

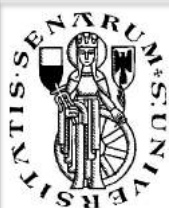
MASTER II LIVELLO IN VESTIBOLOGIA PRATICA 2017-2018

Sapienza Università di Roma

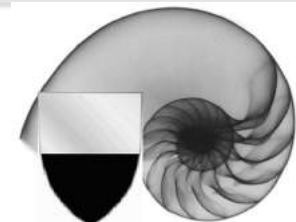
Direttore: Prof. Giovanni Ralli

SISTEMA VESTIBOLARE E SISTEMA NEUROVEGETATIVO

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University of Siena, Italy



- DEFINITIONS
- OVERLAP OF SYMPTOMS AND SIGNS
- ANATOMOPHYSIOLOGICAL BASIS of INTERACTIONS
 - SOME CLINICAL POINTS
 - CONCLUSIONS

VESTIBULAR SYSTEM: is the sensory system that provides the leading contribution to the sense of balance and spatial orientation.

AUTONOMIC SYSTEM: the part of the nervous system that controls and regulates the internal organs without any conscious recognition or effort by the organism. The autonomic nervous system comprises two antagonistic sets of nerves, the symphatetic and parasymphatetic.

WE MAY ALSO REFERT TO SPATIAL ORIENTATION AND AUTONOMIC SYSTEM SINCE THE ABNORMAL ACTIVATION OF AUTONOMIC RESPONCE ARE DUE MIS-INTERPRETATION OR CONFLICT IN CENTRAL INTEGRATION OF DIFFERENT SENSORY INPUT THAT ARE FUNDAMENTAL TO MAINTEN EQUILIBRIUM.

OVERLAP OF SYMPTOMS AND SIGNS

Pallor and fright

Disorientation

Asthenia

Difficulties in walking

Near-faint

Falls

Nausea or vomiting

Impaired vision

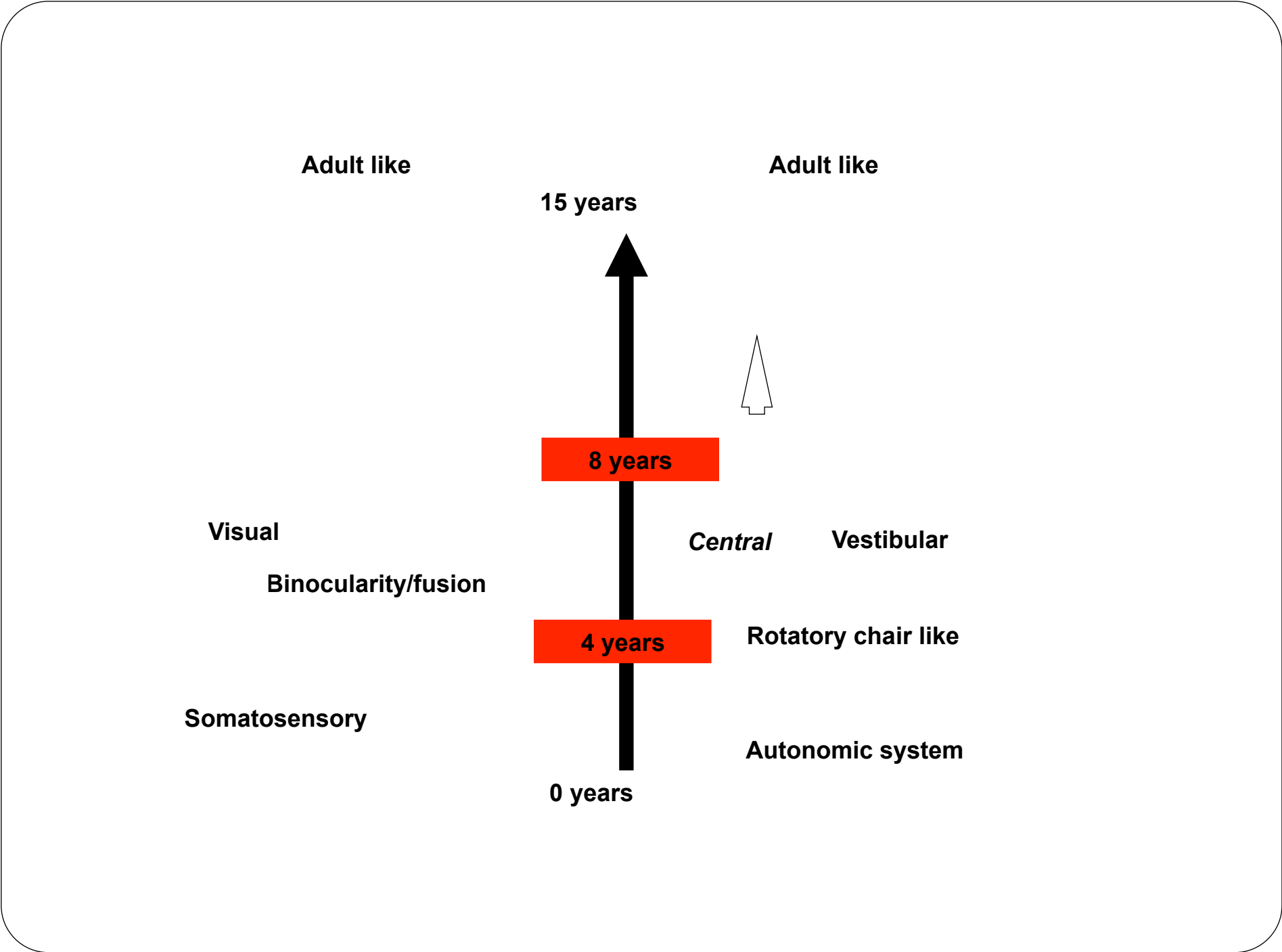
Hyperventilation

Tachycardia/bradycardia

Cold sweating

sialorrhoea

DROP ATTACKS: TUMARKIN CRISIS VS CARDIOVASCULAR DISORDERS

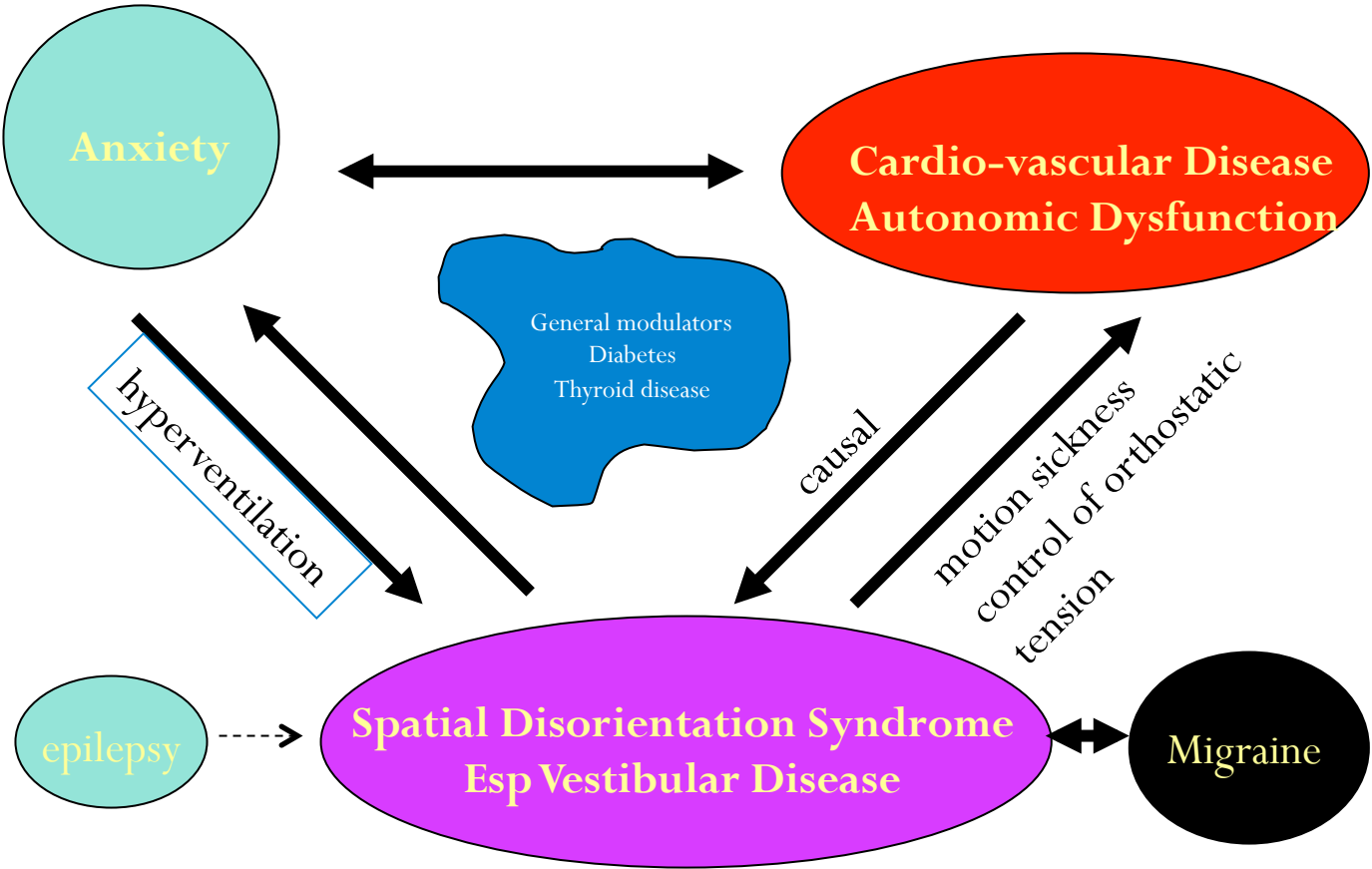


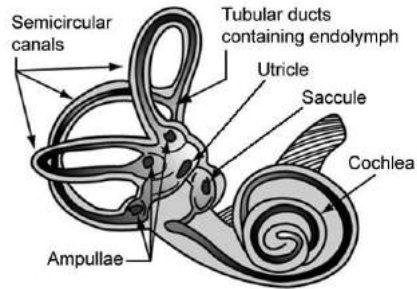
PRESENTATION OF BALANCE PROBLEMS

- Obvious dizziness/vertigo/lightheadedness (+ 8y)
- Fright or pallor
- Periodic episodes of nausea or vomiting
- Clutching
- Fatigue
- Bumping into things
- Clumsiness
- Sudden pole axing falls
- Migrainous features
- Delayed motor functions
- Loss of postural control
- Difficulty with ambulating in the dark
- Abnormal movements or behavior
- Difficulties in challenging movements (swimming, dancing)
- Oscillopsia
- Difficult to track challenging visual targets
- Poor head eye coordination

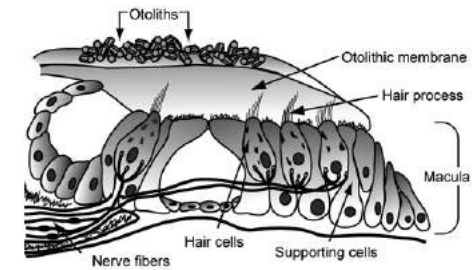
Increased autonomic response in case of motion due to immaturity of vestibular system and central integration!

The Dizziness Triad





The Labyrinths



semi circular canals

are stimulated by angular acceleration

giving a signal approximately of angular velocity

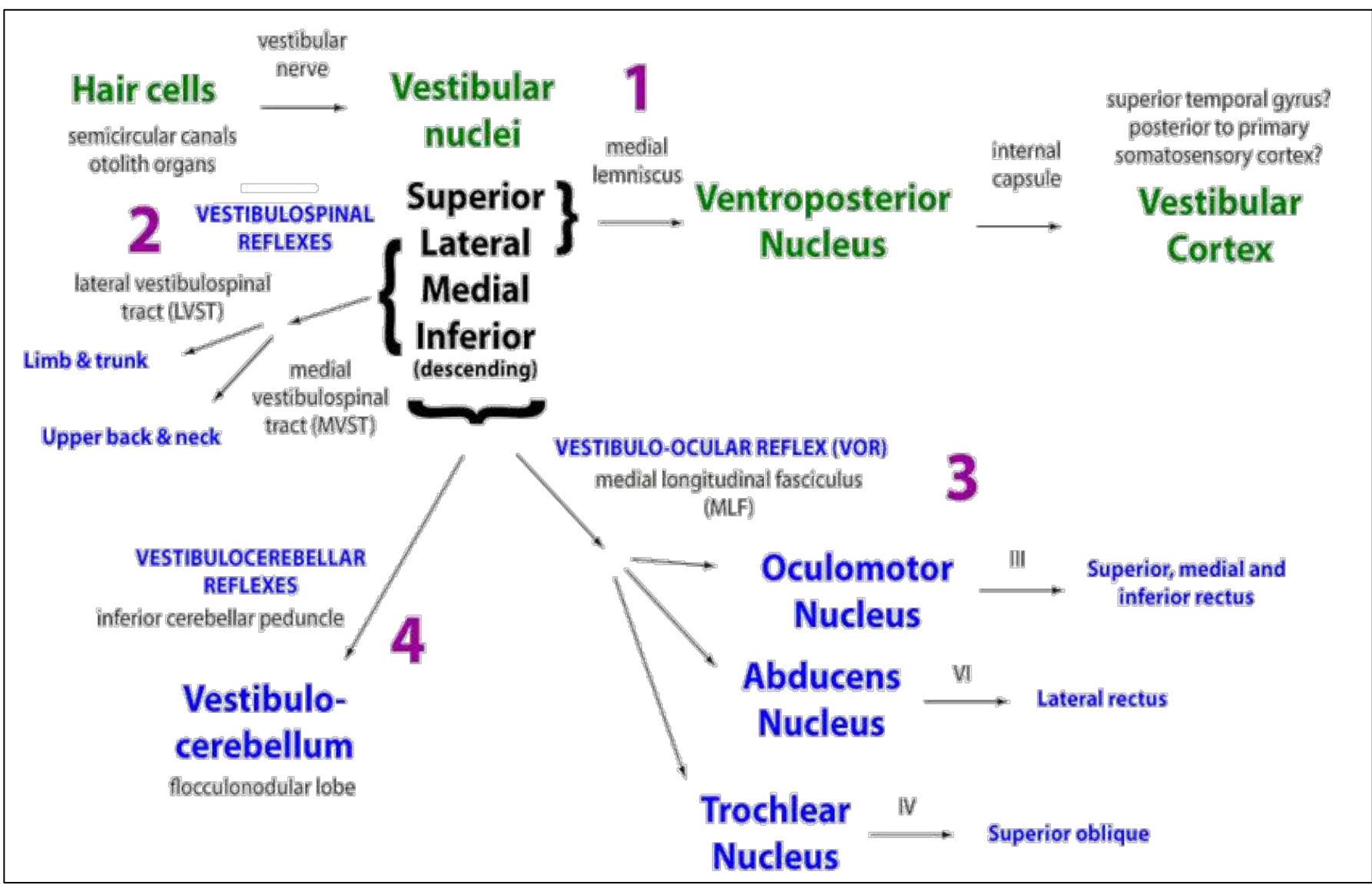
otolith organs

are stimulated by linear acceleration
and gravito-inertial force

giving a signal of head acceleration and tilt

these signals are used to:

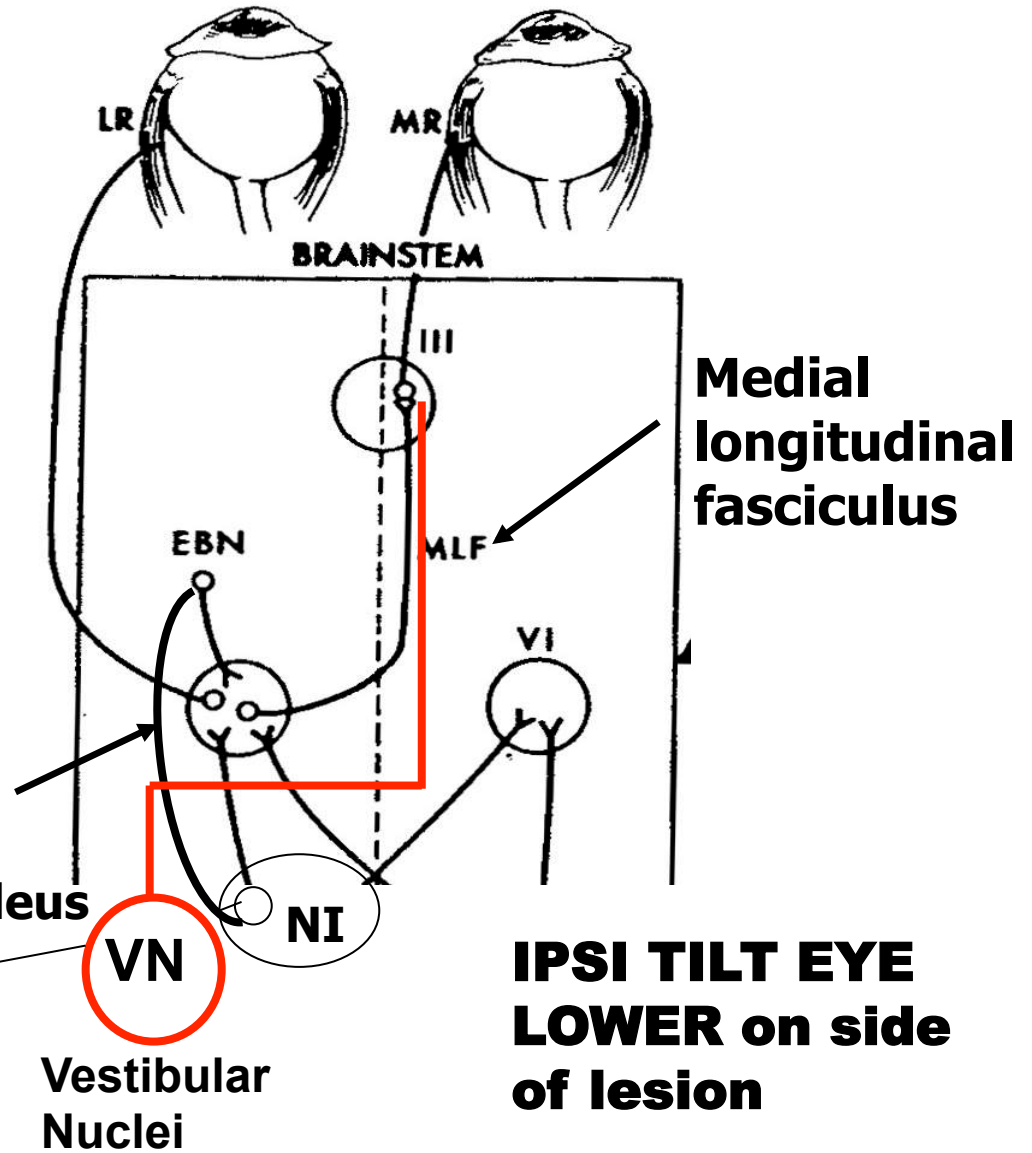
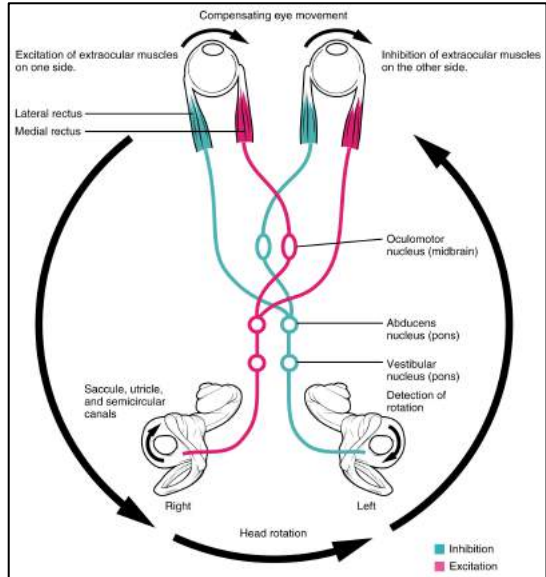
- control balance reactions
- provide compensatory reflexes (VOR)
- tune autonomic function for re-orientations
- serve perception of motion in space
- provide spatial reference for other sensory motor co-ordinations



Ocular Tilt Reaction (OTR) PATHWAY

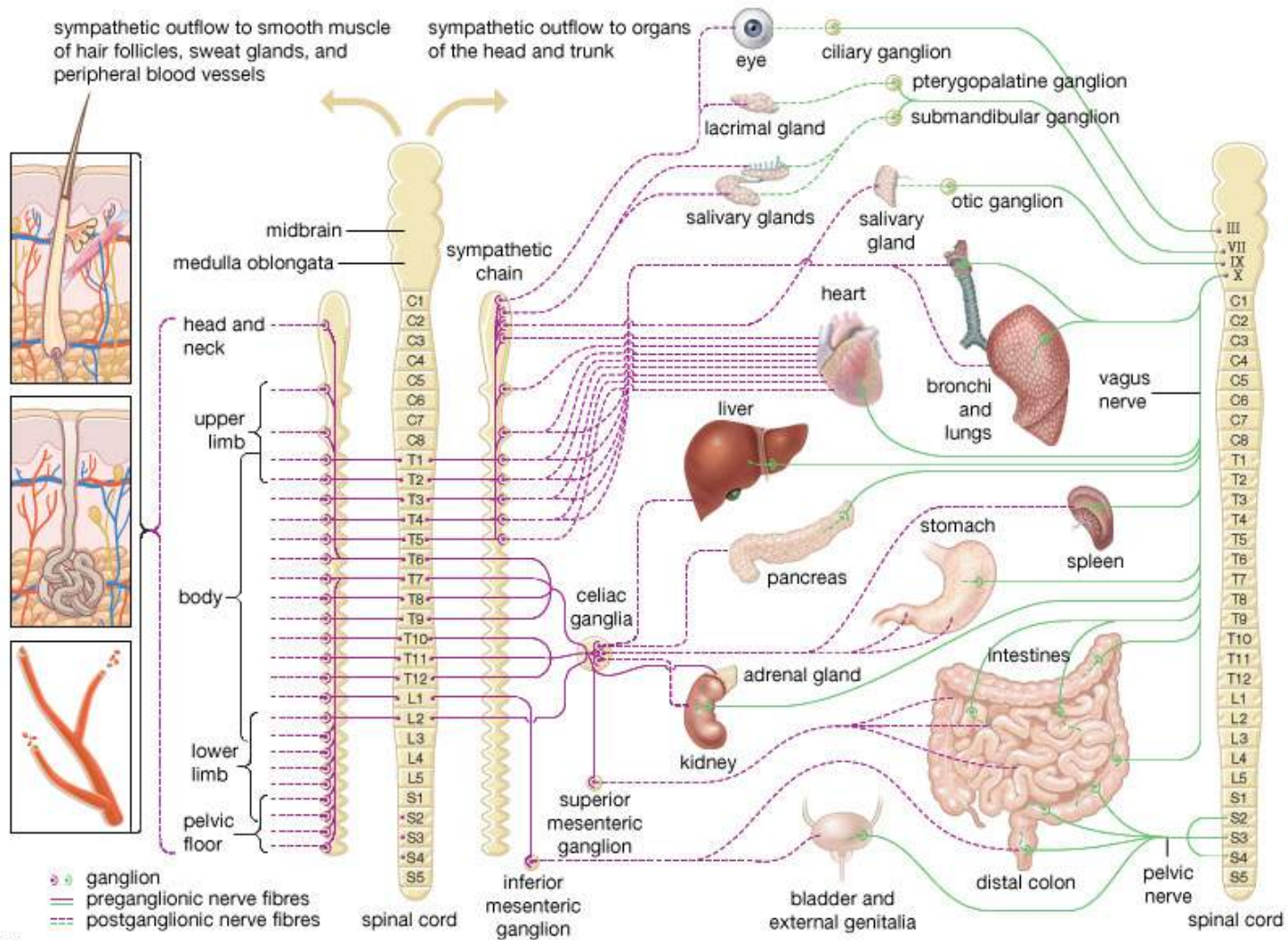
Utricle - Vestibular Nuclei – MLF - III, IV - INC

H-VOR PATHWAYS

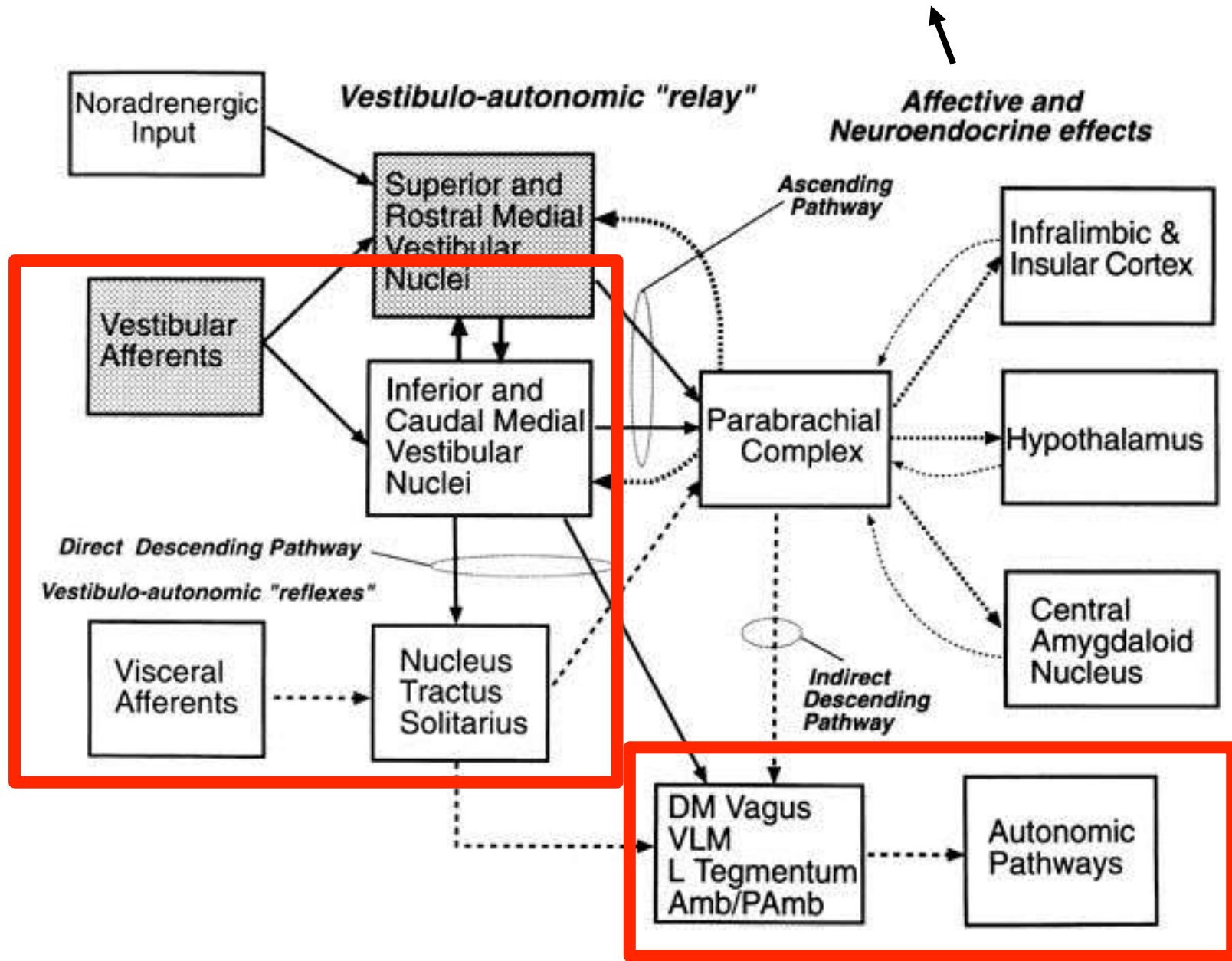


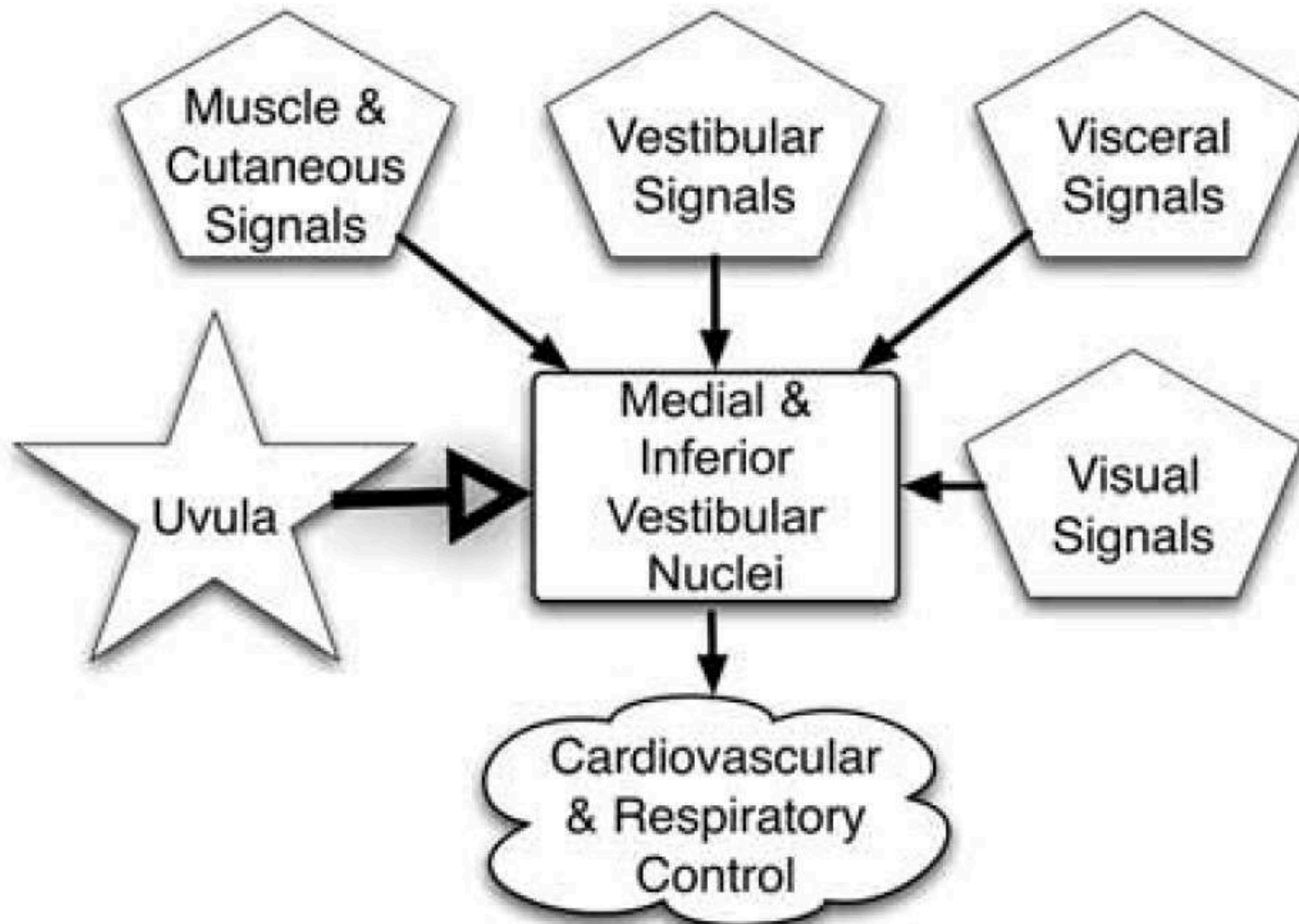
Sympathetic nervous system

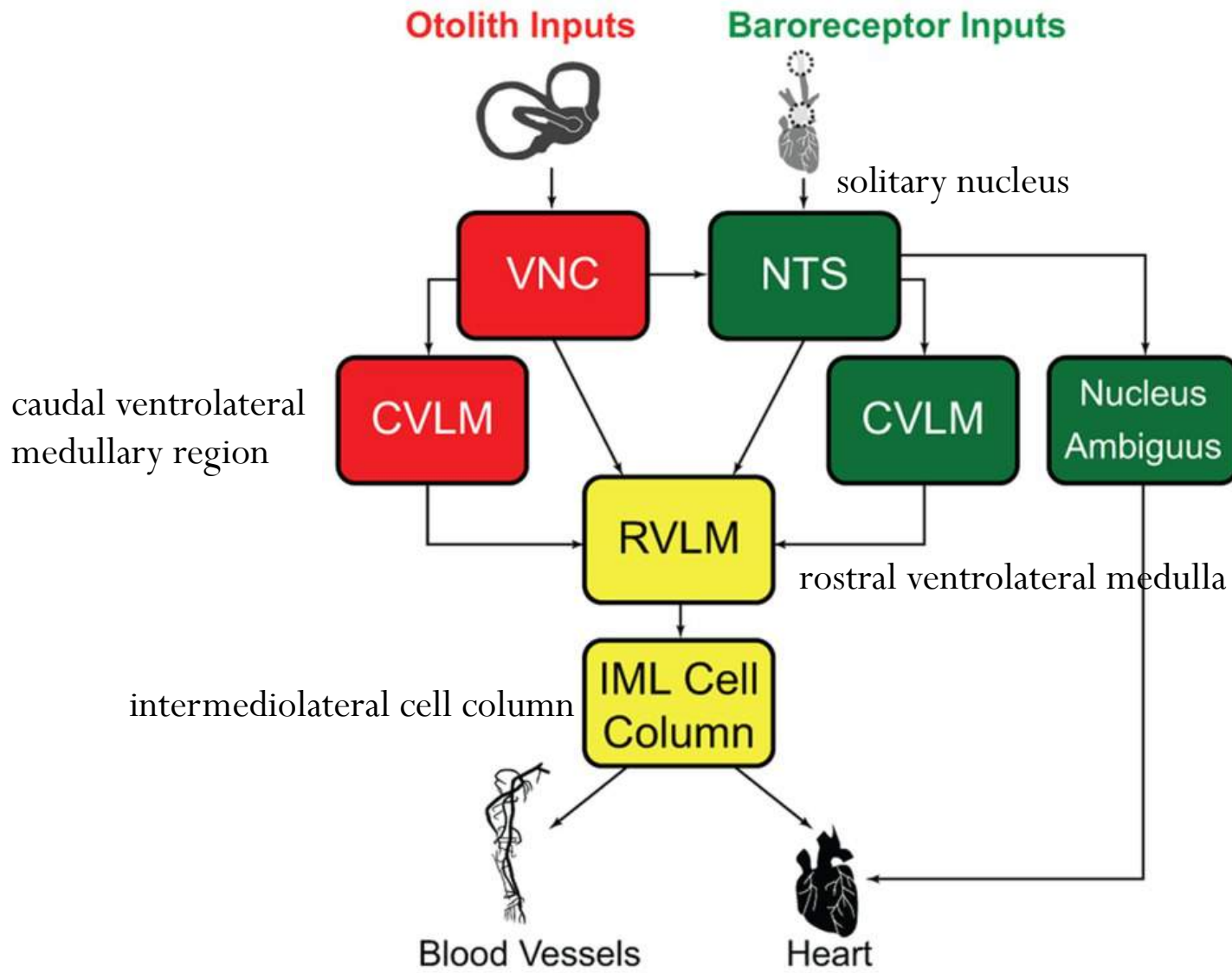
Parasympathetic nervous system



Agarophobia may be a vestibulo-autonomic reactive disorder







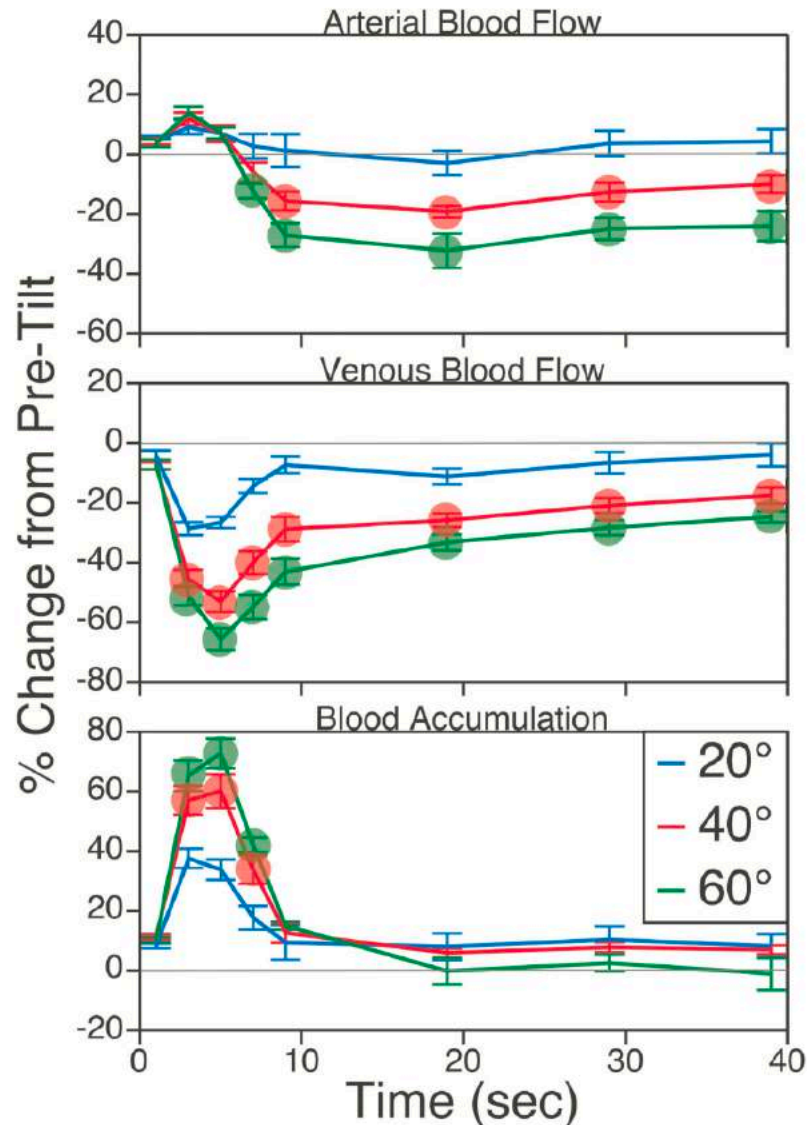
Vestibulo-sympathetic reflex pathway

Baroreflex pathway

Convergent vestibular and baroreflex pathways

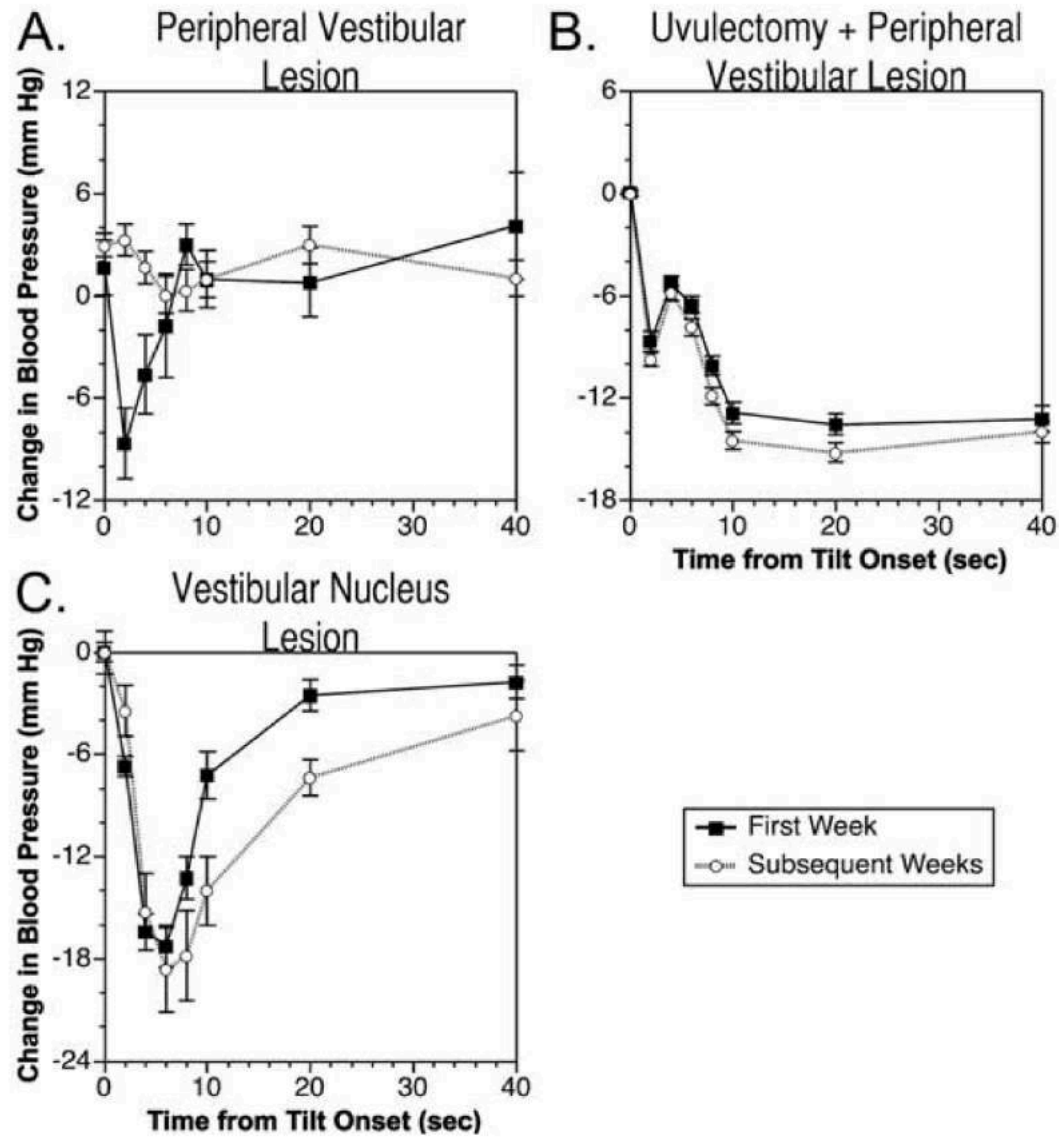
Holstein et al., 2012

Average changes in femoral artery and vein blood flow during 20°, 40°, and 60° head-up tilts



Vestibulosympathetic reflexes differ from responses triggered by unloading of cardiovascular receptors such as baroreceptors and cardiopulmonary receptors, as they can be elicited before a change in blood distribution occurs in the body.

Change in blood pressure after head tilt



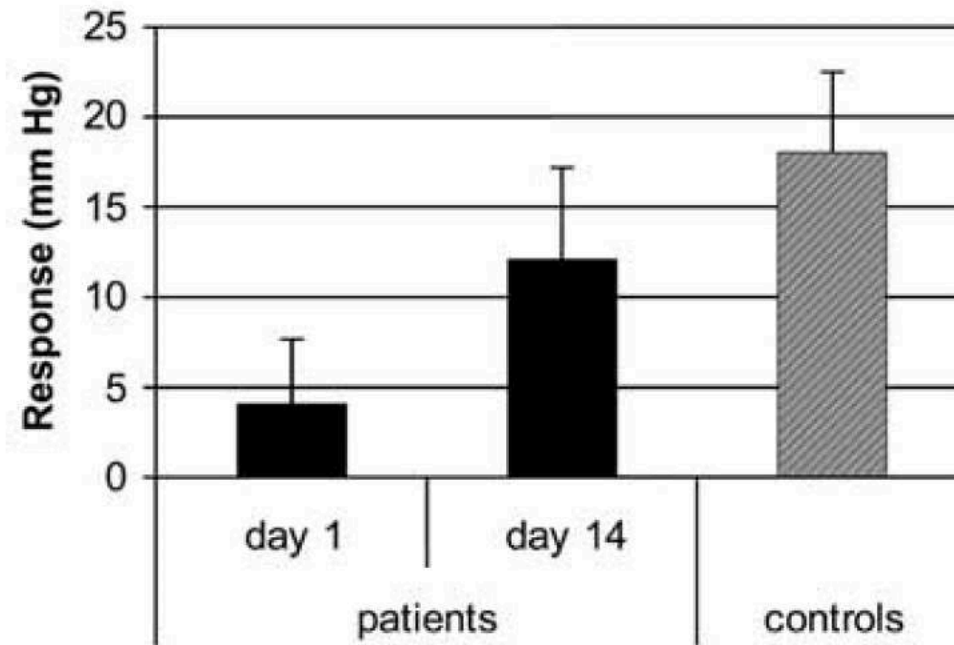


Fig. 7. Mean and standard deviation of the systolic blood pressure response to immersion of the hand in cold water (cold hand test) of 7 patients with vestibular neuritis and 7 age-matched healthy subjects. Patients were tested near the onset of vertigo (acute phase of their vestibular dysfunction) and at a two-week follow up. Courtesy of K. Jauregui-Renaud, adapted from reference [16].

A significant correlation between decreased functionality of the vestibular otolith system and a decrease in the mean arterial pressure when a person stands up.

Until now, no experiments on Earth could selectively suppress both otolith systems; astronauts returning from space are a unique group of subjects in this regard.

Their otolith systems are being temporarily disturbed and at the same time they often suffer from blood pressure instability.



Hallgren et al., 2015

VOMITING AND NAUSEA

Elicited by a variety of stimuli, although there is evidence that the same brainstem areas mediate these responses despite the triggering mechanism.

Nucleus tractus solitarius, the dorsolateral reticular formation of the caudal medulla (lateral tegmental field), and the parabrachial nucleus play key roles in integrating signals that trigger nausea and vomiting.

These brainstem areas coordinate the contractions of the diaphragm and abdominal muscles that result in vomiting.

However, it is unclear whether these regions also mediate the autonomic responses that precede and accompany vomiting (gastrointestinal activity, sweating, and changes in skin blood flow).

Recent studies showed that delivery of an emetic compound to the gastrointestinal system affects the processing of vestibular inputs in the lateral tegmental field and parabrachial nucleus, potentially altering susceptibility for vestibular-elicited vomiting.

Findings from these studies suggested that multiple emetic inputs converge on the same brainstem neurons, such that delivery of one emetic stimulus affects the processing of another emetic signal.

Yates et al., 2014

Vertigo and Dizziness: Disorders of Spatial Orientation

- **Vertigo (illusory movement) is a special case of a more general set of symptoms ‘Spatial Disorientation’ may be caused by *anything which disrupts the normal transactions between the organism and environment, either functional or structural and at a peripheral or central level of organisation.***
- **Disabling dizziness will be experienced by circa 70% of this audience during life. Rarely a sign of life threatening disease it has profound psychological and psycho-social impact and is handicapping.**
- **You have ALL experienced spatial disorientation**

BUT WHAT KIND OF DIZZINESS?

**often the patient cannot find words
to explain his symptoms!**

Is it faintness?

Is it somatic symptoms of anxiety?

Is it illusory movement or disorientation?

Is it derealisation?

Mechanisms of Spatial Orientation

Visual system – navigator: Relativistic. Cannot distinguish self versus object motion.
Misinterpretation → the railway carriage illusion; visual vertigo; oscillopsia.

Somato-sensory system – relate local forces and geometry. Relativistic.
Disorder → plastic rubbery legs and undulating floor.

Vestibular system – absolute motion of the head in space. Provide a spatial reference for other senses.
Disorder and misinterpretation → vertigo; motion sickness; derealisation.

VESTIBULAR DISORDER

Functional or Structural (organic) or autonomic?

30-40% of patients attending specialised clinics do not receive firm diagnosis

Structural: destructive or irritative disease

OR

**Functional: misinterpretation of sensory input
mal adaptation**

**loss of rules of correspondence between senses
over awareness/magnification of sensory input**

OR

Both!: structural disorder provoking chronic dysfunction

But don't worry: the treatment is just the same!

The forgotten sense



In the early days of flying, It was not uncommon for pilots to come out of a cloud bank to find themselves flying upside down.

Here only the autonomic system can sense the upside-down condition

In the absence of a sure frame of reference even the most experienced divers lose orientation in a matter of a few tens of seconds when diving in murky waters.

Helen Ross
University of Stirling



Altered autonomic response!



Do you need
vision to cycle?



Not, but it may trigger
autonomic symptoms!



VESTIBULAR DISORDERS WITH AUTONOMIC EFFECTS

BPPV

Vestibular migraine

(The trigeminal nerve is accompanied by both sympathetic and parasympathetic fibers)

Acute unilateral vestibulopathy

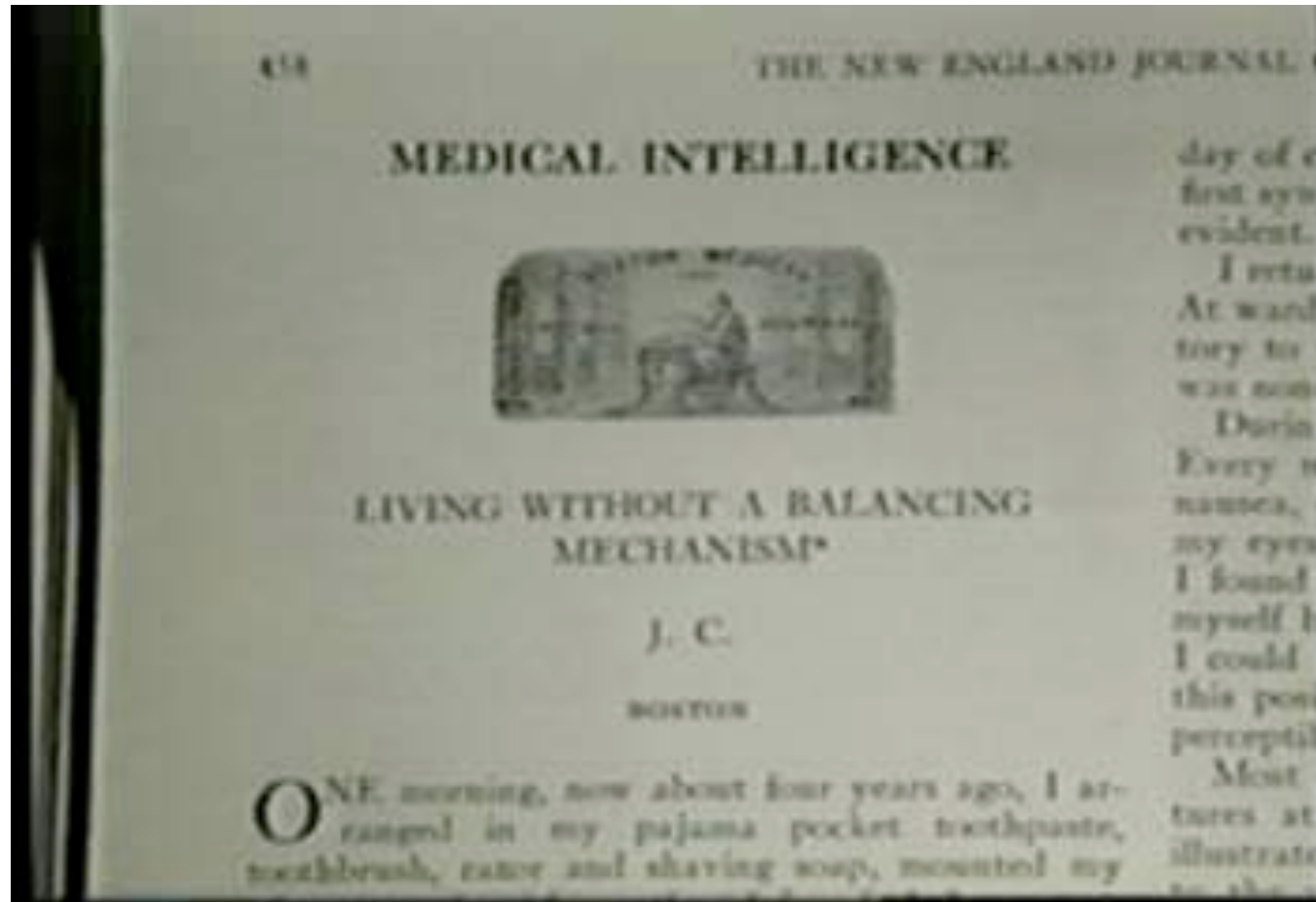
Meniere's disease

Central vestibular disorders affecting the vestibulo-autonomic pathway

Acute or long-lasting imbalance

Bilateral vestibular loss

(absent vestibulo-autonomic reflex...even if fast recovery)



Do not use drugs that can affect autonomic system:

- Propranolol (increase parasympathetic tone)
- Scopolamine/Dymenhydrinate (increase sympathetic tone)

MOTION SICKNESS

(from fish to humans over millions of years)

Poison or toxin detector hypothesis: activation of a defence reflex due to sensory conflict/mismatch (mainly visuo-vestibular).

Autonomic hypothesis: visceral discomfort after activation of vestibular autonomic reflexes due to the convergence of vestibular and autonomic afferent information in the brainstem and cerebellum (Balaban, 1999).

MAL DE DEBARQUEMENT / BROKEN EXCALETOR PHEN.

- Duration: more than a month
- Internal model theory. In particular, an internal model of periodic boat motion (Hain, 2007)
- Not generally associated with autonomic symptoms
- Improve with re-exposition to motion

Hyperventilation it was found that normal subjects become posturally unstable, with large amplitude and low frequency body sway movements.

Patients with bilateral severe loss of peripheral vestibular function became equally unstable during hyperventilation, suggesting that the unsteadiness was more likely to be mediated by non-vestibular than by direct vestibular mechanisms (except for rare disorders, vestibular schwannoma etc...)

Thus, hyperventilation mostly interferes with somatosensory mechanisms and central processes mediating vestibular compensation

Vestibular loss: physical therapy

Table Tennis
Badminton
Tango Dancing
Qi Gong (also
for motion
sensitivity)
Bowling (ten
pins, duck pins)



**MAKE SURE YOUR PATIENTS DO NOT HYPERVENTILATE
OR HAVE LOW BLOOD PRESSURE DURING
VEDTIBULASR REHAB!**

CONCLUSIONS

Evidence accumulated over 30 years, from experiments on animals and human subjects, has demonstrated that inputs from the vestibular otolith organs contribute to the control of blood pressure during movement and changes in posture.

Vestibulosympathetic reflexes differ from responses triggered by unloading of cardiovascular receptors such as baroreceptors since they can act faster.

Not fully clear vestibulo-autonomic pathways but we have to consider that in our daily practice.

Not easy...but I may try to trigger some of your autonomic reflexes!







THANK YOU