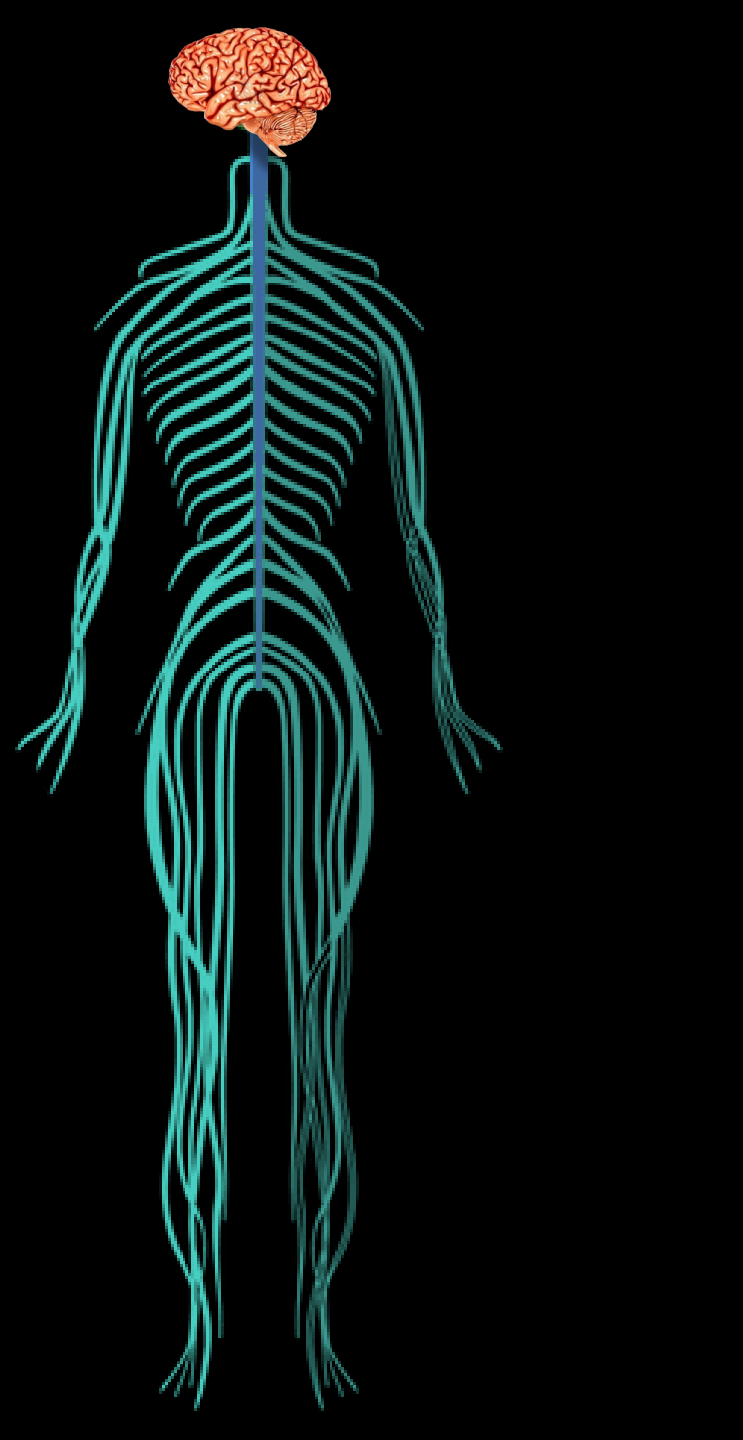
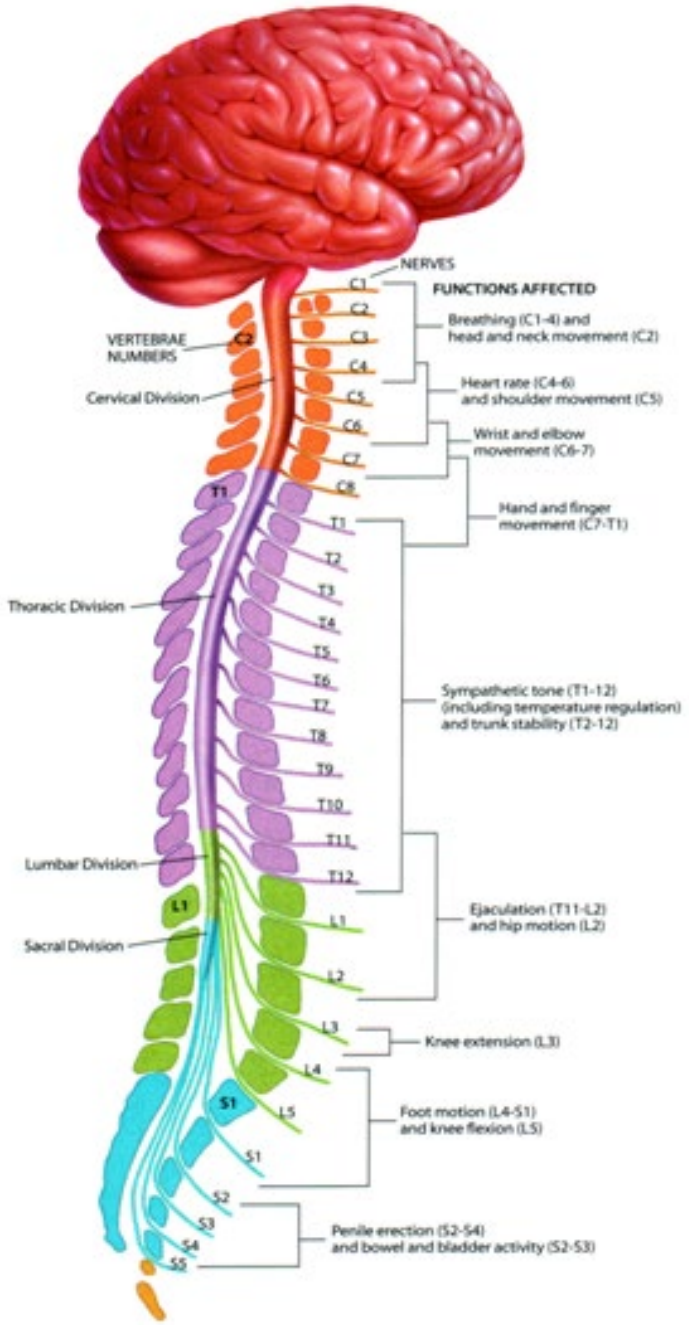
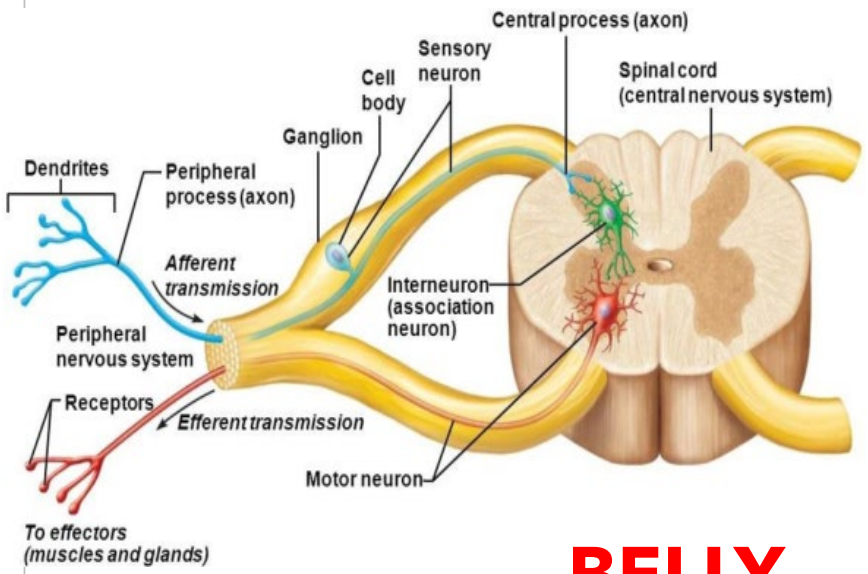
HOW THE AUTONOMIC NERVOUS SYSTEM MAY GOVERN ANXIETY IN AUTISM

Emily L. Casanova, PhD

Manuel F. Casanova, MD







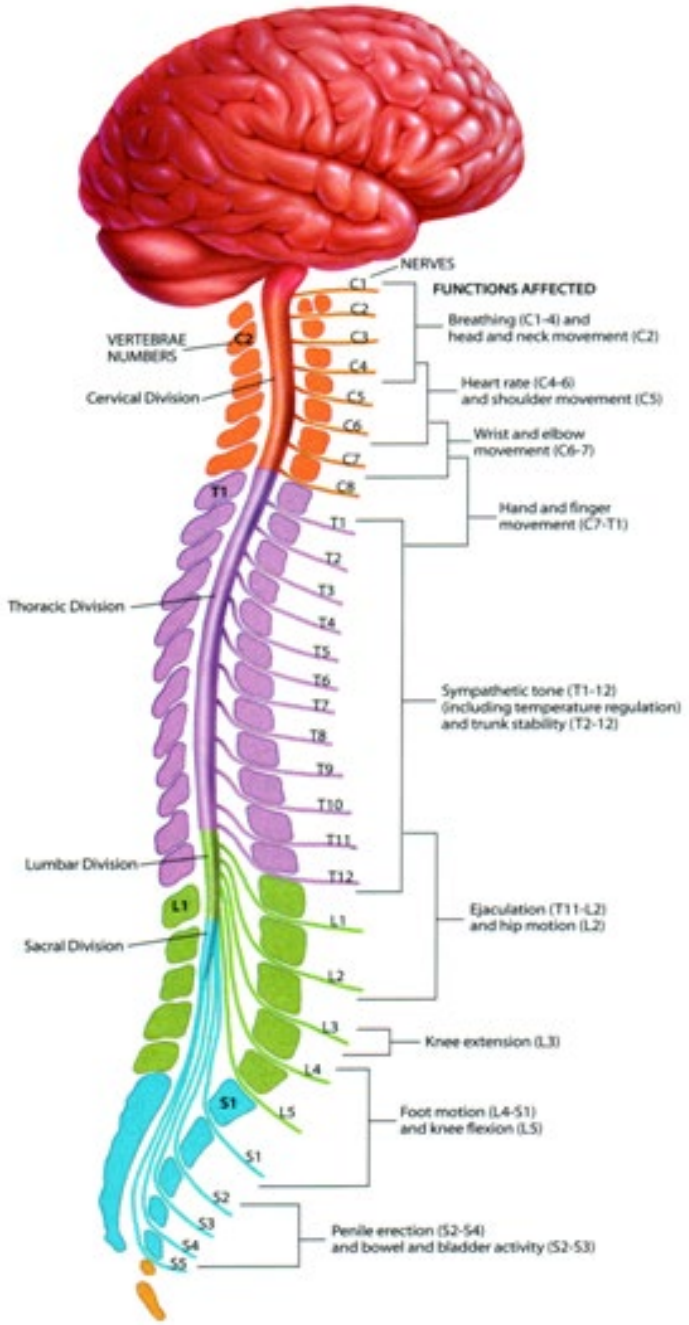
BACK

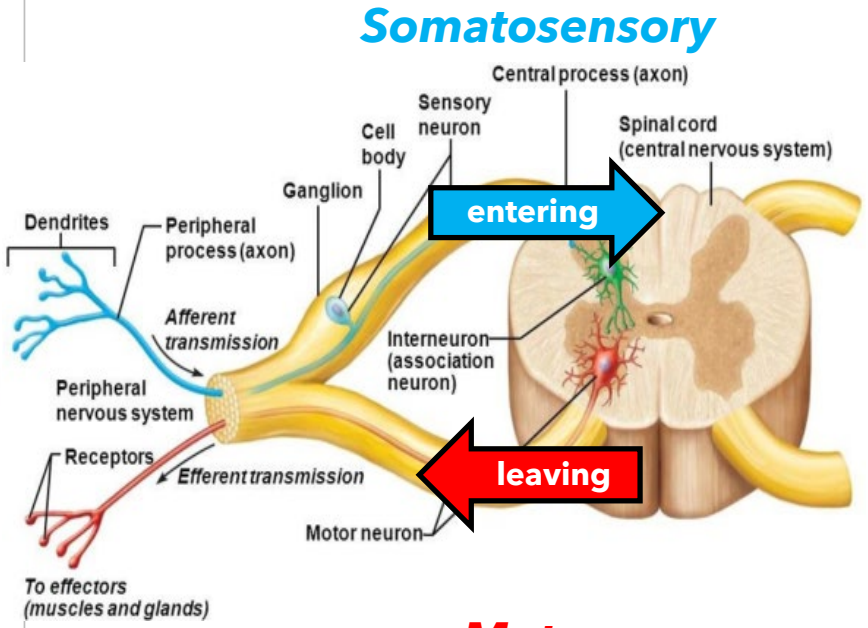
(aka "dorsal")

BELLY

(aka "ventral")

THE CENTRAL NERVOUS SYSTEM



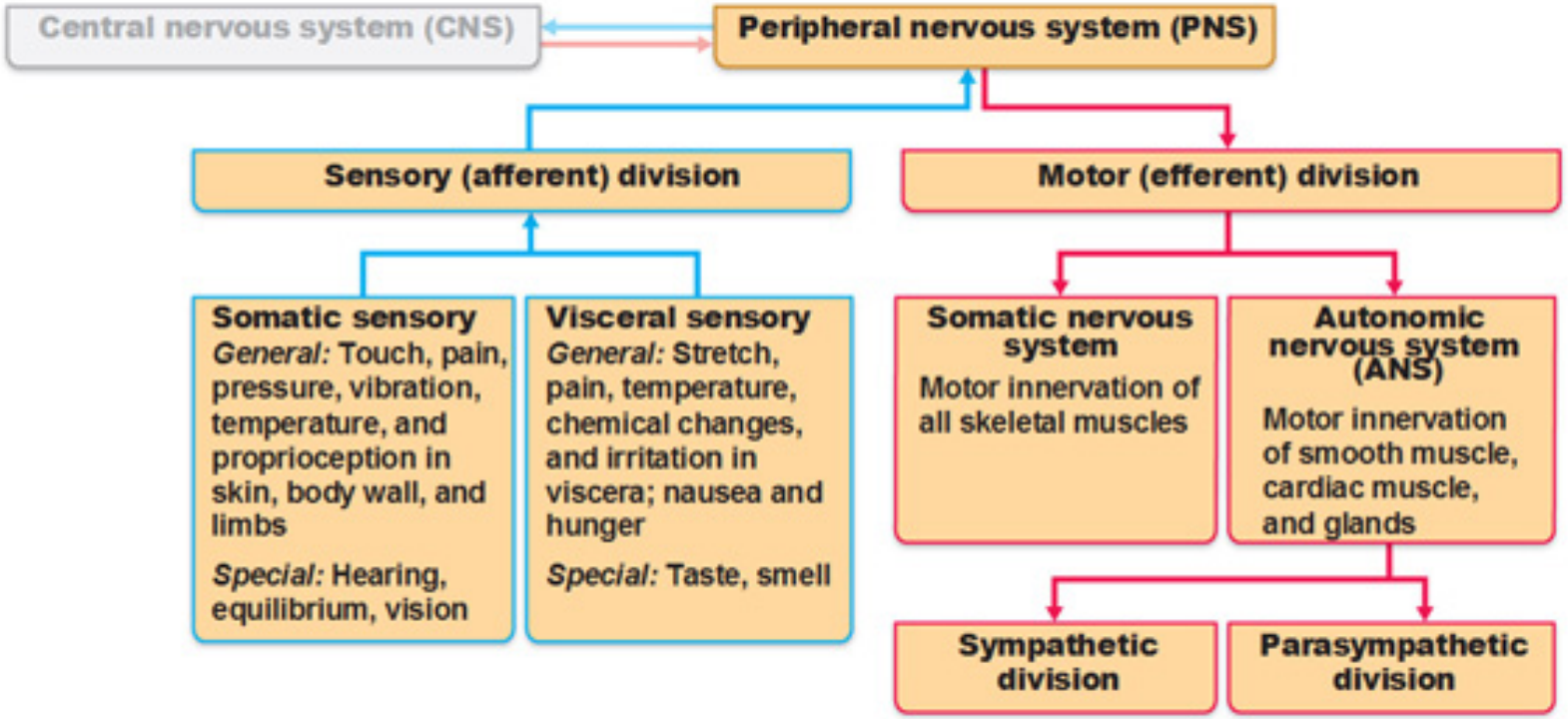


Somatosensory

Motor

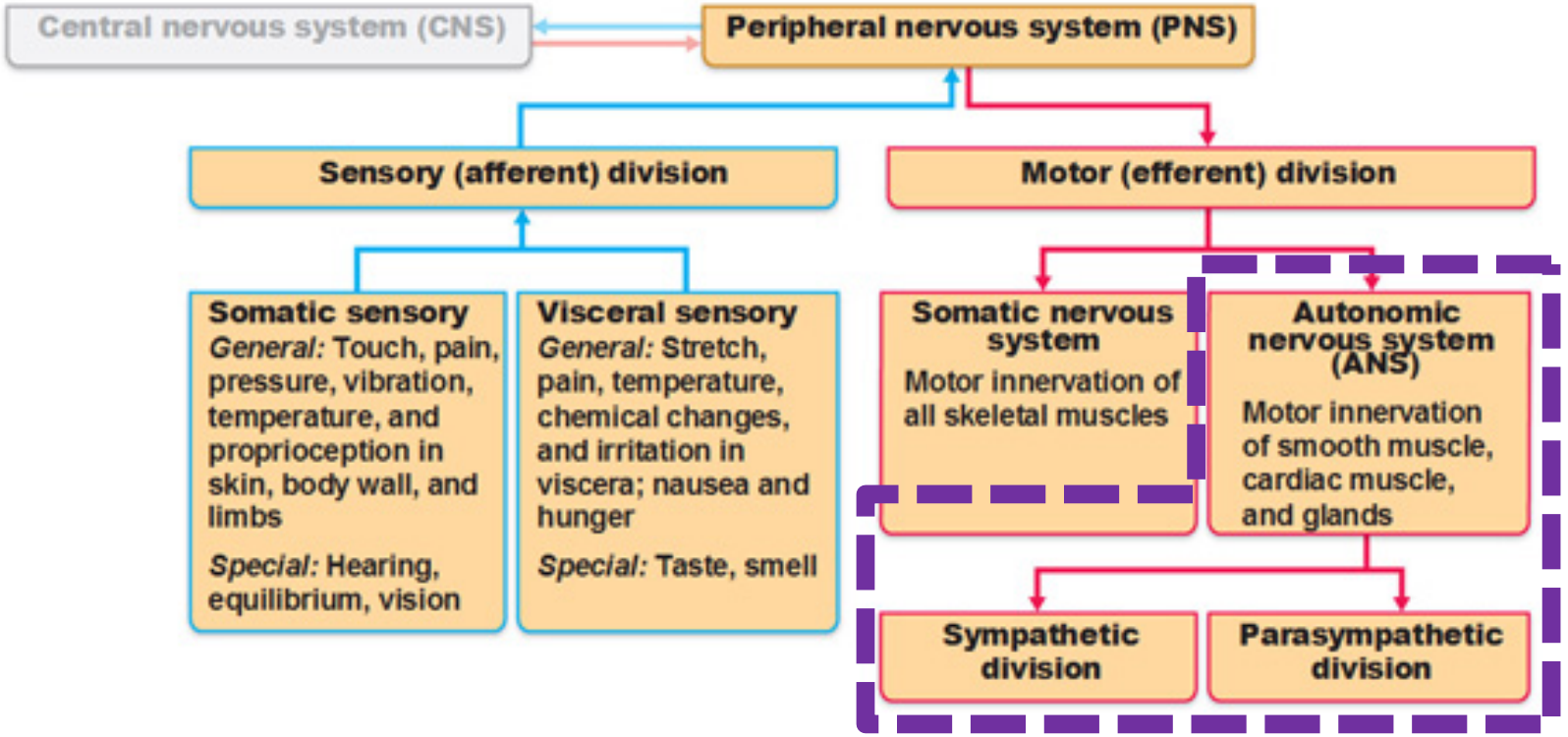
THE CENTRAL NERVOUS SYSTEM

Functional Organization of the PNS



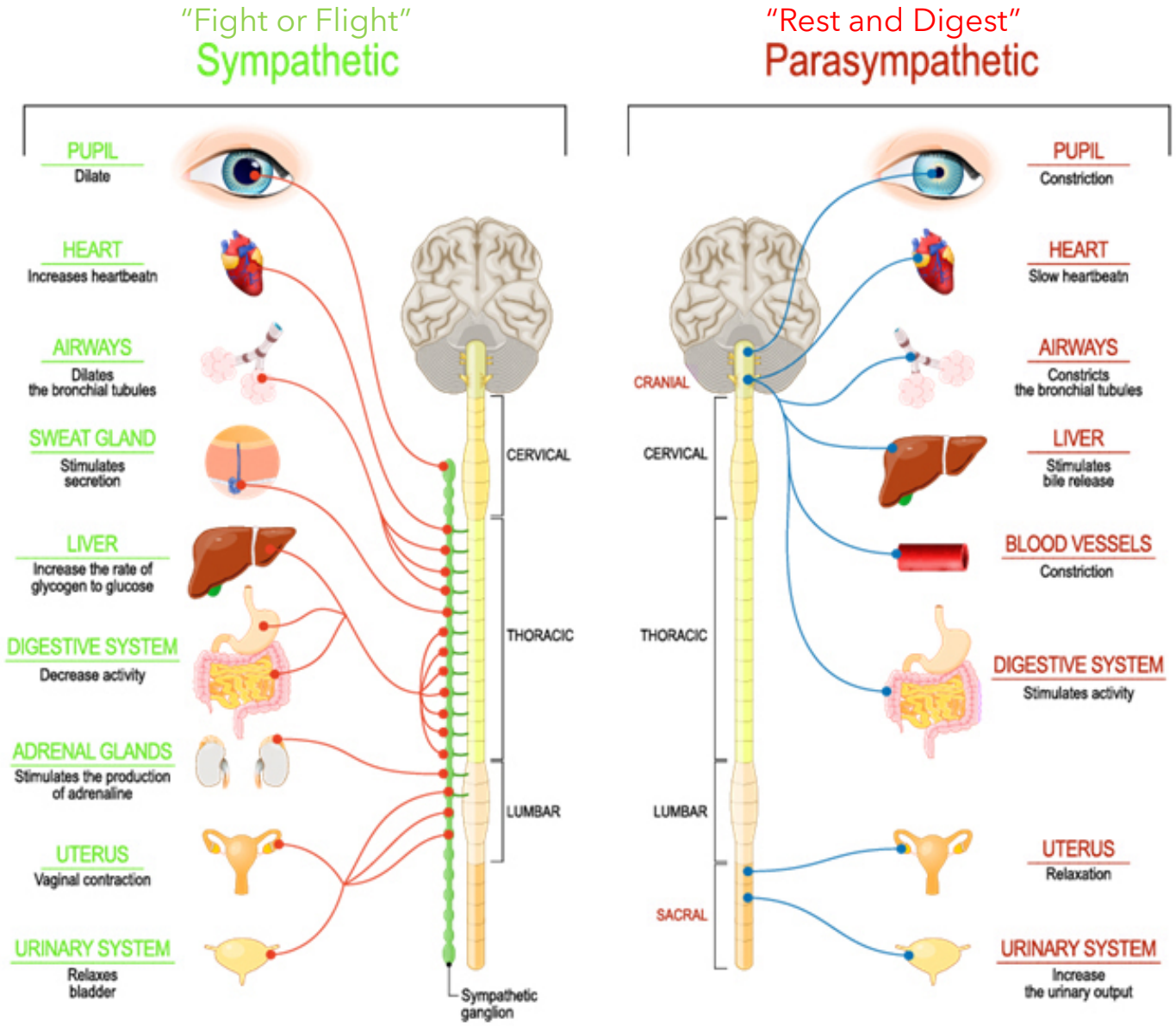
THE PERIPHERAL NERVOUS SYSTEM

Functional Organization of the PNS

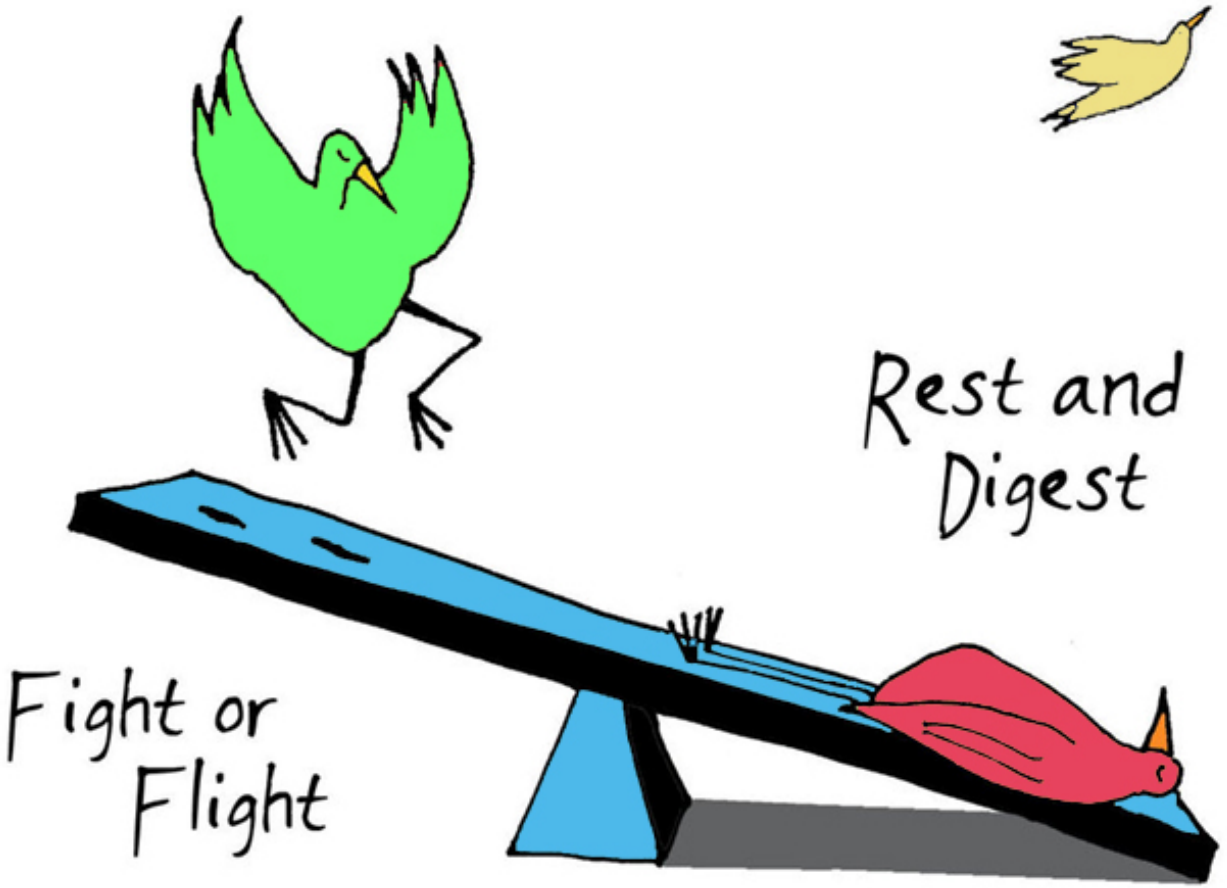


THE PERIPHERAL NERVOUS SYSTEM

Autonomic Nervous System



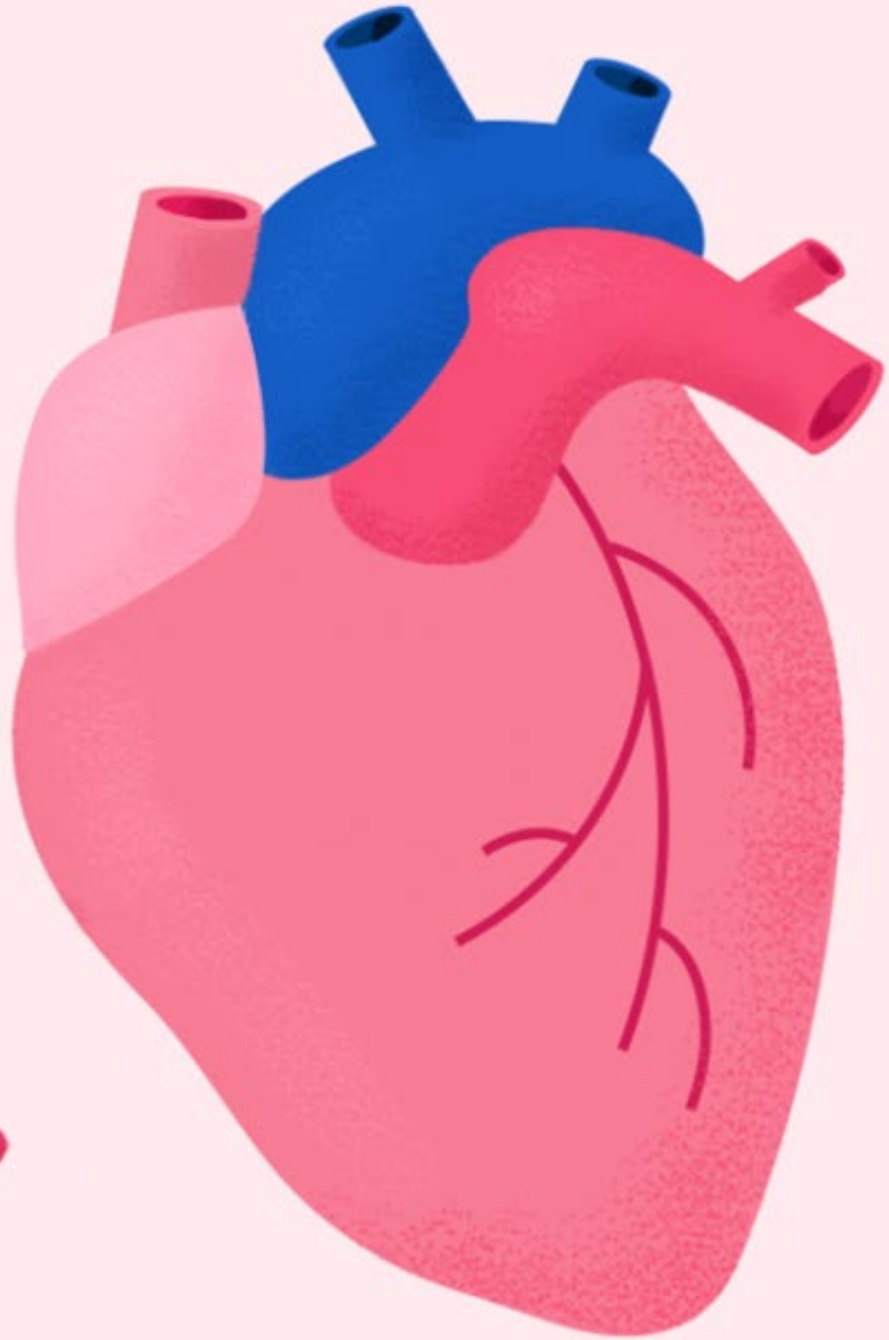
THE PERIPHERAL NERVOUS SYSTEM


Rest and
Digest
Fight or
Flight


Sympathetic
Parasympatheti
c

Autonomic Dysregulation in Autism

- **Autistic people tend to exhibit:**
  - Higher at-rest sympathetic (fight or flight) activation, as evidenced by:



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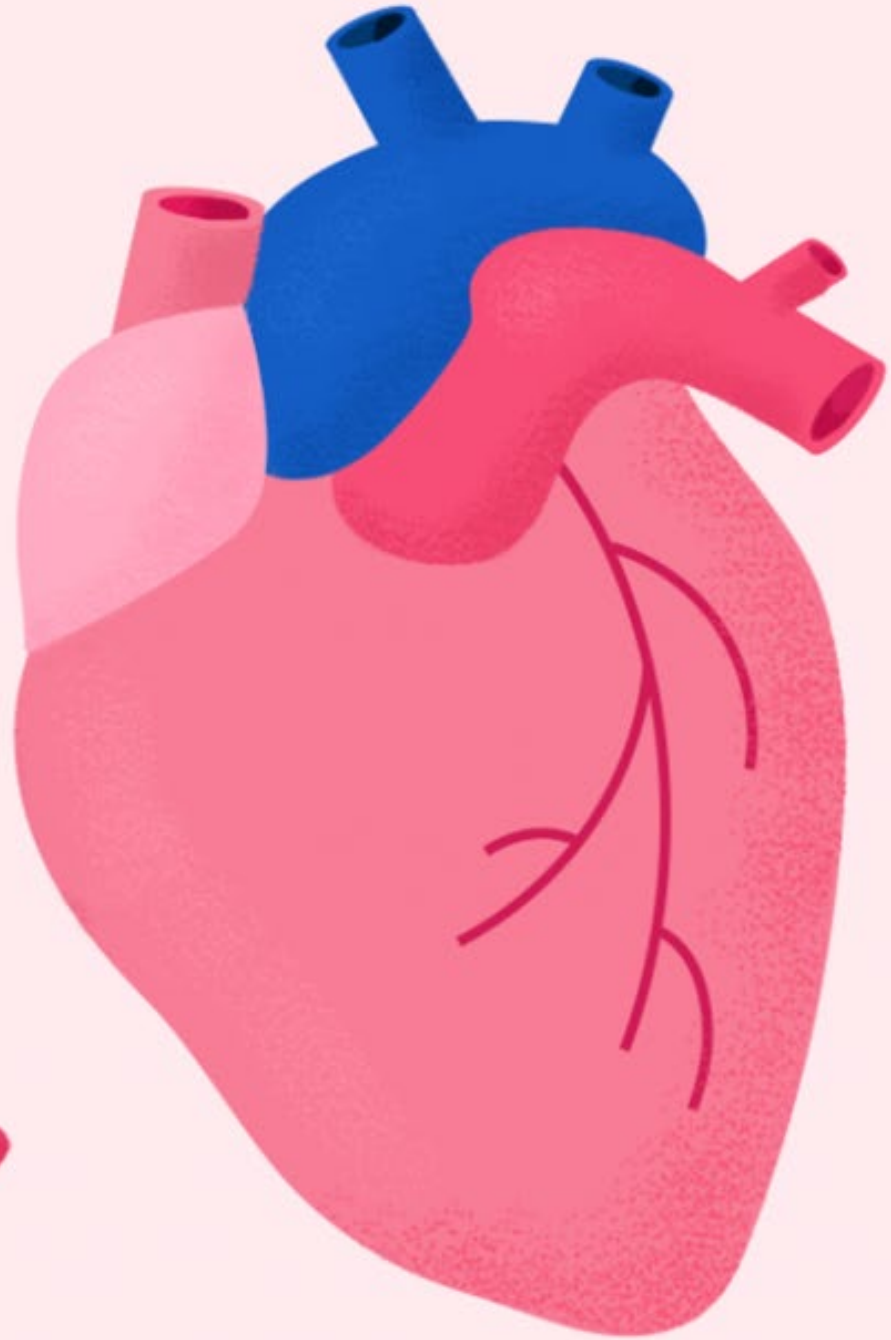
    - Higher resting heart rate[1,2]



Autonomic Dysregulation in Autism

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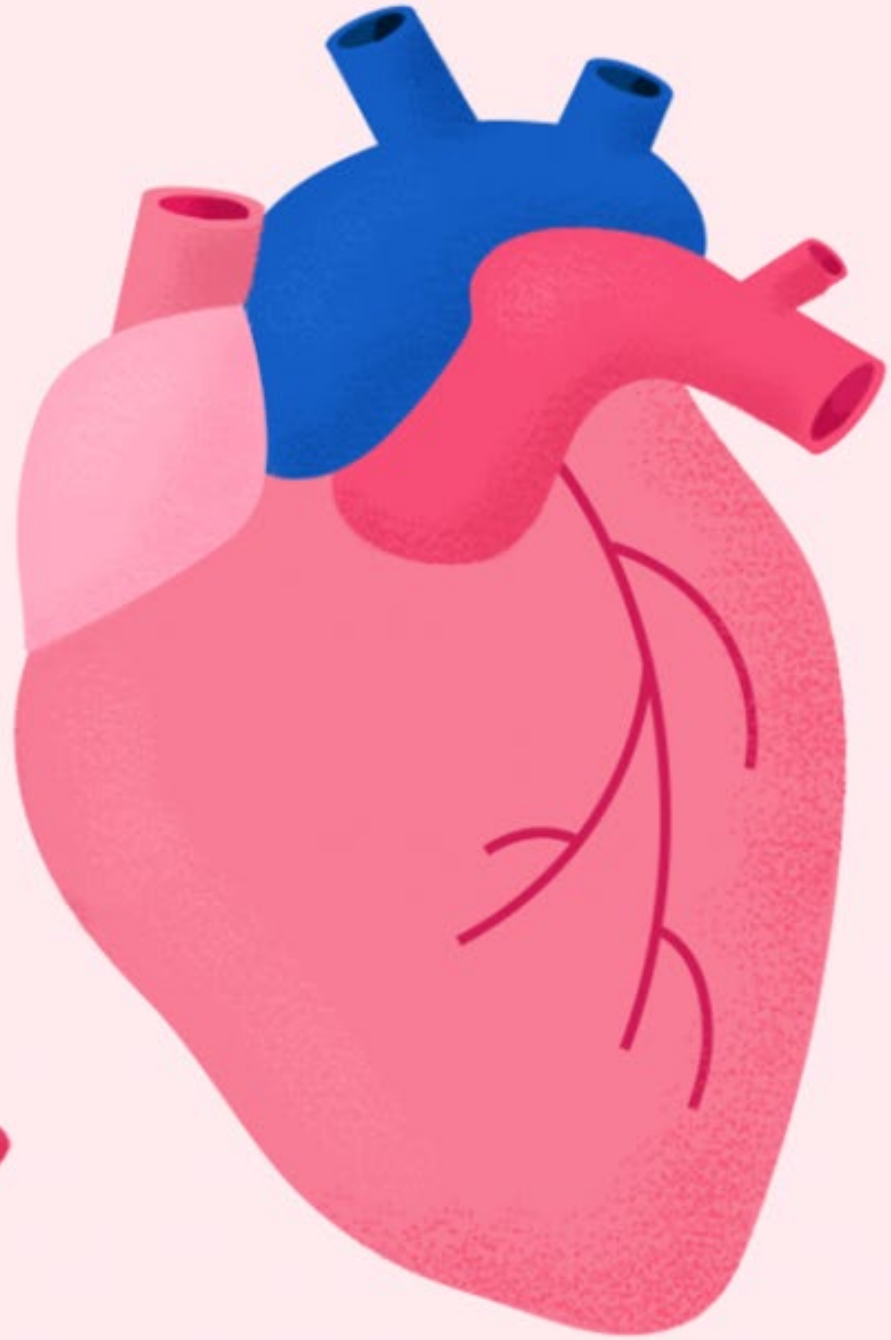
    - Increased pupil size[3]



Autonomic Dysregulation in Autism

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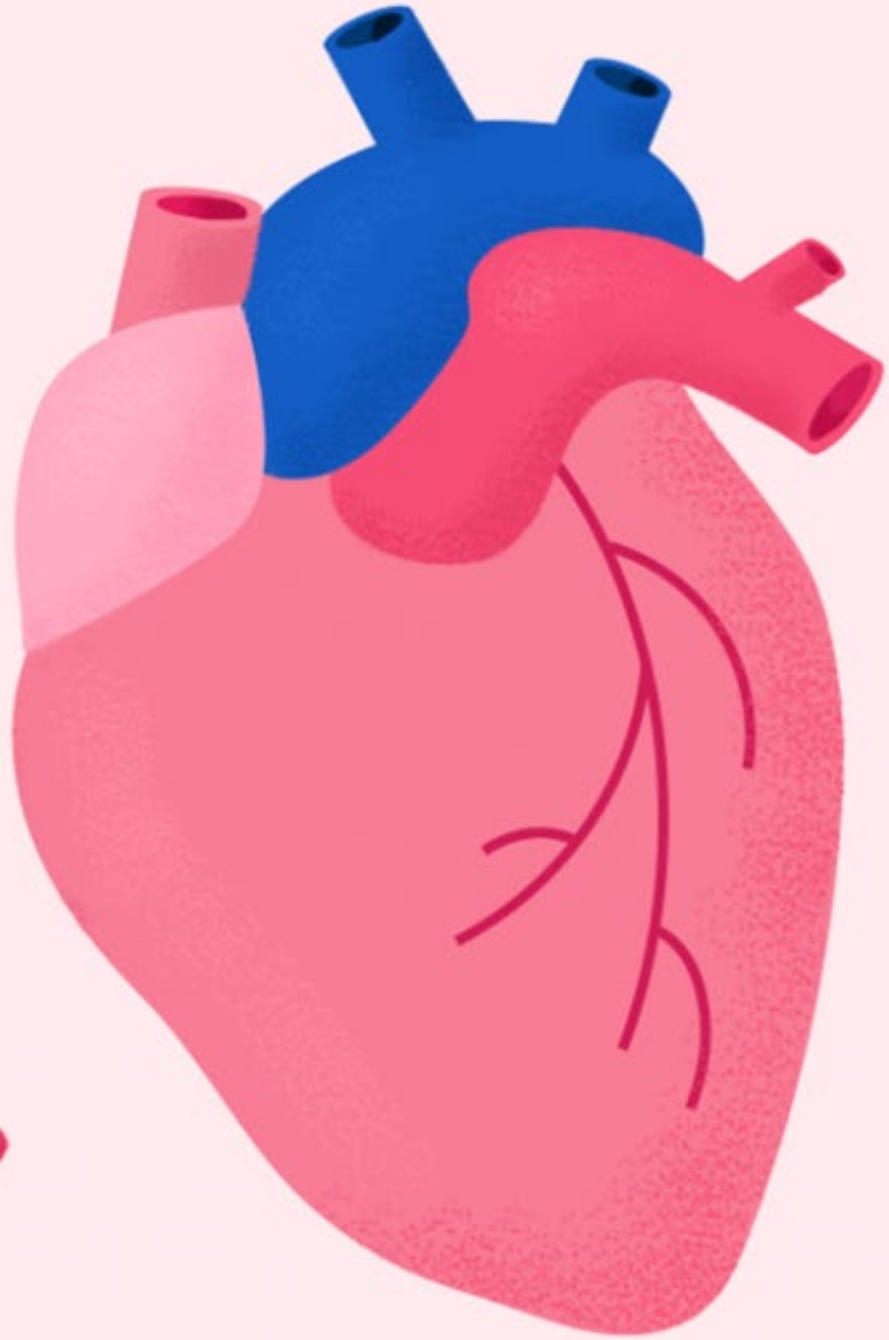
    - Higher respiration rate[4]



Autonomic Dysregulation in Autism

- **Autistic people tend to exhibit:**
  - Higher sympathetic (fight or flight) activation during:
    - Certain stages of sleep (N2, N3, REM)[5]

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    - Social interaction with peers[6]

Autonomic Dysregulation in Autism

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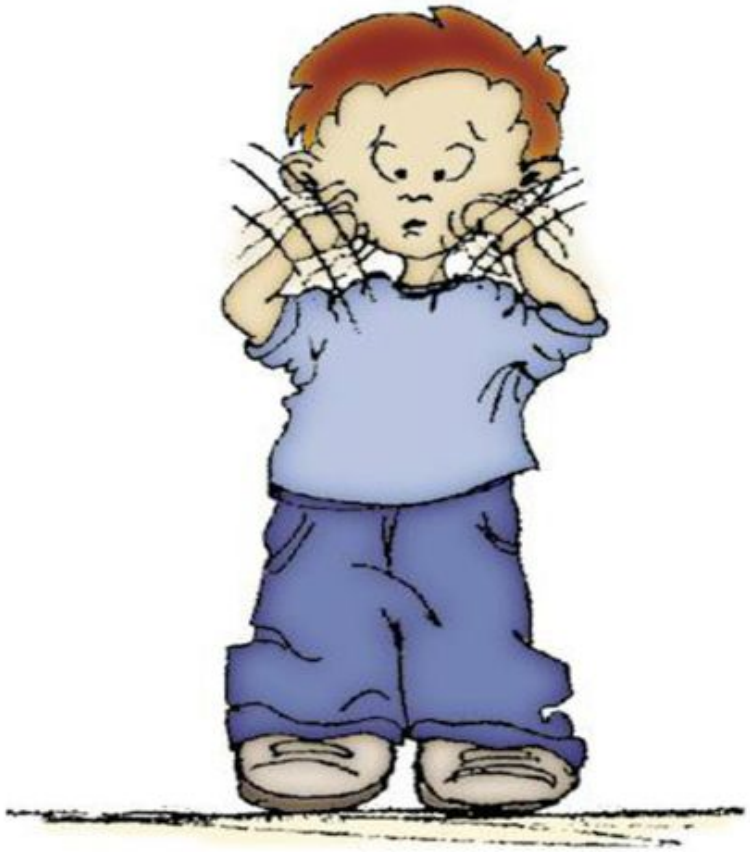
    - Social interaction with peers[6]

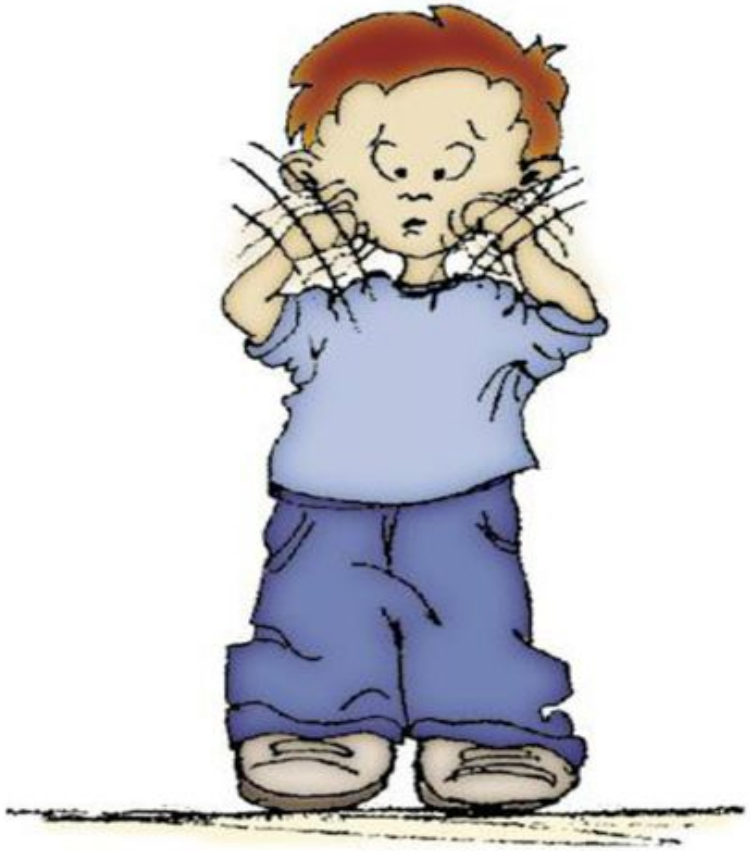
BUT...

Spinning and hand flapping



And… autistic people often use stimulatory behaviors to reduce sympathetic hyperarousal.[7]

Spinning and hand flapping



In fact, these probably shouldn't be called "stimulatory" behaviors but "calming" behaviors.

But a small percentage of autistic people have low sympathetic activation, except during self-injurious behavior.[7]

These may more accurately be called "stimulatory" behaviors.

Autonomic Dysregulation in Autism

- **Autistic people tend to exhibit:**
  - Lower sympathetic (fight or flight) activation during:
    - Fear-eliciting responses (toddlers)[8]

Autonomic Dysregulation in Autism

- **Autistic people tend to exhibit:**
  - Lower parasympathetic (rest and digest) activity during the morning[9]

Autonomic Dysregulation in Autism

- **Autistic people with lower parasympathetic tone tend to:**
  - Have greater symptoms of anxiety[10, 11]

Autonomic Dysregulation in Autism

- **Autistic people with lower parasympathetic tone tend to:**
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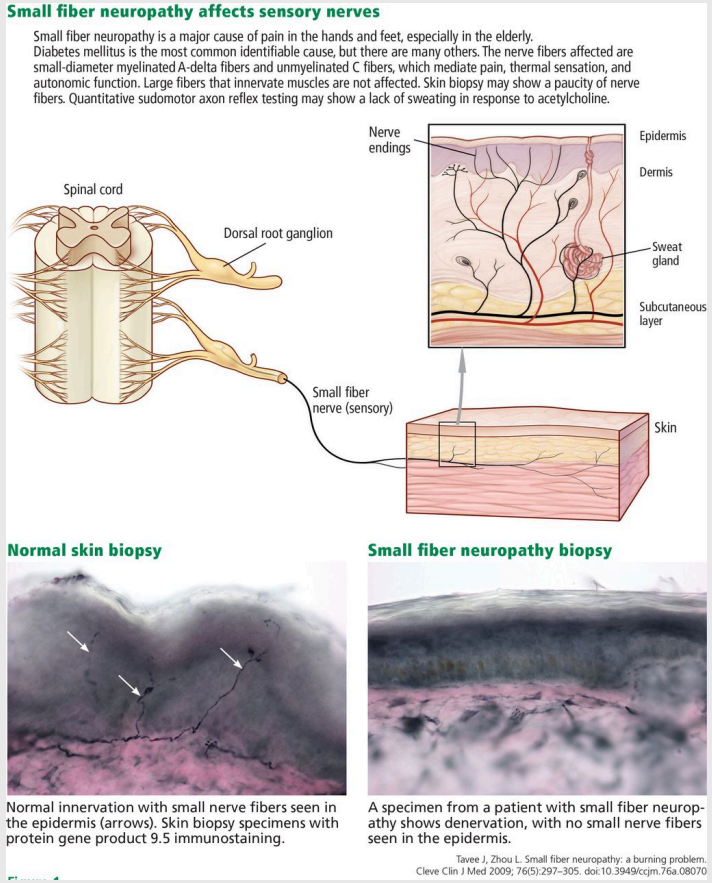
  - Poorer social skills[12]

Autonomic Dysregulation in Autism

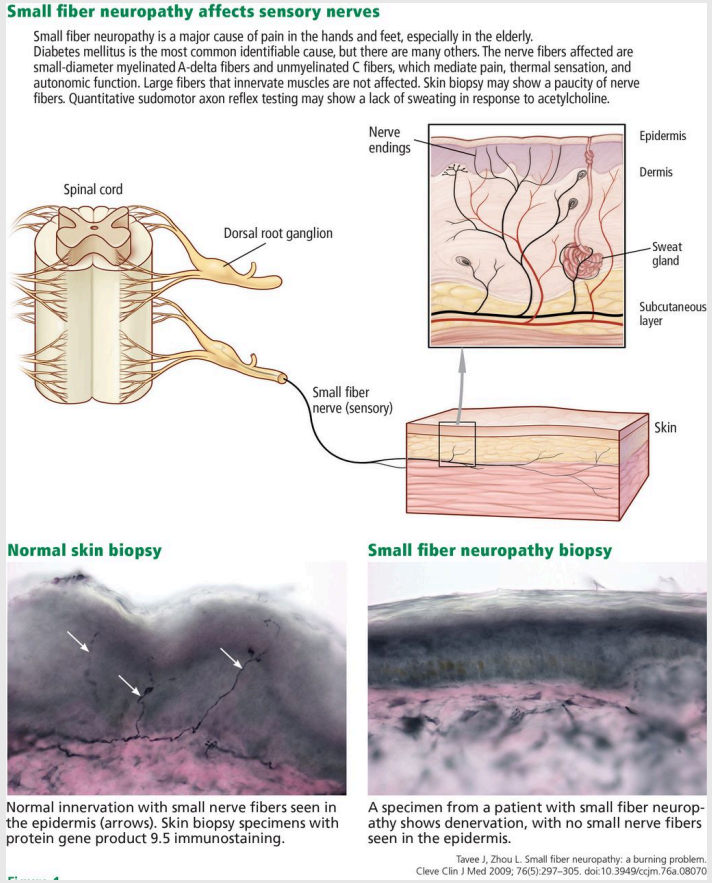
- **Autistic people with lower parasympathetic tone tend to:**
  - Have greater symptoms of anxiety[10, 11]
  - Poorer social skills[12]
  - Lower GI tract problems (e.g., constipation), common with regression[13]

Nerve Fiber Loss in Some Kids with Autism



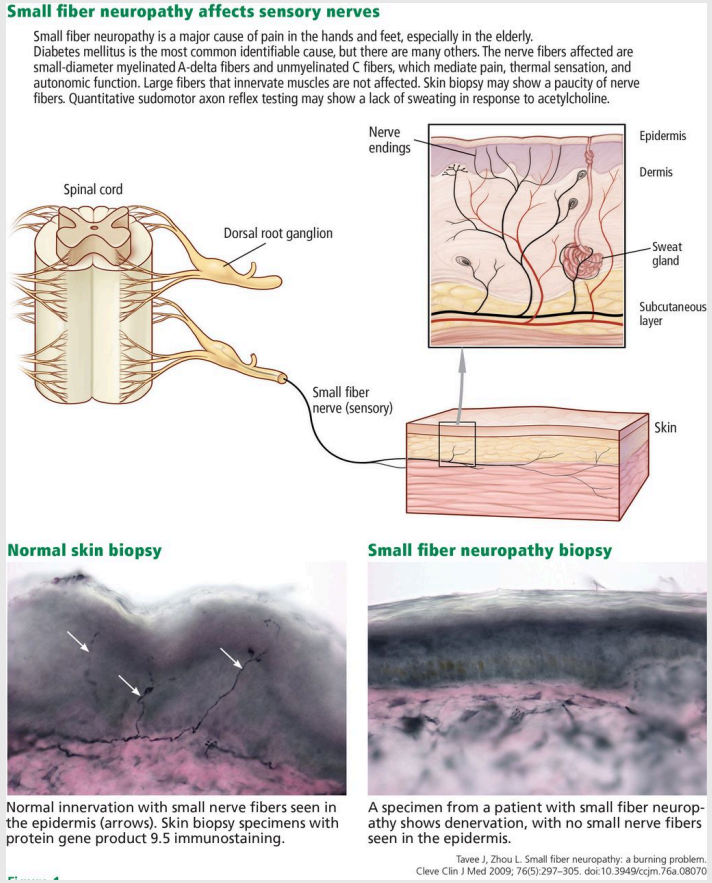
- Loss of small unmyelinated C-fibers in the skin in autistic children with reduced sensation (including pain)[14]
- This type of small fiber is also involved in the **autonomic nervous system**

Nerve Fiber Loss in Some Kids with Autism



- Loss of small unmyelinated C-fibers in the skin in autistic children with reduced sensation (including pain)[14]
- This type of small fiber is also involved in the autonomic nervous system
  - **Small Fiber Neuropathy has been implicated in:**
    - GI motility disorders
    - Sleep disorders
    - Pain disorders
    - Altered temperature perception

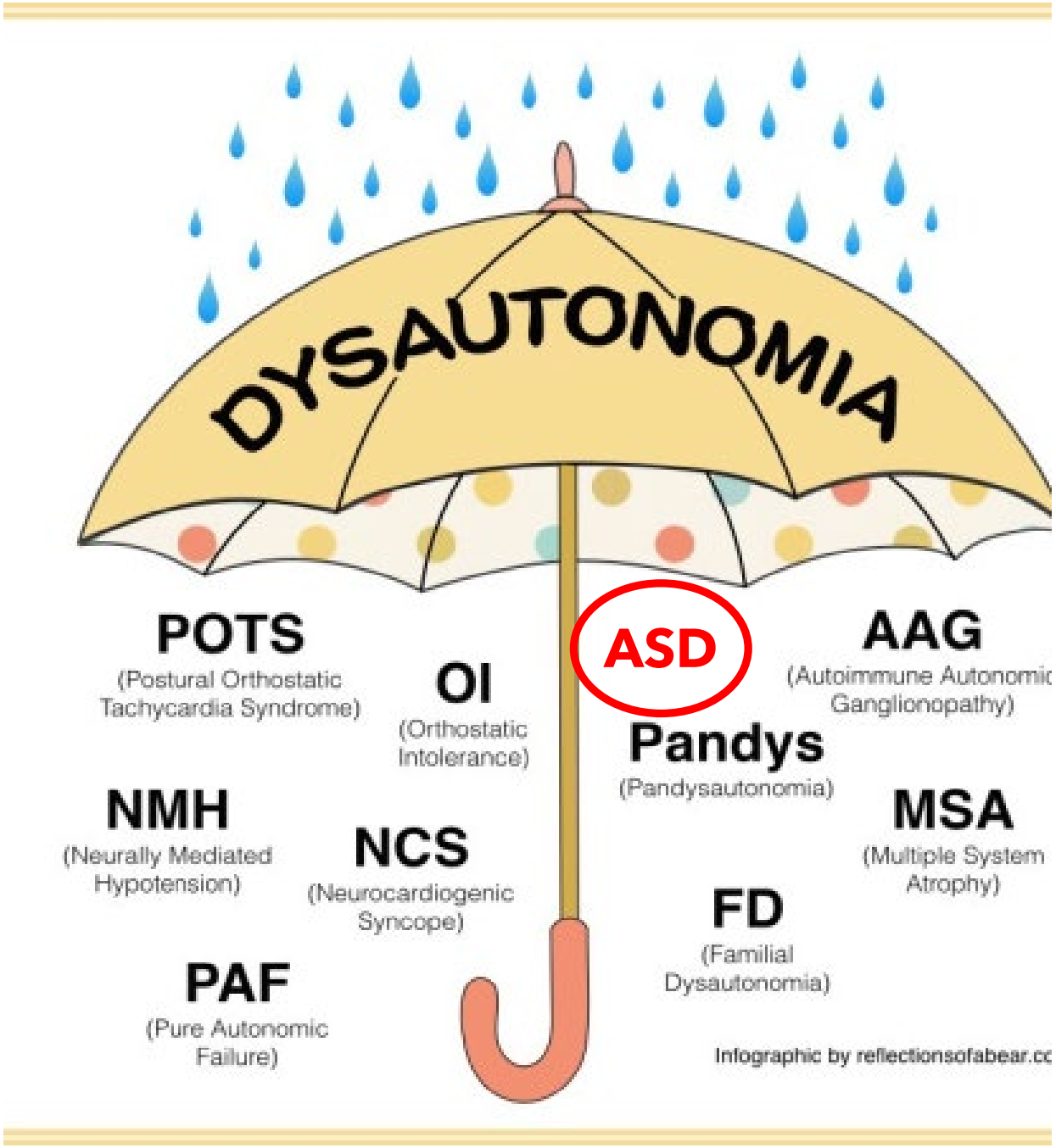
Nerve Fiber Loss in Some Kids with Autism



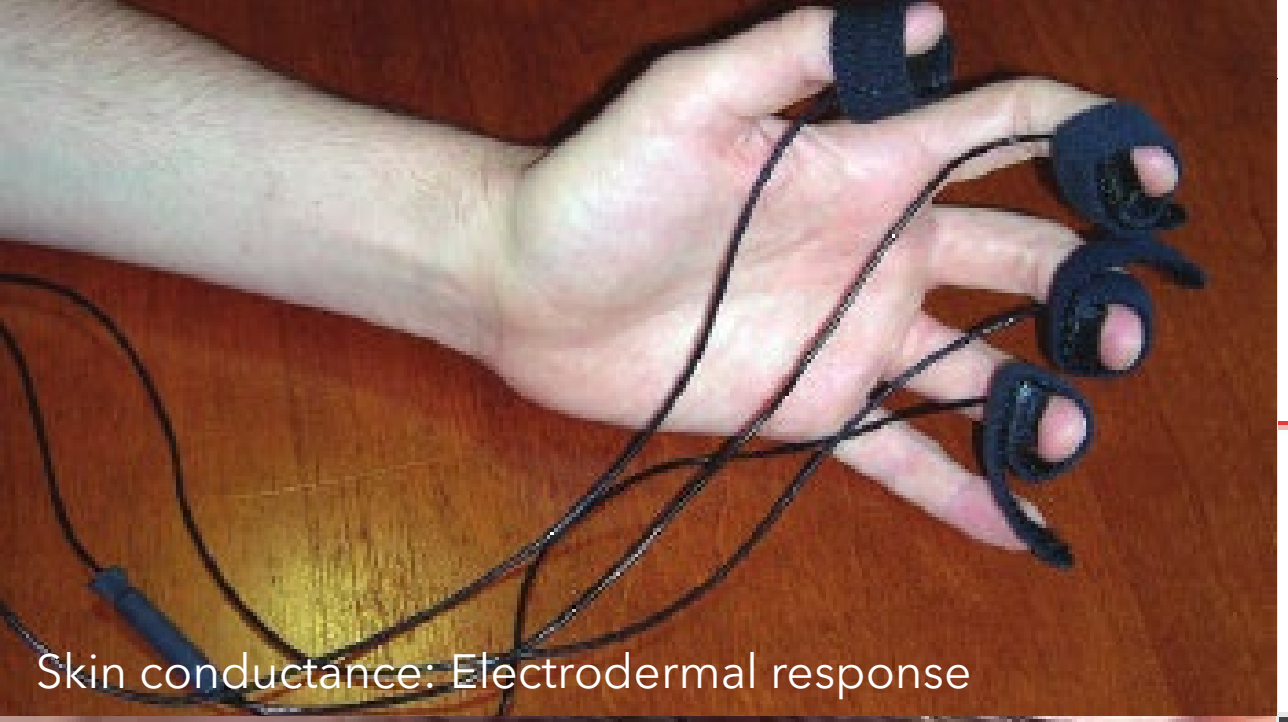
- Loss of small unmyelinated C-fibers in the skin in autistic children with reduced sensation (including pain)[14]
- This type of small fiber is also involved in the autonomic nervous system
  - **We see this same kind of small fiber loss in Ehlers-Danlos syndrome/hypermobility spectrum disorders.**
  - Previous ARI webinar on autism and hypermobility-related disorders: https://www.autism.org/hypermobility-asd/

Other Materials on EDS & Autism:

- **"What Ehlers-Danlos Syndrome Can Teach Us About Autism" – *Spectrum News***
  https://www.spectrumnews.org/opinion/viewpoint/what-ehlers-danlos-syndrome-can-teach-us-about-autism/
- **"Researchers Have Identified a Relationship between Ehlers-Danlos Syndrome and Autism" – *Autism Research Institute***
  https://www.autism.org/researchers-have-identified-a-relationship-between-ehlers-danlos-syndrome-and-autism/
- **"Sensory Issues in Ehlers-Danlos Syndromes and Hypermobility Spectrum Disorders" - *TheMighty***
  https://themighty.com/2020/10/overlap-ehlers-danlos-syndrome-autism/
- **Emily's Blog: "*Science Over a Cuppa*" -**
  https://scienceoveracuppa.com/

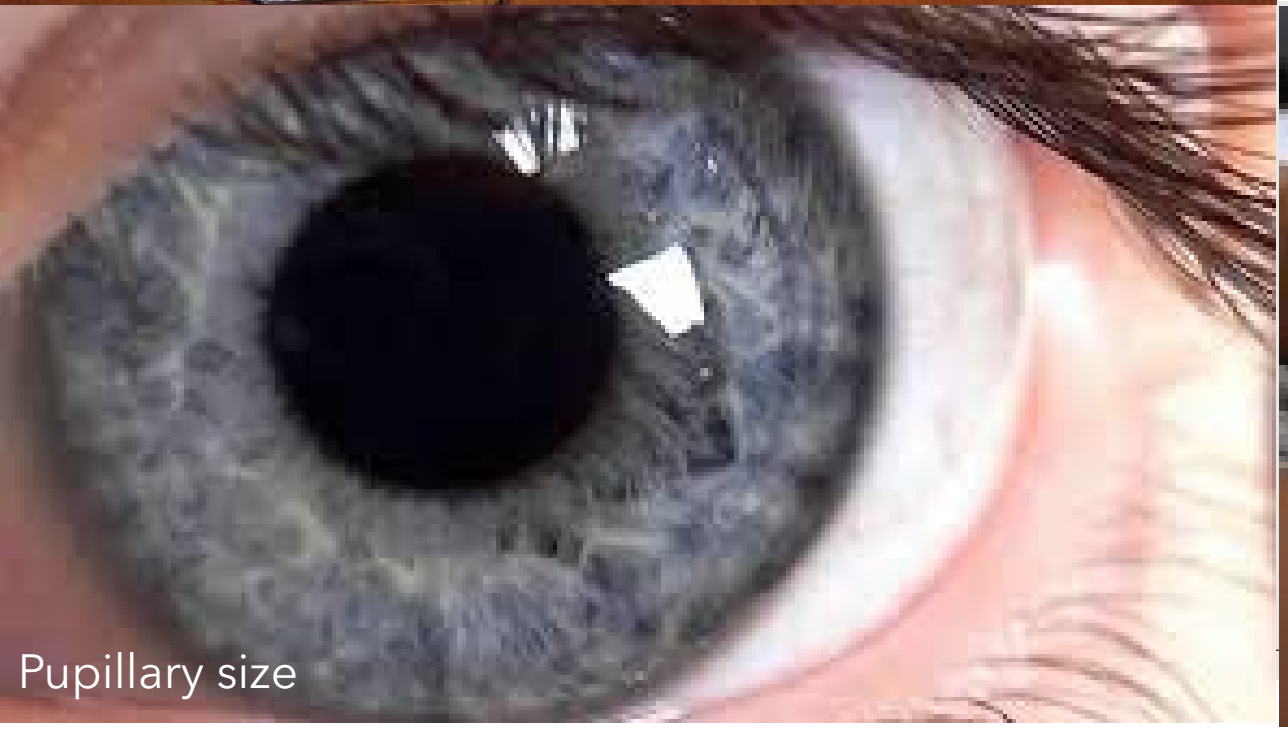


DYSAUTONOMIA IN AUTISM: PART 2



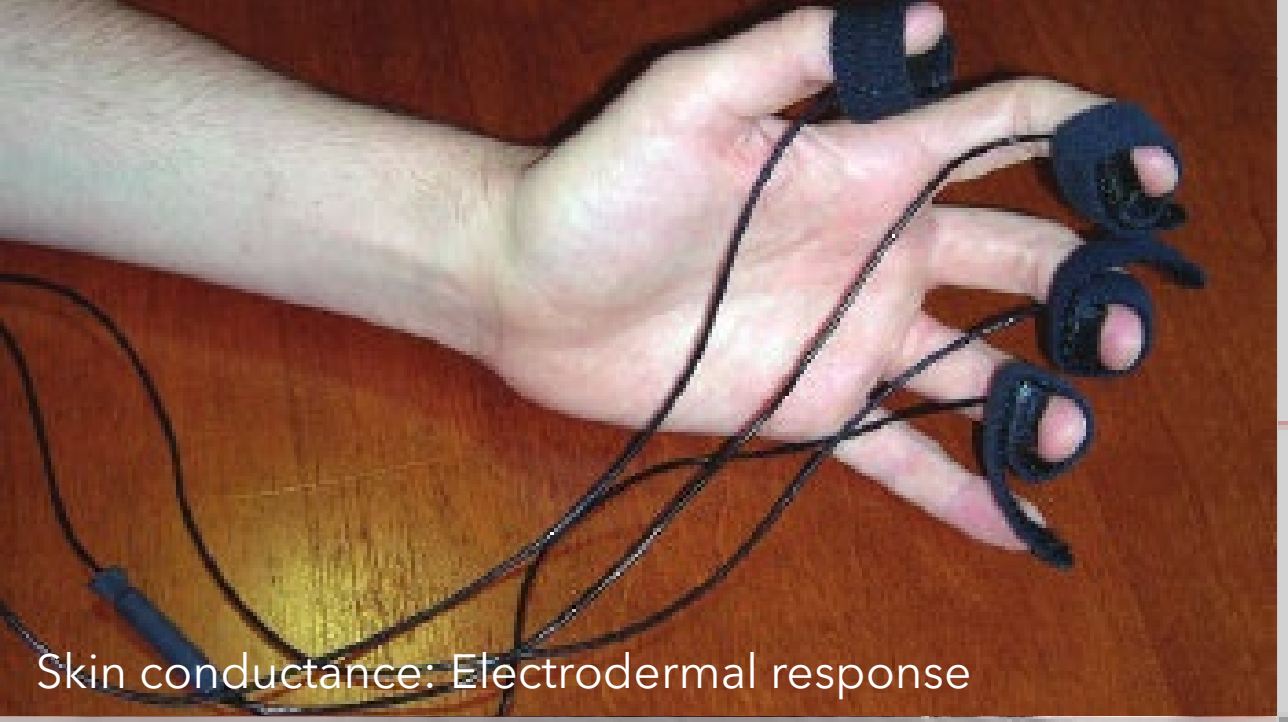
Skin conductance: Electrodermal response

Heart rate regulation



Pupillary size

Sleep problems



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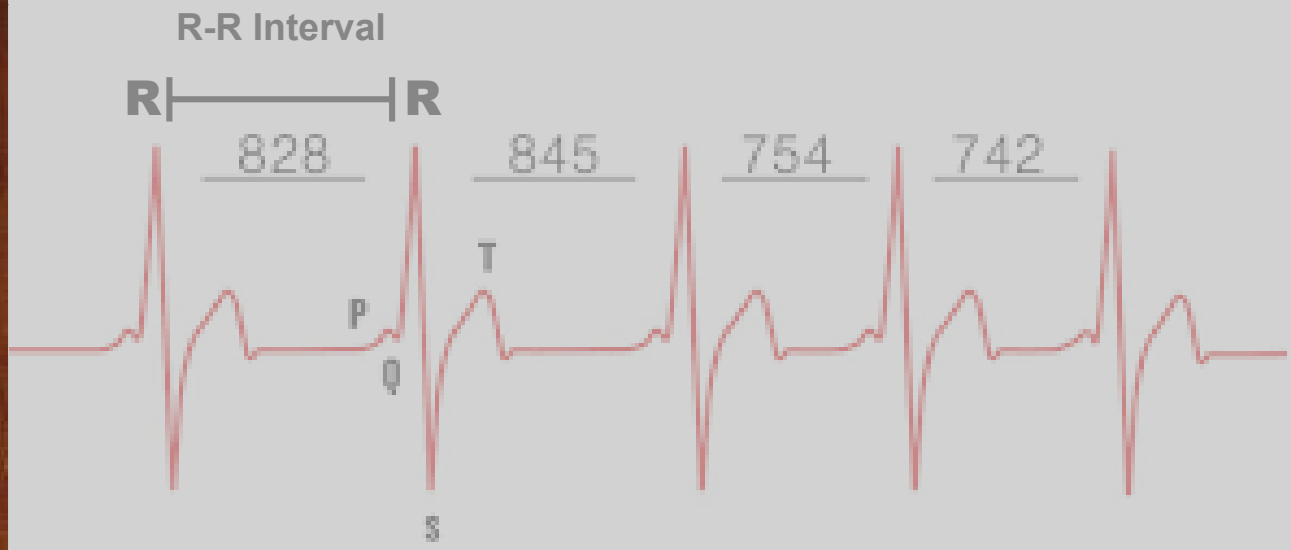

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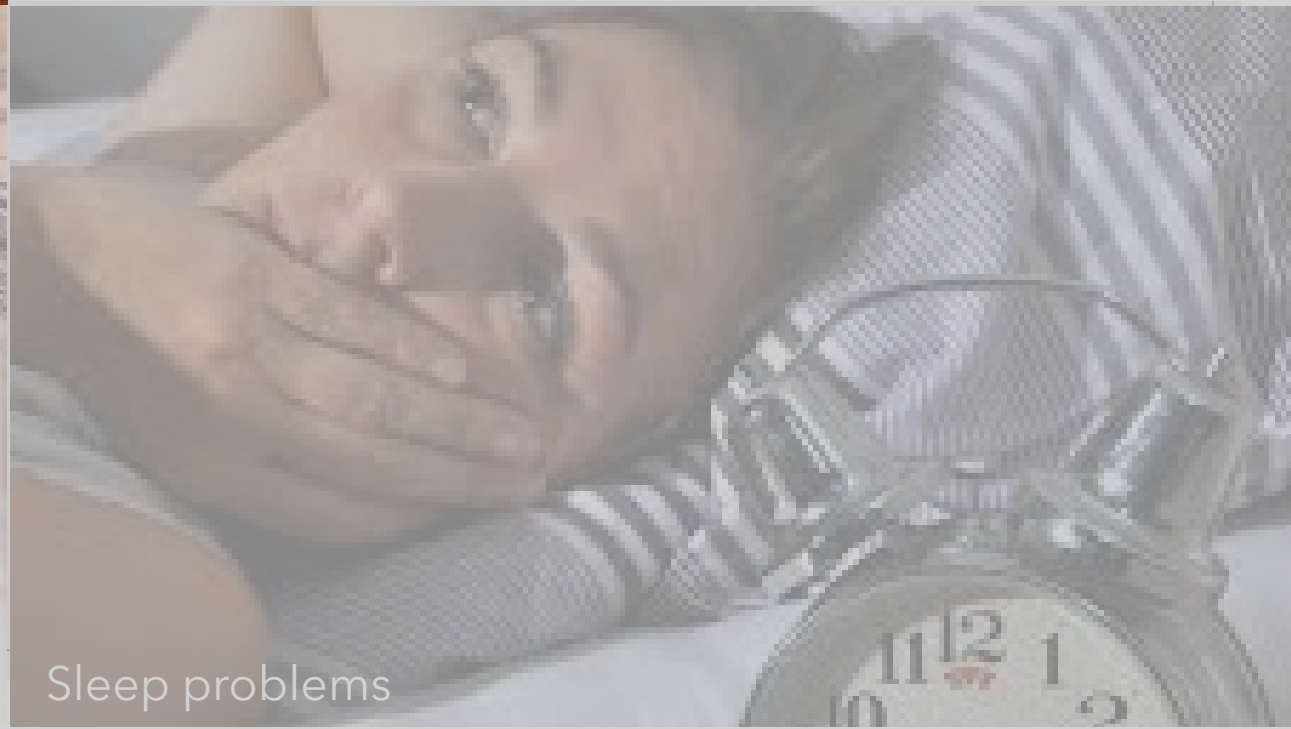

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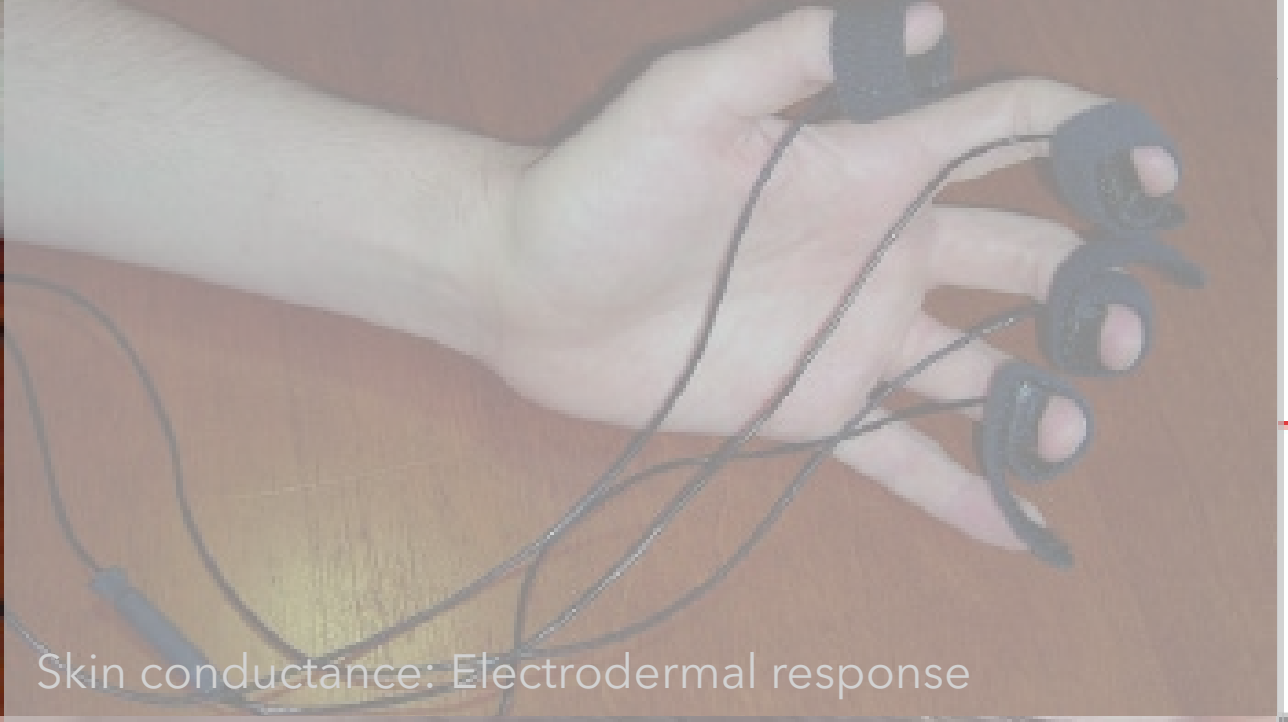

Skin conductance: Electrodermal response

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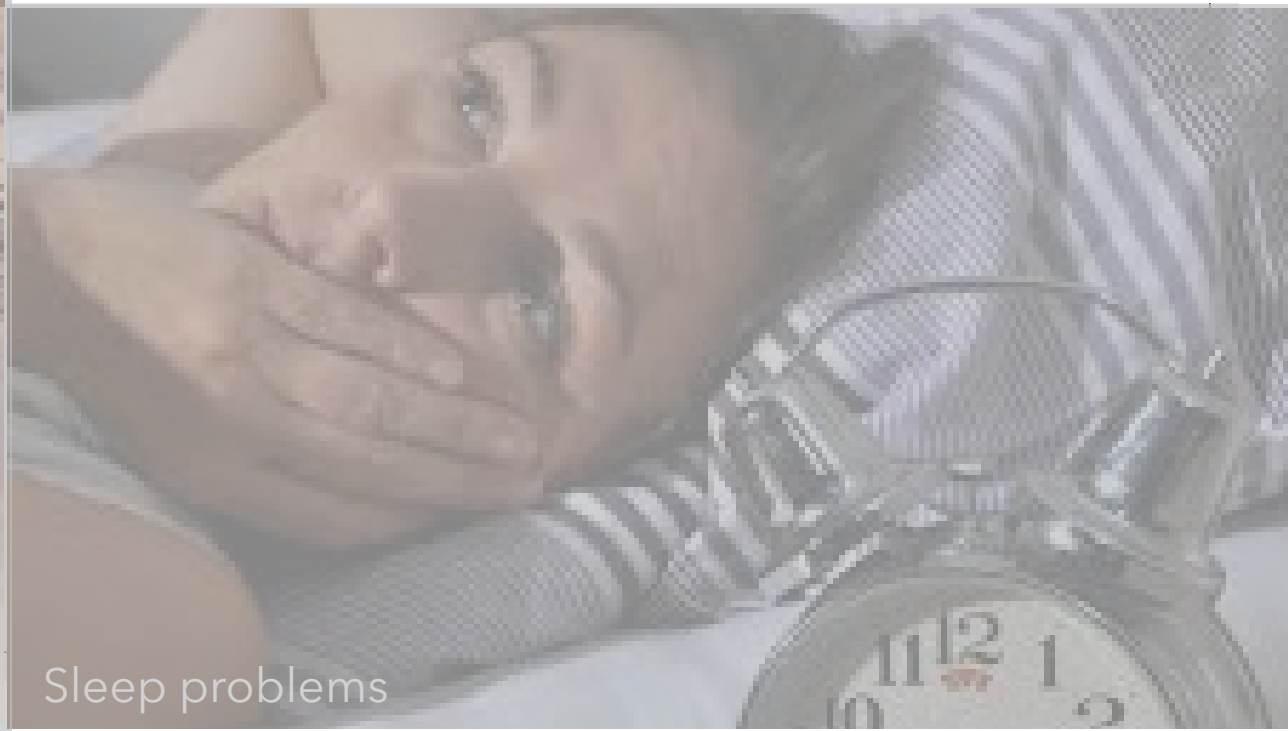
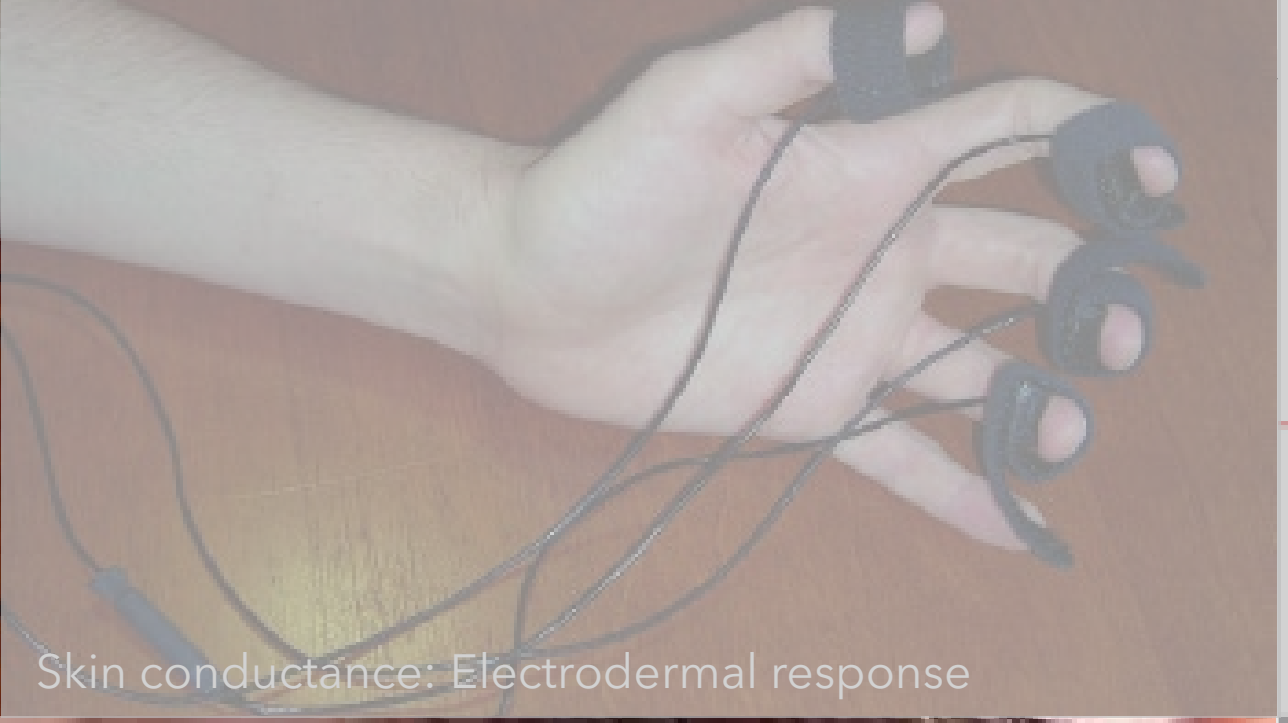


Sleep problems



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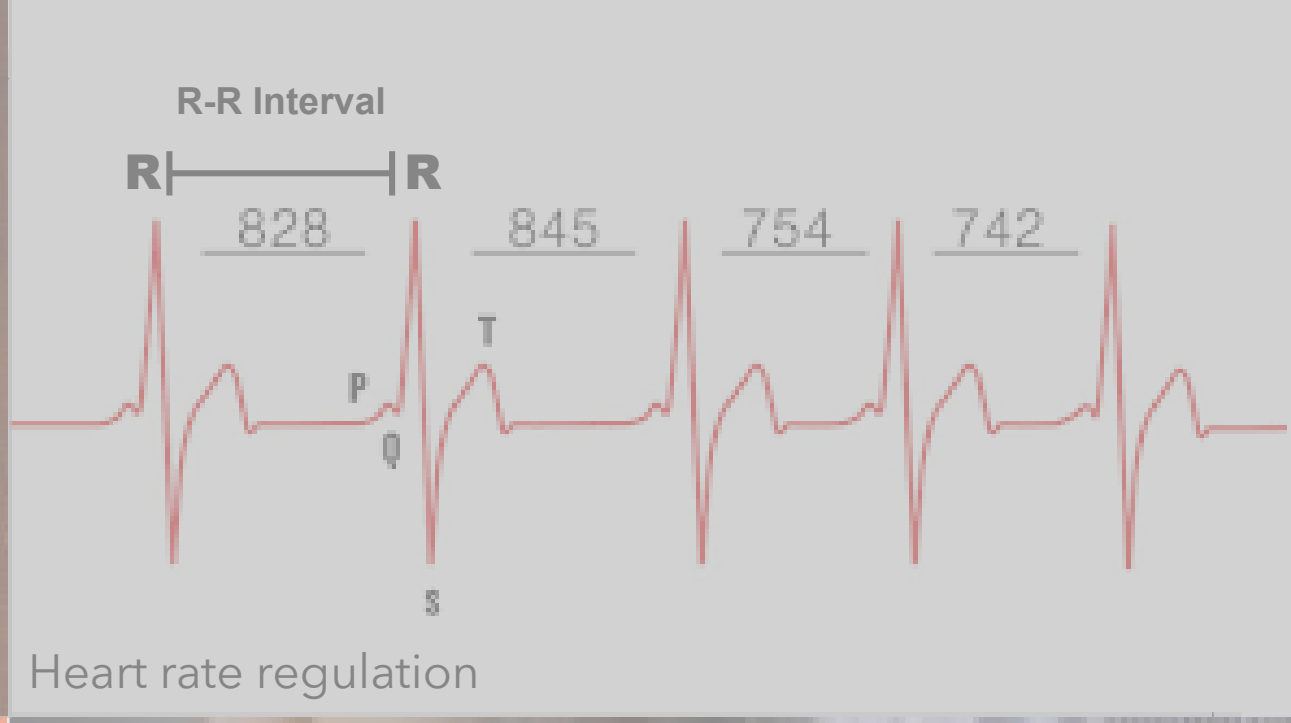

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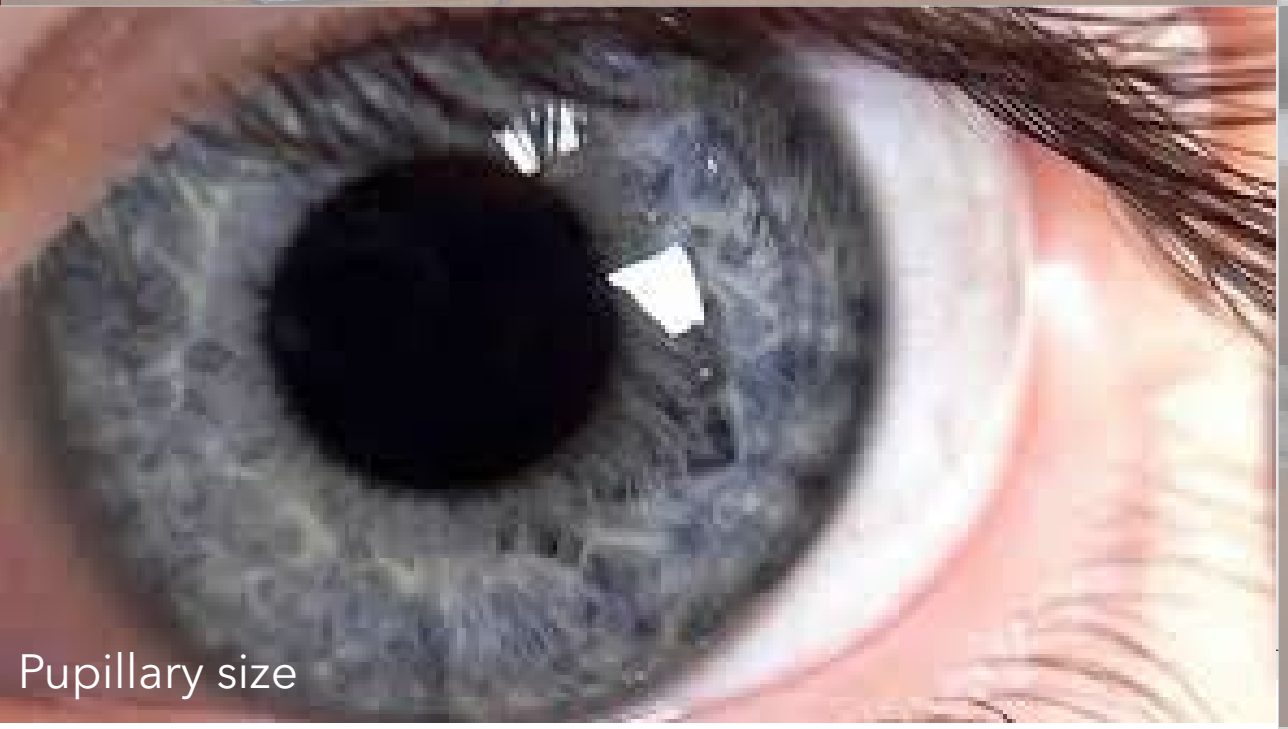

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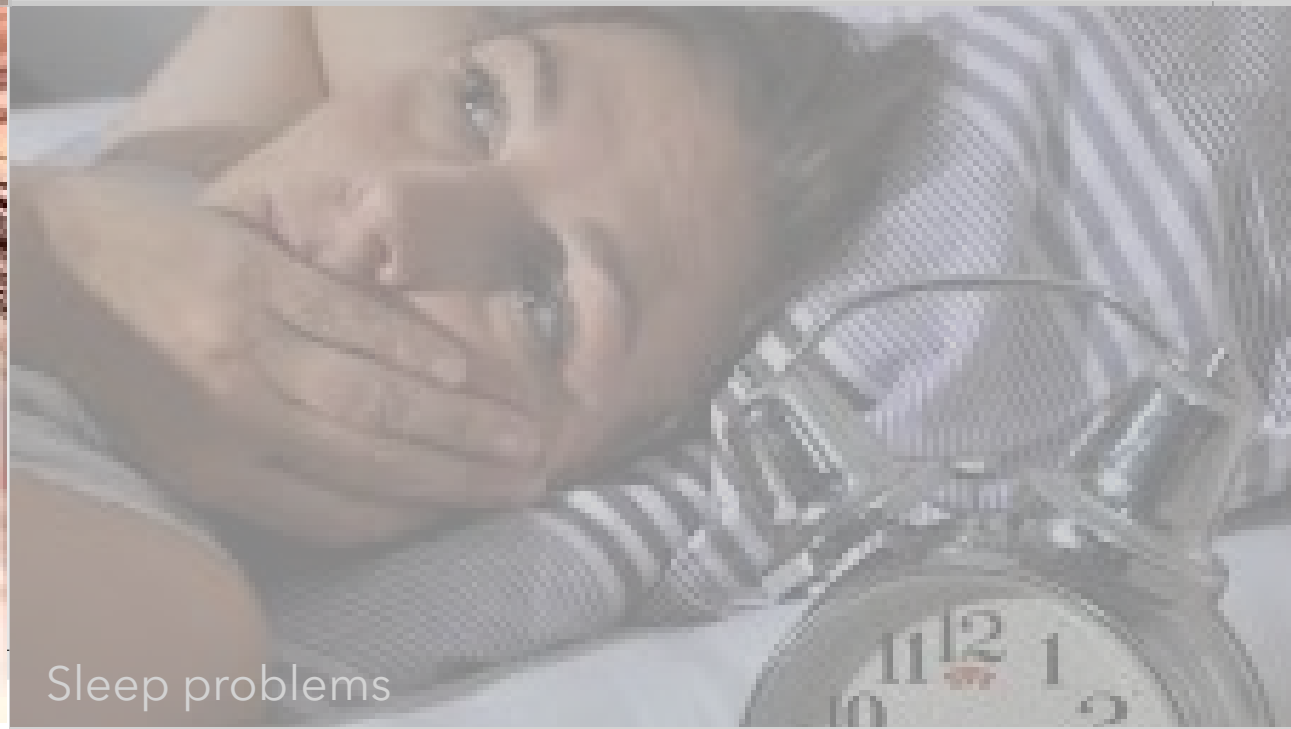
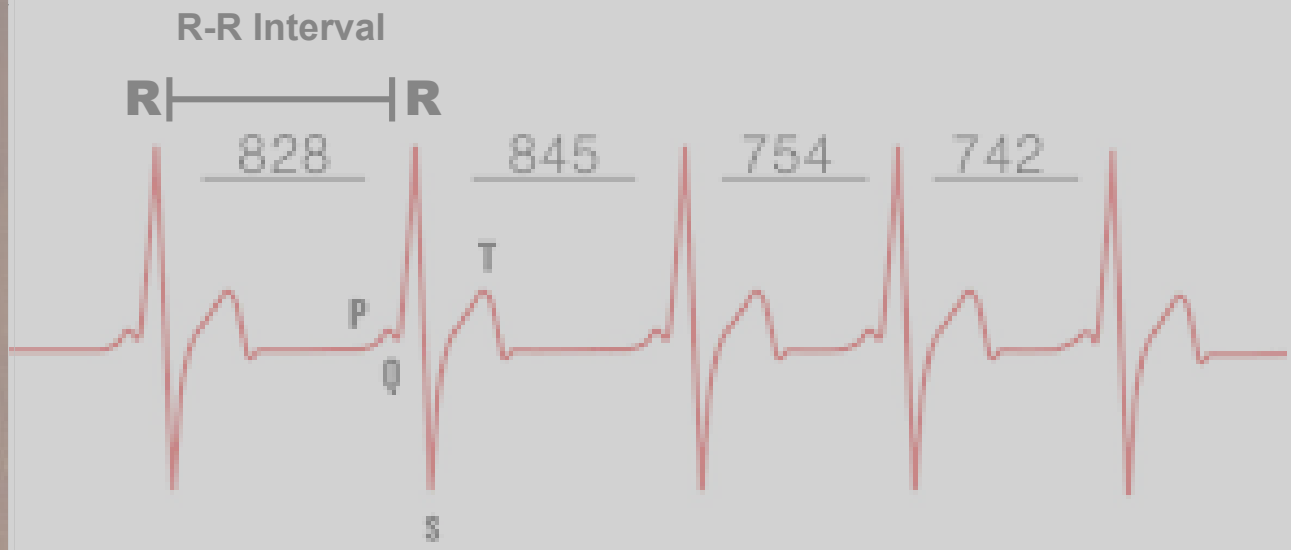


Sleep problems

Skin conductance: Electrodermal response



Heart rate regulation

Pupillary size

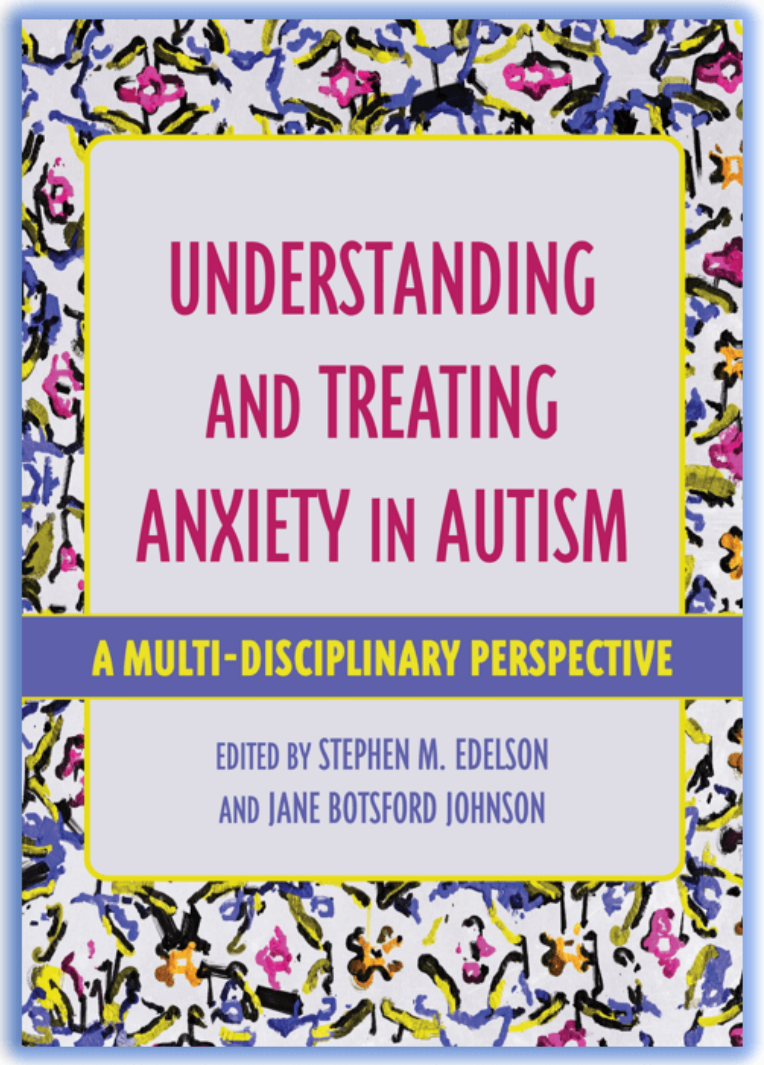
Sleep problems

Anxiety

Subjective experience of fear and its physical manifestations.

Autonomic symptoms

- Palpitations
- Perspiration
- Dizziness
- Mydriasis
- GI disturbances
- Urinary urgency and frequency
- Trembling
- "Buterflies" in the abdomen
- Tingling in the peripheral extremities
- Shortness of breath
- Choking sensation



Catatonia: *a disturbance that may involve muscle rigidity, stupor or mutism, purposeless movements, negativism, echolalia and inappropriate or unusual movements.*

Catatonia and Autism

- Increased recognition of catatonia as a comorbid syndrome of autism
- A limited number of studies suggest catatonia occurs in 12-17% of adolescents and young adults with autism
- An increasing number of cases of catatonia in autism have been reported throughout the world over the last 15 years

(Kakooza-Mwesige, A., Wachtel. L.E., Dhossche, D.M. 2008)

"My son had suffered a terrible breakdown, he was constantly pacing the house with his arms bent at the elbows and his hands pointing downwards with his head flexed back. He was hitting his whole body with great force and extremely distressed. Eating a meal could take a very long time from two to 5 hours. This went on for 3 months, it was soul destroying."

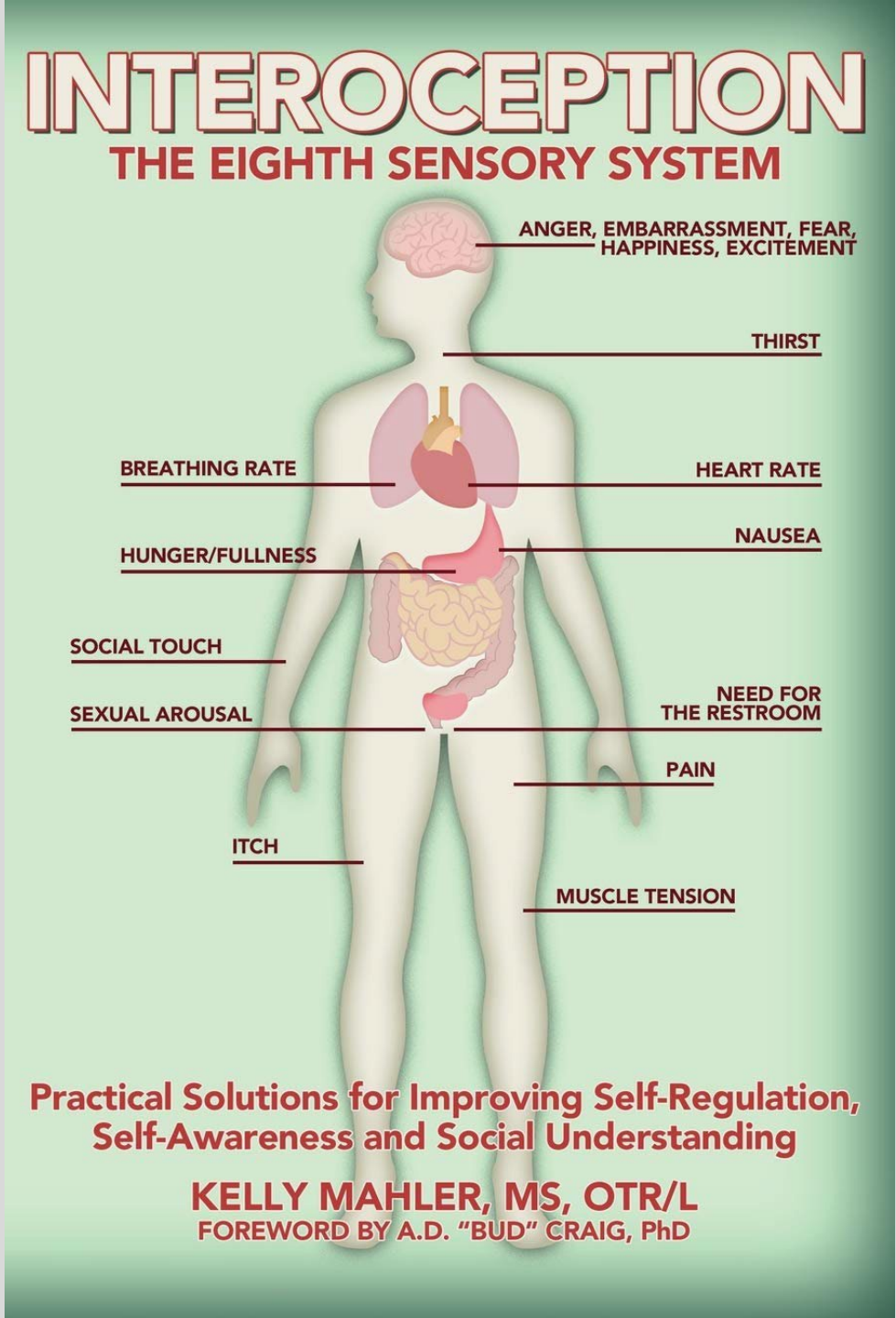
Signs and Symptoms of Stress and Anxiety in Youth

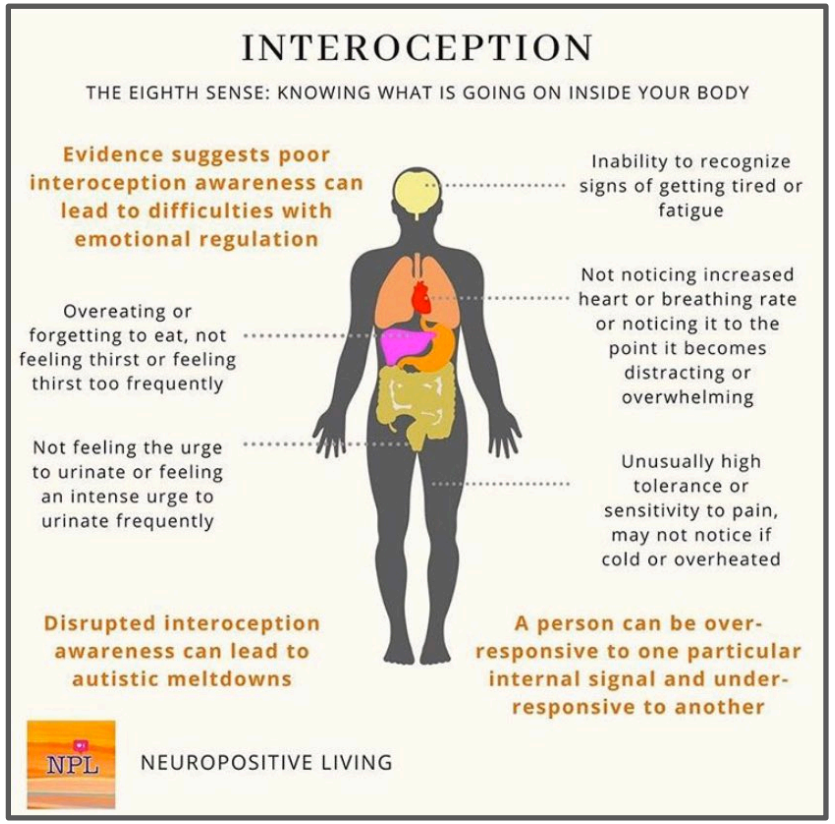
- Recurrent fears and worries
- Difficulty falling asleep or nightmares
- Hard to relax
- Difficulty separating from parents
- Scared about going to school
- Irritability, crying, tantrums
- Uncomfortable in social situations at sch
  restaurants, parties

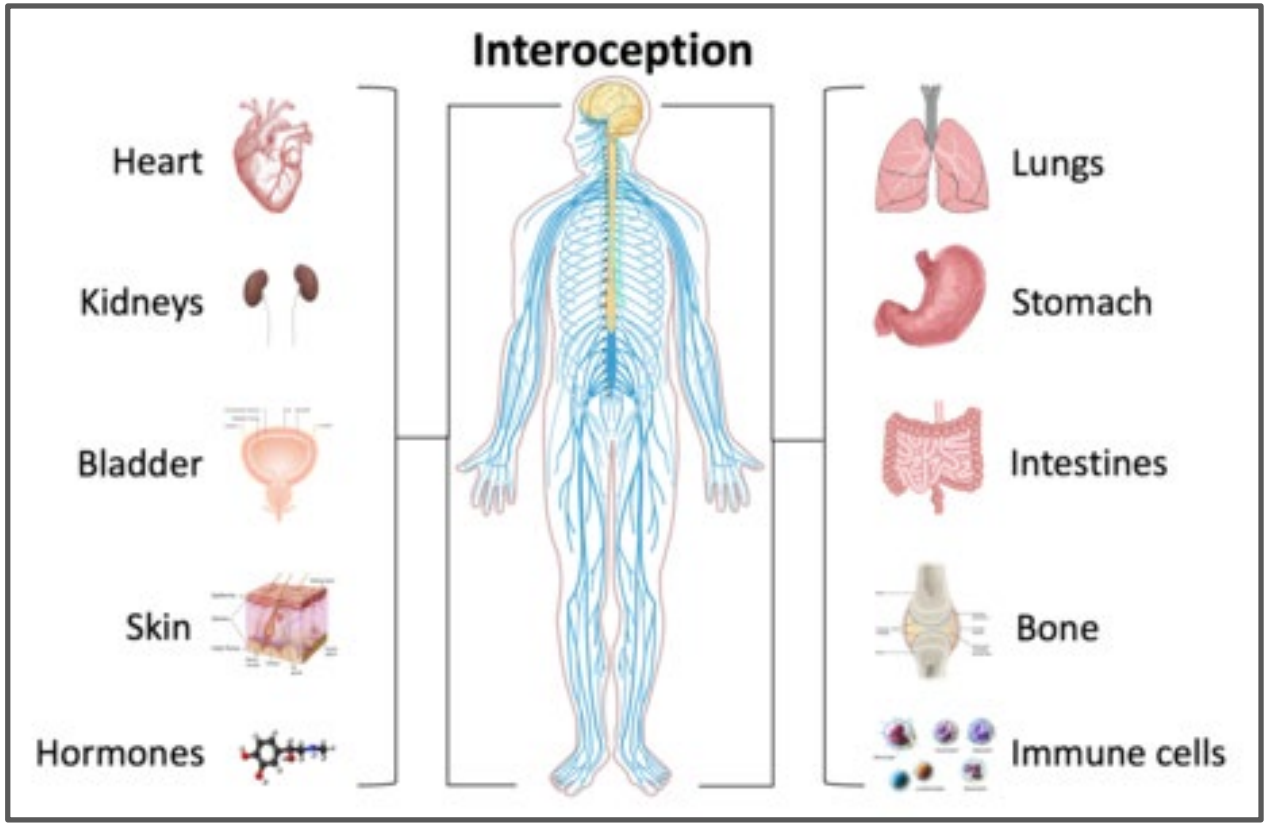
CLINICAL PEARLS

"I do not realize that I am getting angry until I am exploding with anger. By then it is too late. I can't control it." *– Jason, 9-year-old boy with autism.*

"A lot of times the inside of my body feels like one of those glitter timers– the ones that you can shake and the glitter goes every which way. I feel so many different things at once and I'm not sure what is important. It is very overwhelming." *– Gracies, 13-year-old girl with autism.*

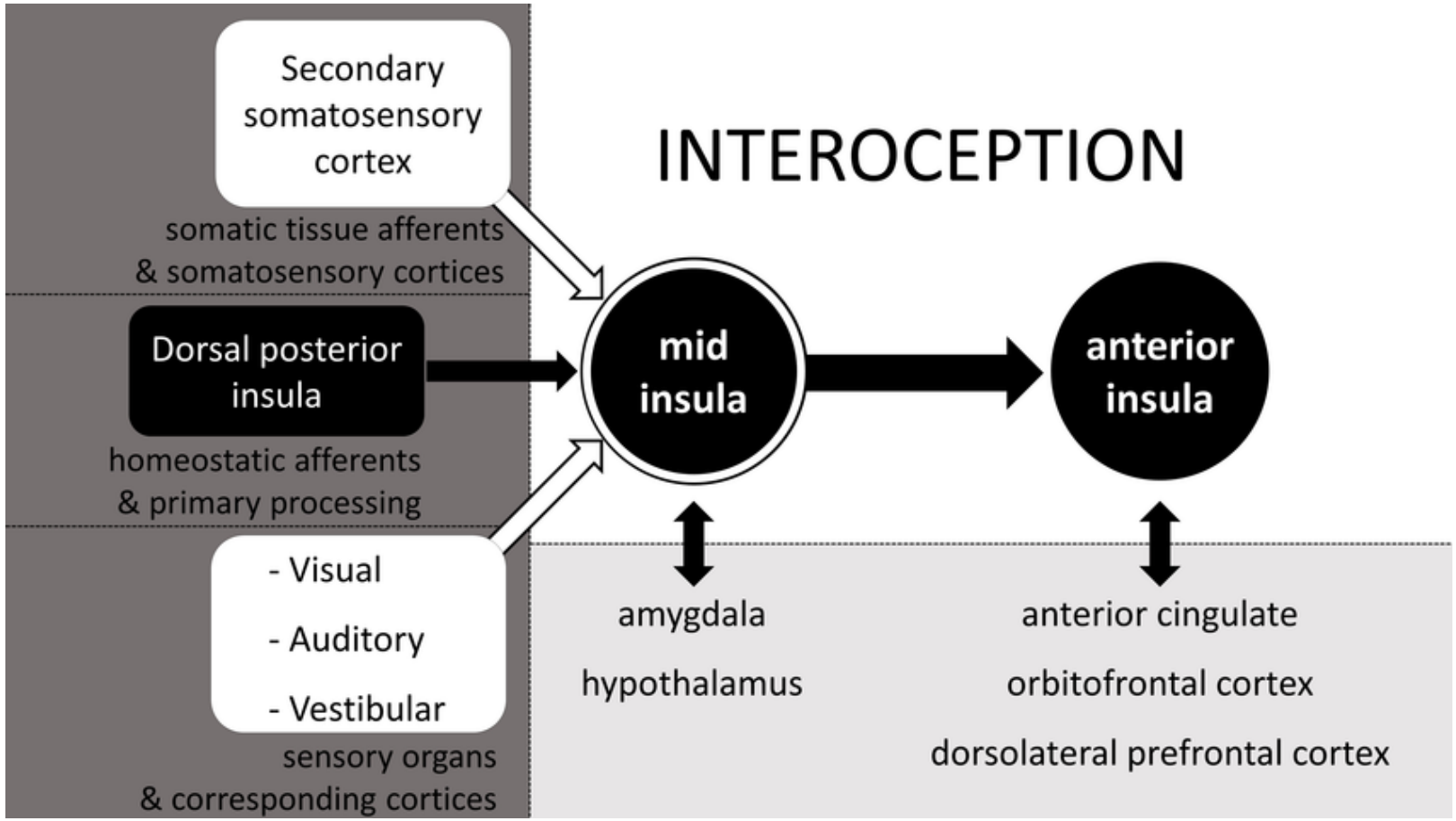



INTEROCEPTION
THE EIGHTH SENSE: KNOWING WHAT IS GOING ON INSIDE YOUR BODY
Evidence suggests poor interoception awareness can lead to difficulties with emotional regulation
Inability to recognize signs of getting tired or fatigue
Not noticing increased heart or breathing rate or noticing it to the point it becomes distracting or overwhelming
Overeating or forgetting to eat, not feeling thirst or feeling thirst too frequently
Not feeling the urge to urinate or feeling an intense urge to urinate frequently
Unusually high tolerance or sensitivity to pain, may not notice if cold or overheated
Disrupted interoception awareness can lead to autistic meltdowns
A person can be over-responsive to one particular internal signal and under-responsive to another
NPL
NEUROPOSITIVE LIVING


Interoception
Heart
Kidneys
Bladder
Skin
Hormones
Lungs
Stomach
Intestines
Bone
Immune cells

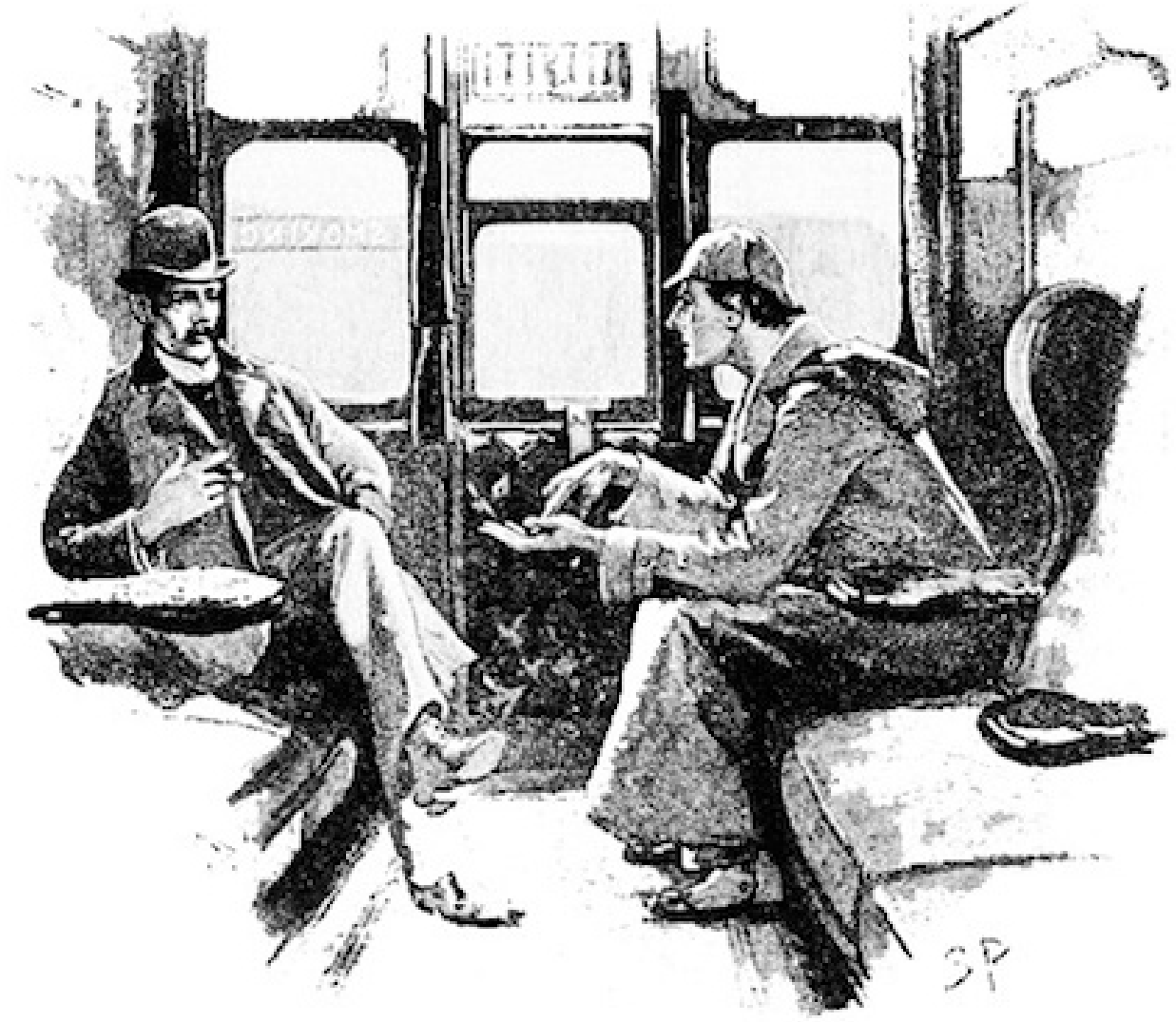
HOW DO I FEEL?

Interoception and the Central Nervous System

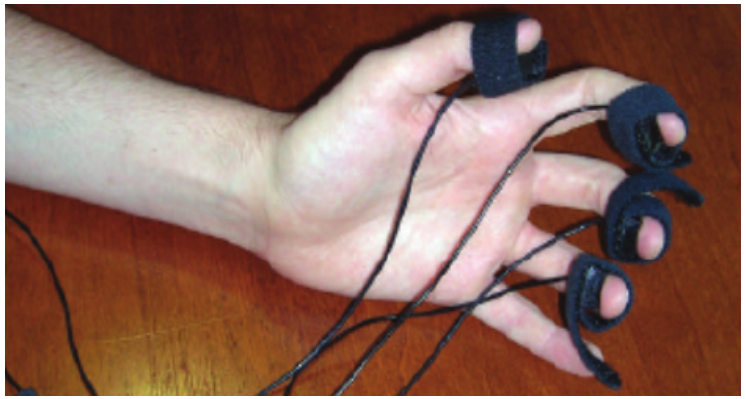


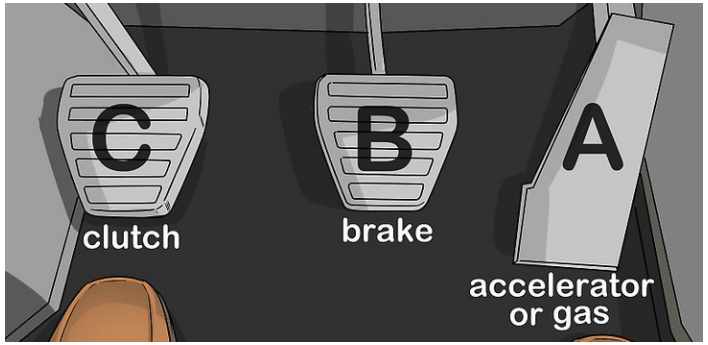
. . . I would emphasize something that may be somewhat speculative as of present: **That many of the behaviors, emotions, and physiological manifestations that we observe in autism are the result of a dysregulated top down process stemming from cortical influences on the limbic system and brainstem centers.**

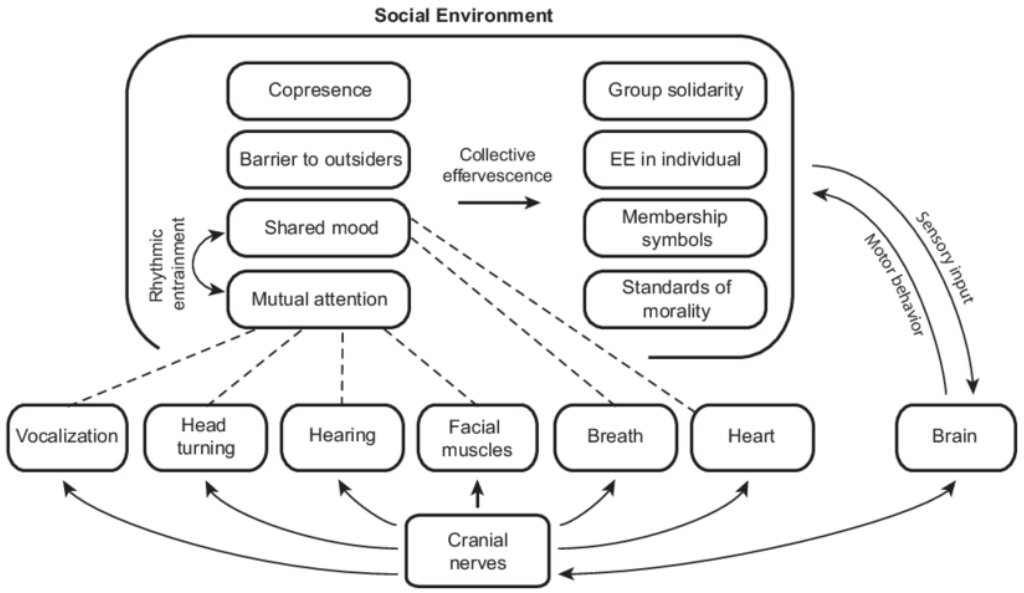
Sherlock Holmes & Dr. Watson

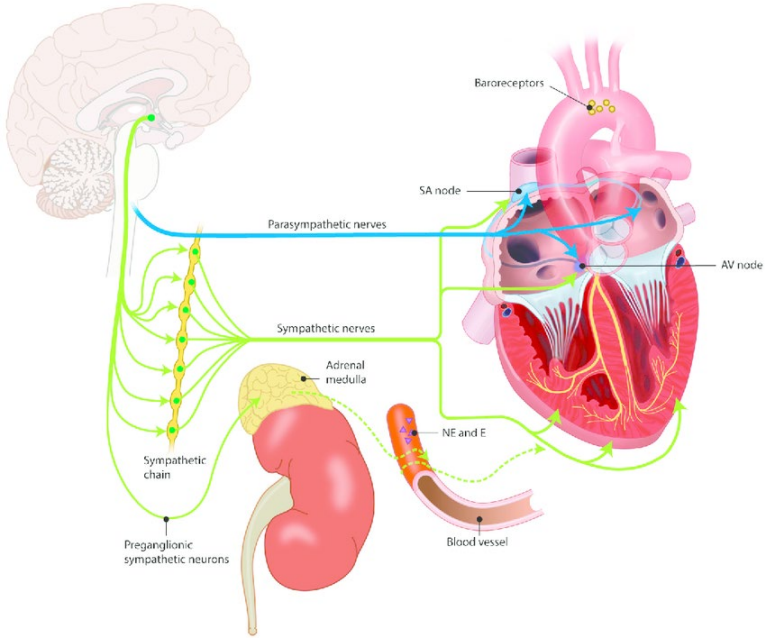


Skin conductance

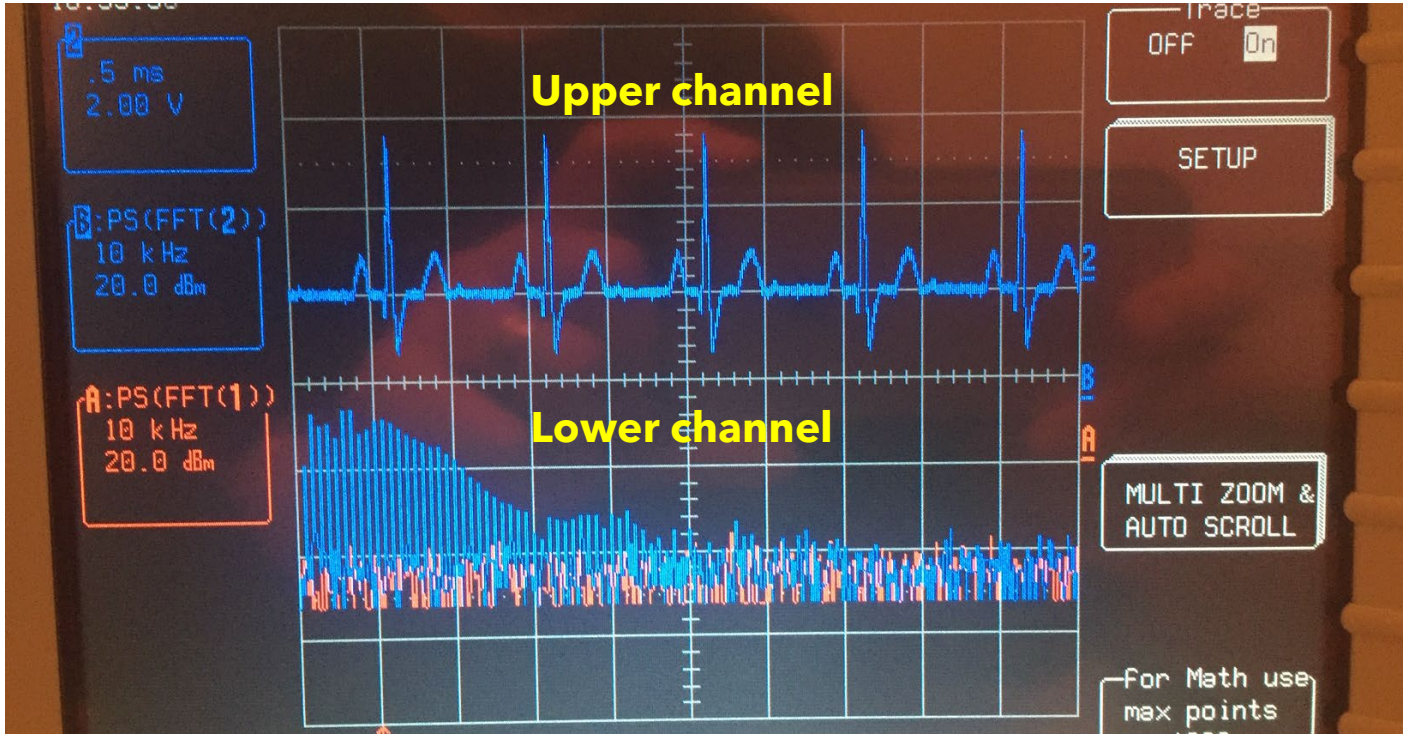


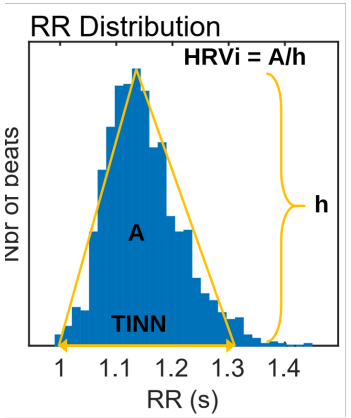


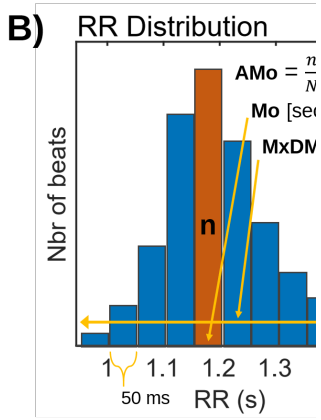


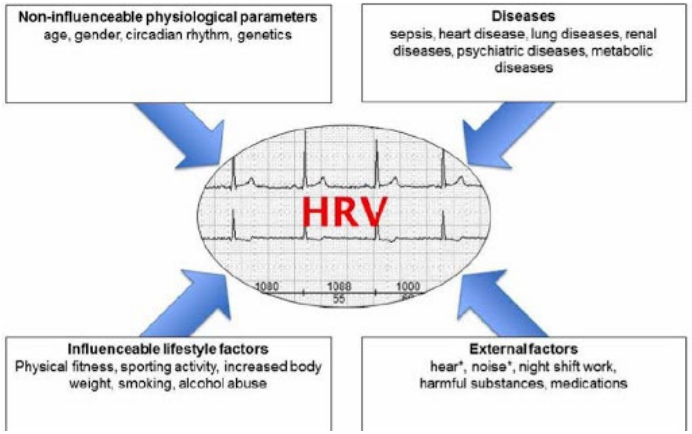


ANS : CNS : SOCIAL ENGAGEMENT







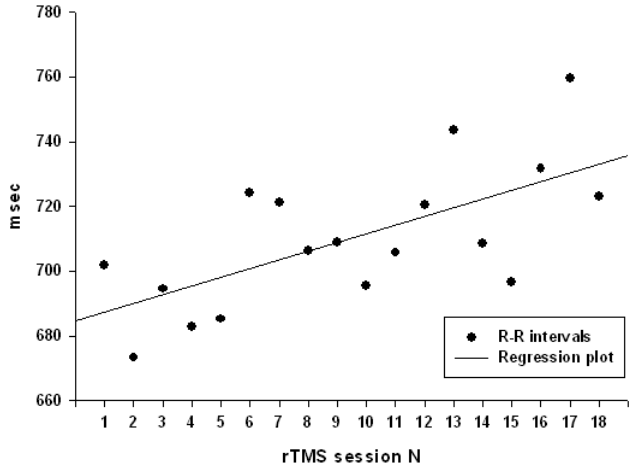


HEART RATE : TIME AND SPECTRAL MEASUREMENTS

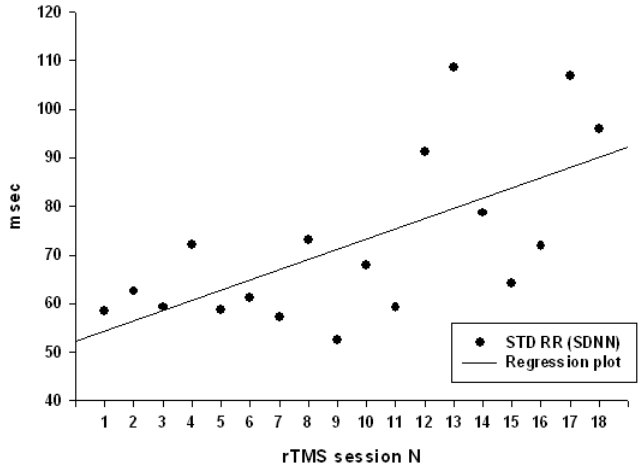
EFFECTS OF 18 SESSIONS OF RTMS ON AUTONOMIC FUNCTIONS IN AUTISM

Measure	Units	t	p-value	R	R^2	Regression equation	Power at $\alpha = 0.05$
RR	ms	3.52	0.003	0.661	0.437	$y = 2.696x + 684.57$	0.868
SDNN	ms	3.38	0.004	0.645	0.417	$y = 2.098x + 52.28$	0.844
RMSSD	ms^2	2.15	0.047	0.473	0.224	$y = 1.480x + 52.80$	0.512
LF power	ms^2	−1.02	0.323	0.247	0.061	$y = -15.23x + 1775.4$	0.163
HF power	ms^2	5.12	<0.001	0.788	0.621	$y = 68.65x + 671.9$	0.985
LF/HF ratio	N/A	−3.83	0.001	0.691	0.478	$y = -0.028x + 1.619$	0.913
SCL	µS	−3.71	0.002	0.681	0.464	$y = -0.17x + 8.65$	0.948

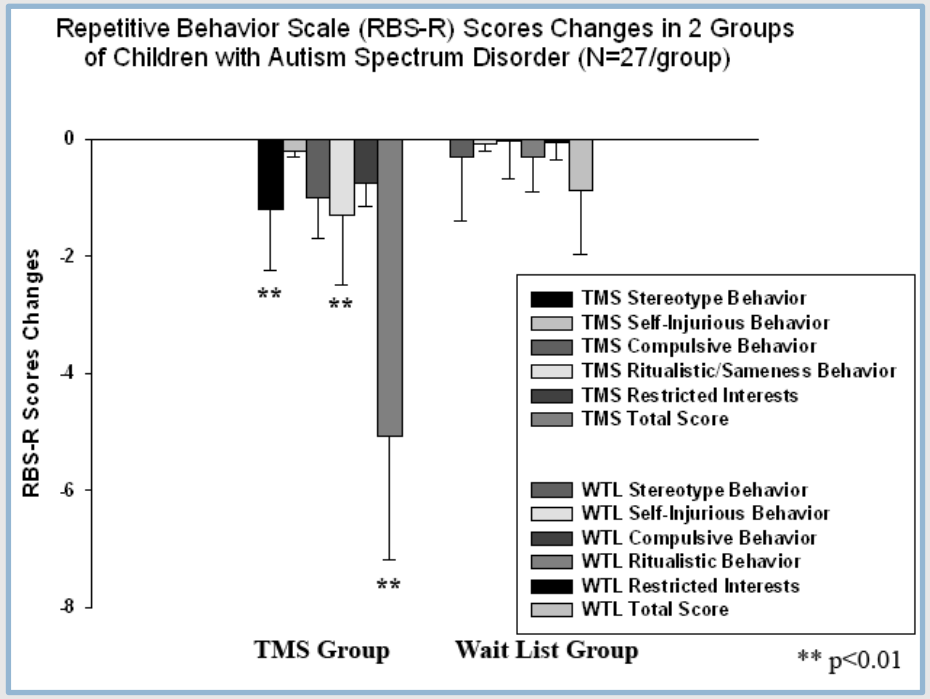
(a) R-R intervals of ECG in 18 sessions of rTMS course

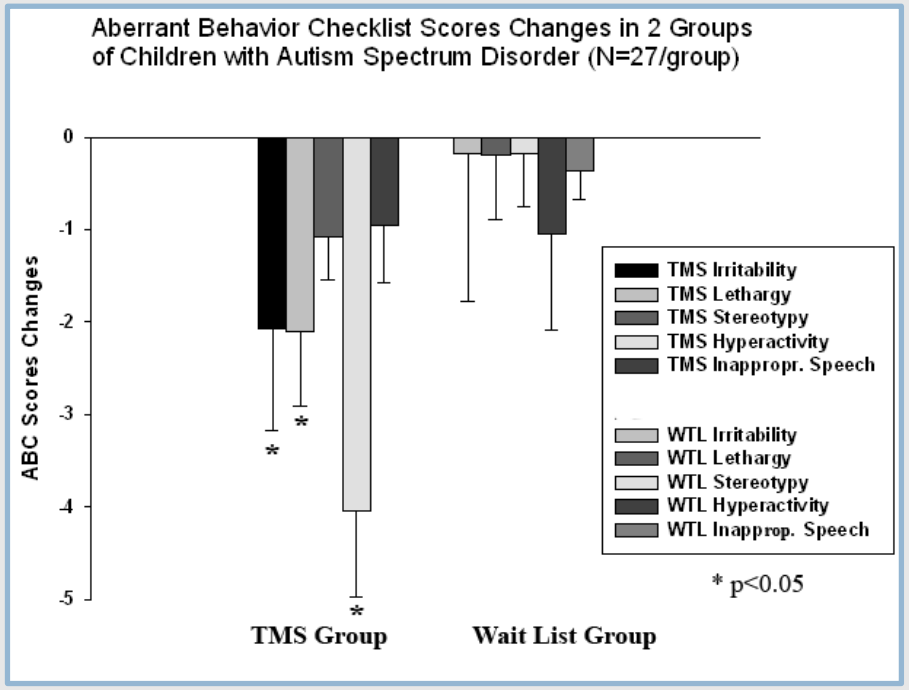


(b) Standard Deviations of R-R intervals in 18 sessions of rTMS



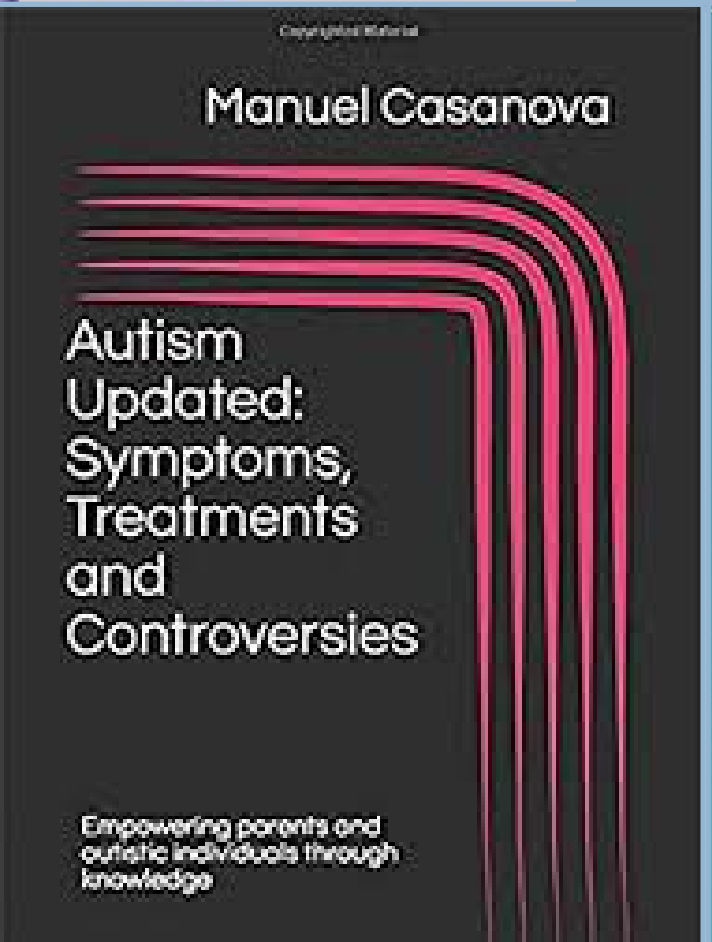
Effects of 18 Sessions of rTMS on Autism

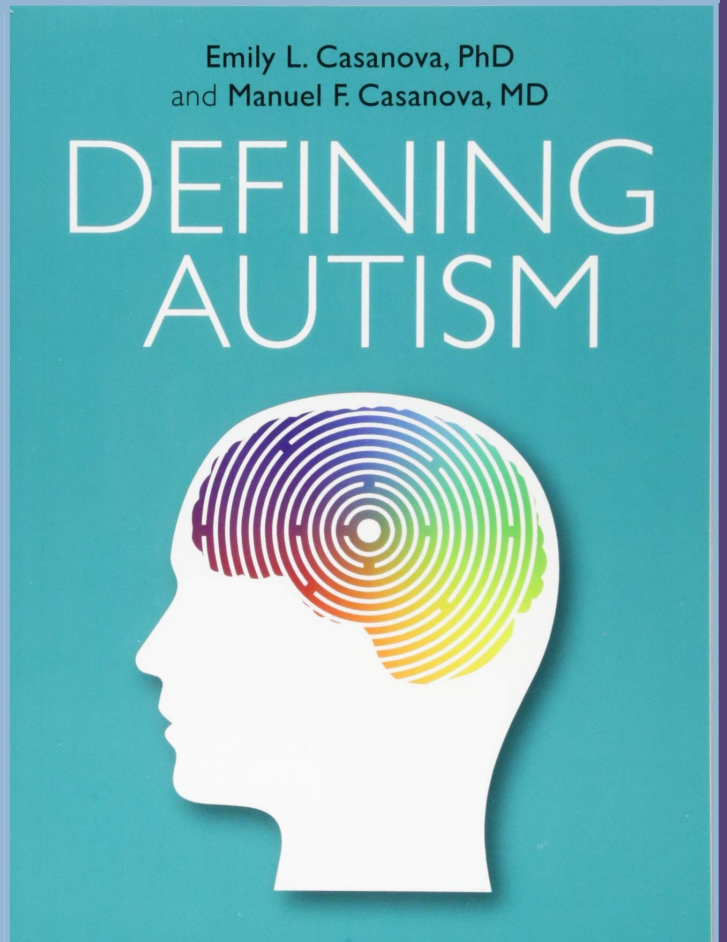




Our results showed a positive correlation of LF of HRV with Stereotyped ratings on ABC and a positive correlation of LF/HF index with Total Repetitive and Stereotyped Behaviors scores on RBS-R.

Sokhadze et al. (2014). *Front. Syst. Neurosci., 8,* 134.





MORE OF OUR WORK


That's all Folks!

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