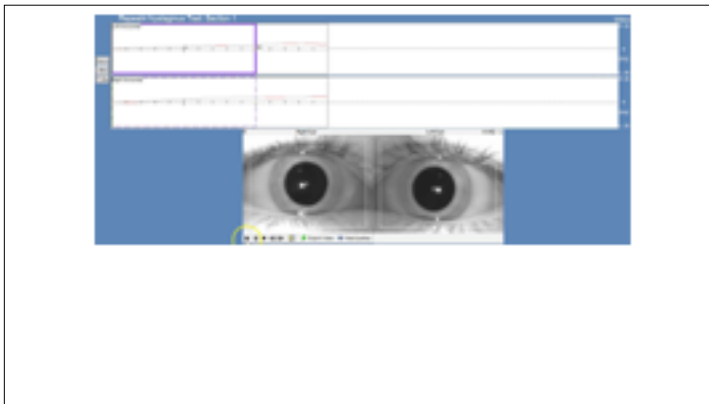
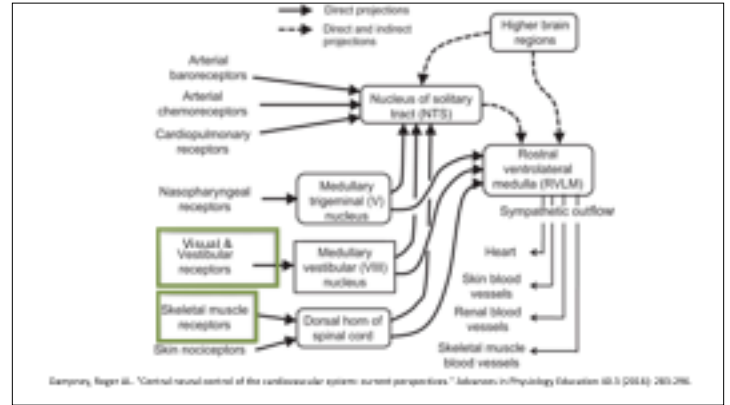
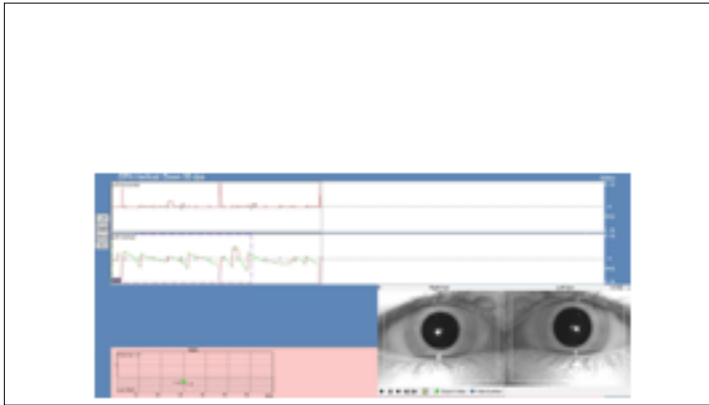


Esperany, Roger W. "Central neural control of the cardiovascular system: current perspectives." *Advances in Physiology Education* 40.3 (2014): 260-286.



TREATMENT TYPE AND DOSAGE ARE DEPENDENT ON METABOLIC CAPACITY





16 y/o female with head pain, POTS following head trauma

- Elevated HR with rise of 34 bpm upon standing
- Headache 6 week duration protracted 6/10 SWAS.
- Worse with physical, mental and orthostatic stressors.

Salient Exam findings:

- Dysesthesia in left hemi-distribution to light touch, pinwheel and vibration.
- Distribution was patchy and changed with orthostasis.
- "Belladonna" pupils
- Slowness in RAM in the left upper and lower extremities.
- Pronounced acrocyanosis and was cold to palpation in lower 2/3 of both legs.

A diagram of a human body showing acrocyanosis in the lower legs, indicated by a shaded area on the lower 2/3 of both legs.



Acrocyanosis

"The sympathetic neural activity is primarily involved in the regulation of muscular blood vessels that are influenced by the distinctly functional demand of the distinct vascular segment"

(Huang and Tsai, 2009)

Vasomotor units are topographically organized.

(Huang and Tsai, 2009)

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