

Human Emotion

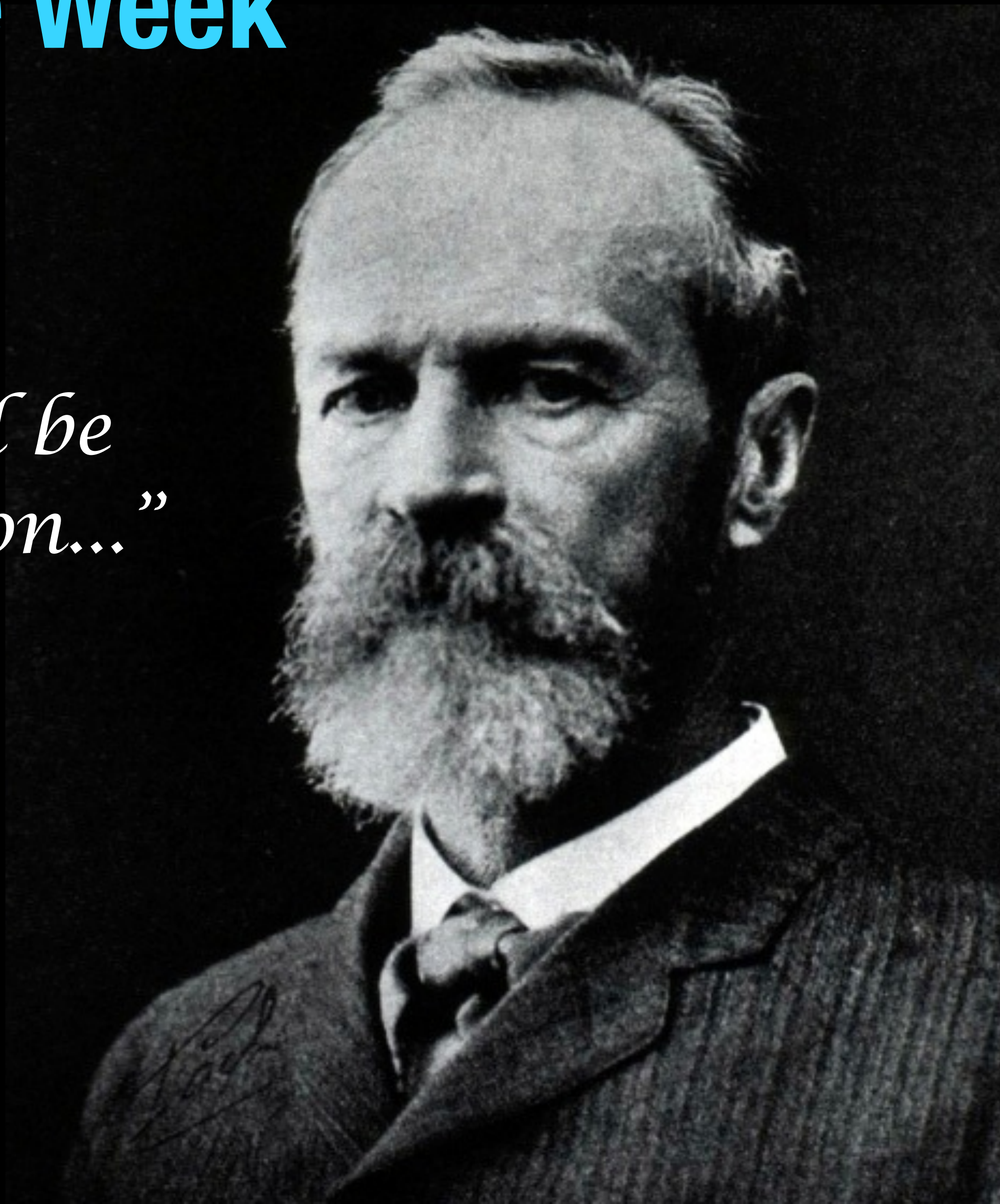
Emotion and Psychophysiology
Blood, sweat, tears, and fears?



Quote of the Week

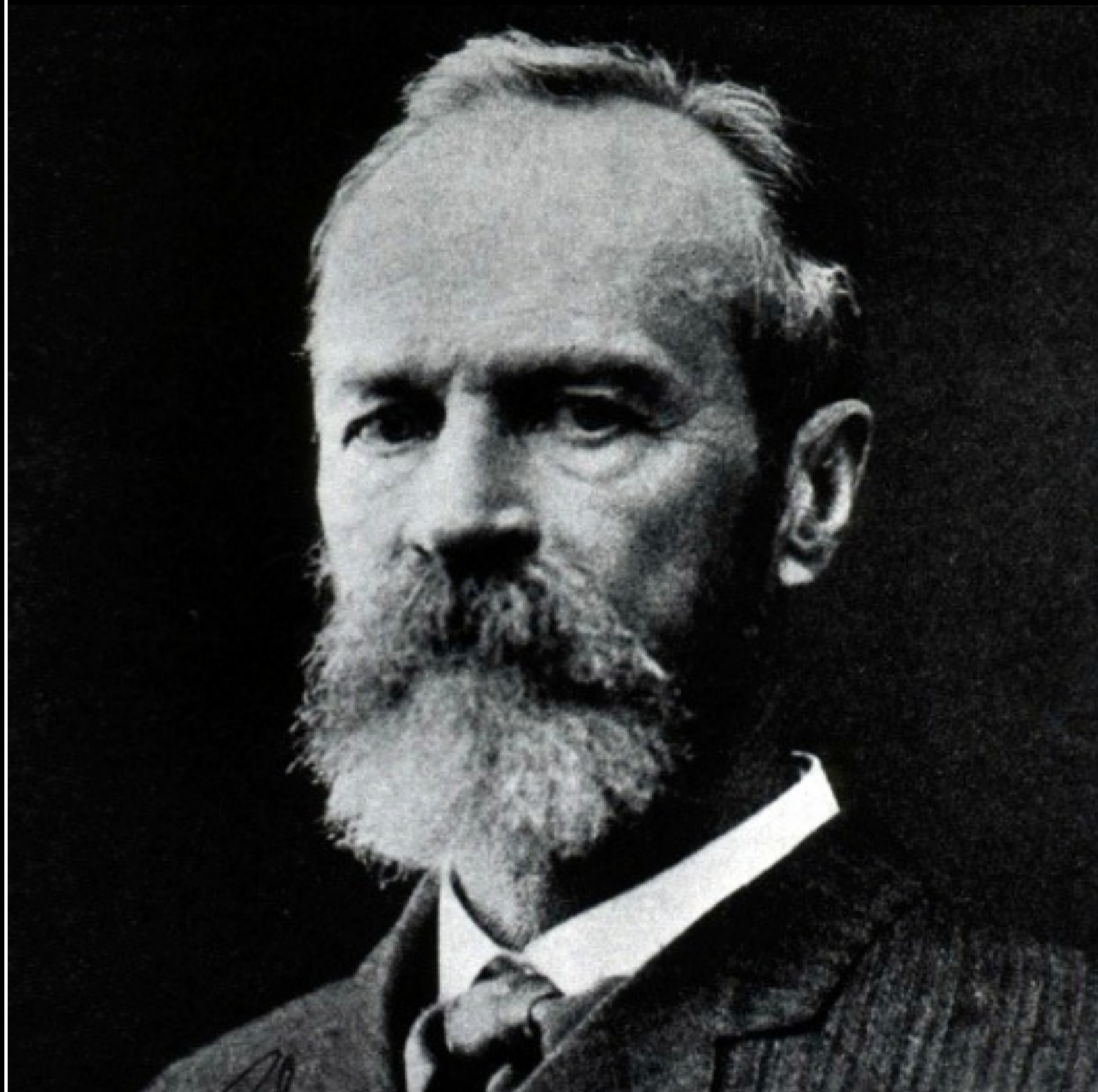
“No shade of emotion should be without a bodily reverberation...”

William James (1898)



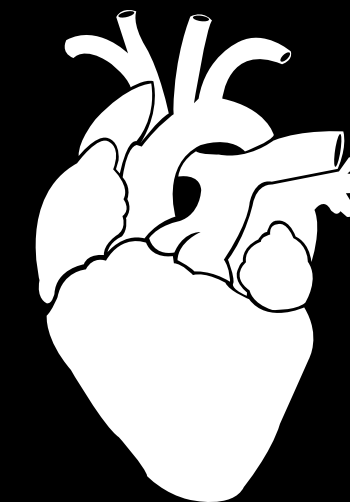
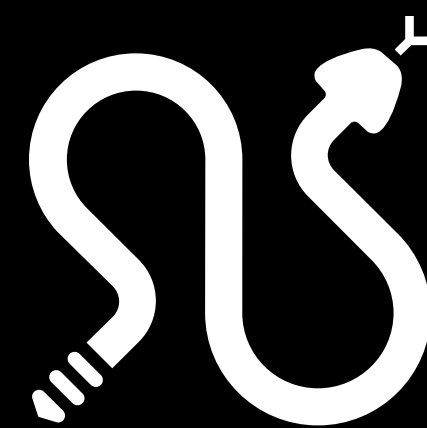
Theories of Emotion Timeline

William James



Physiological Approach

Emotions secondary to physiological phenomenon





Roadmap

Course Logistics

Definitions and Measurement

Emotion Specificity

Emotion Coherence

Take-Away Qs & Expert Interview

Course Logistics

Exam 1 - Questions?

Exam 2 - Not So Distant Future

Exam Review Sheet Handed Out Next Week in Class

Course Logistics

Project Proposals

Grades Released this Week on Canvas

Course Logistics

Outreach Project

5 minute break out, pick partner you have not yet spoken to or know from class

- Share your current project topic**
- Share your progress (where are you at)**
- Share any questions you have at this point**
- Generate “1 question” you have for class and “1 thing” you’re most excited about**

Roadmap

Course Logistics

Definitions and Measurement

Emotion Specificity

Emotion Coherence

Take-Away Qs & Expert Interview

Definitions

Psychophysiology: Definition

“The science which concerns physiological activities which underlie or relate to psychic events.”

Darrow (1964)

“The scientific study of social, psychological, and behavioral phenomena as related to and revealed through physiological principles and events in functional organisms.”

Cacioppo, Tassinary, & Berntson (2000)

“The use of a particular set of physiologically-based dependent or independent variables to gain insights into psychological questions.”

Allen (2006)

Psychophysiology: What it is NOT

Physiological psychology

Subdivision of biological psychology that studies the neural mechanisms of behavior through the direct manipulation of neural tissue in experiments.

Behavioral neuroscience

Scientific study of the neural bases of behavior and mental states.

Psychophysiology: Pros and Cons

PROS

- Get around social desirability (pressure to respond correctly)
- Provide information outside of conscious awareness
- Identify how mental and physical health are related

CONS

- Methods are sometimes difficult and expensive
- Controversy on what to infer
(e.g., does a higher heart rate = anger? sadness?
or just a sign of movement?)

The Nervous System

Central Nervous System

BRAIN +
SPINAL CORD

Peripheral Nervous System

ALL OTHER
NERVES

Autonomic Nervous System

Monitors internal world; carries out automatic processes.

Somatic Nervous System

Monitors external world; carries out voluntary processes.

Sympathetic Nervous System

Facilitates energy expenditure
(fight or flight)

Parasympathetic Nervous System

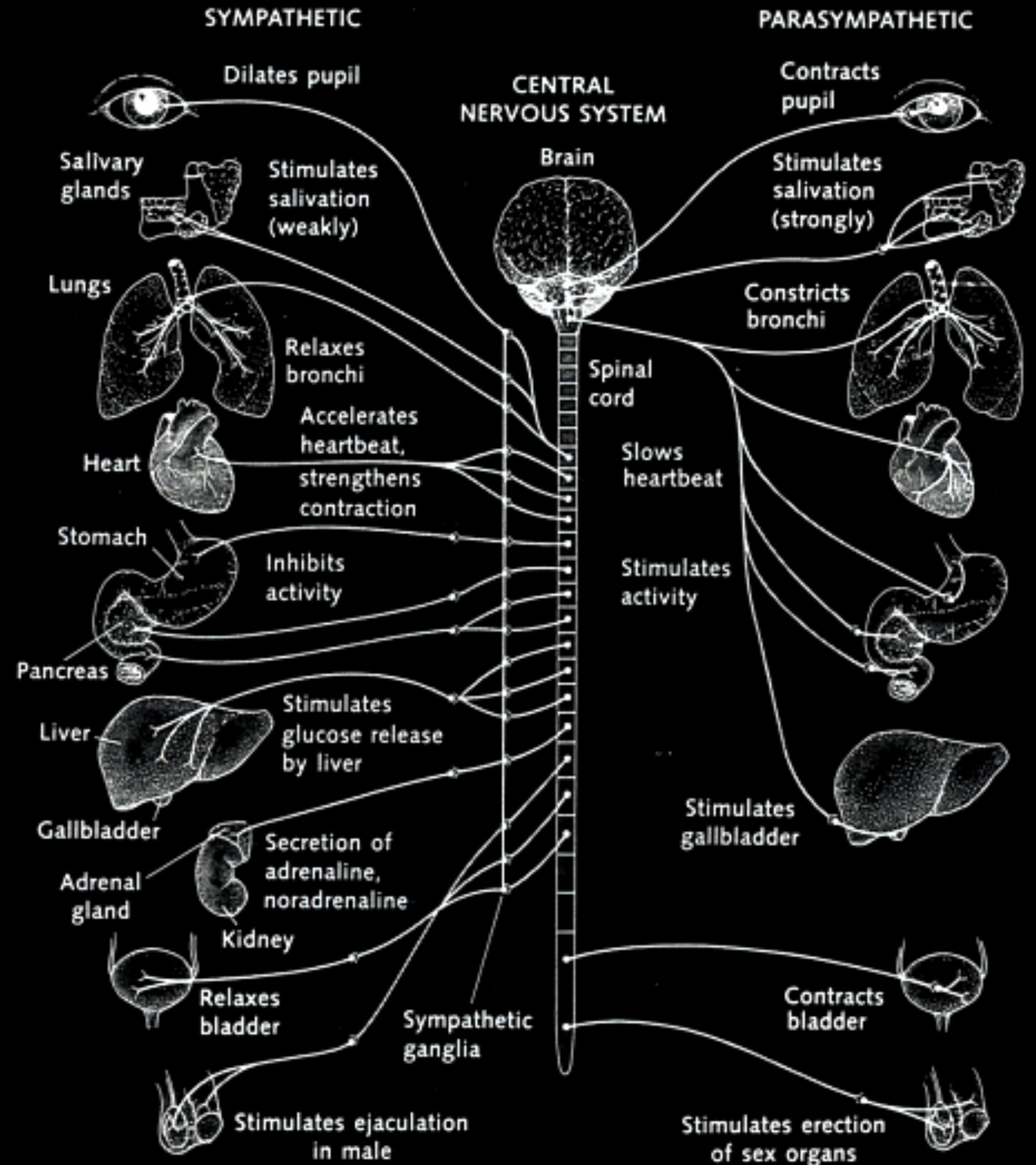
Facilitates energy storage
(rest and digest)

Sympathetic Nervous System (SNS)

Fight or Flight, Excitatory

Parasympathetic Nervous System (PNS)

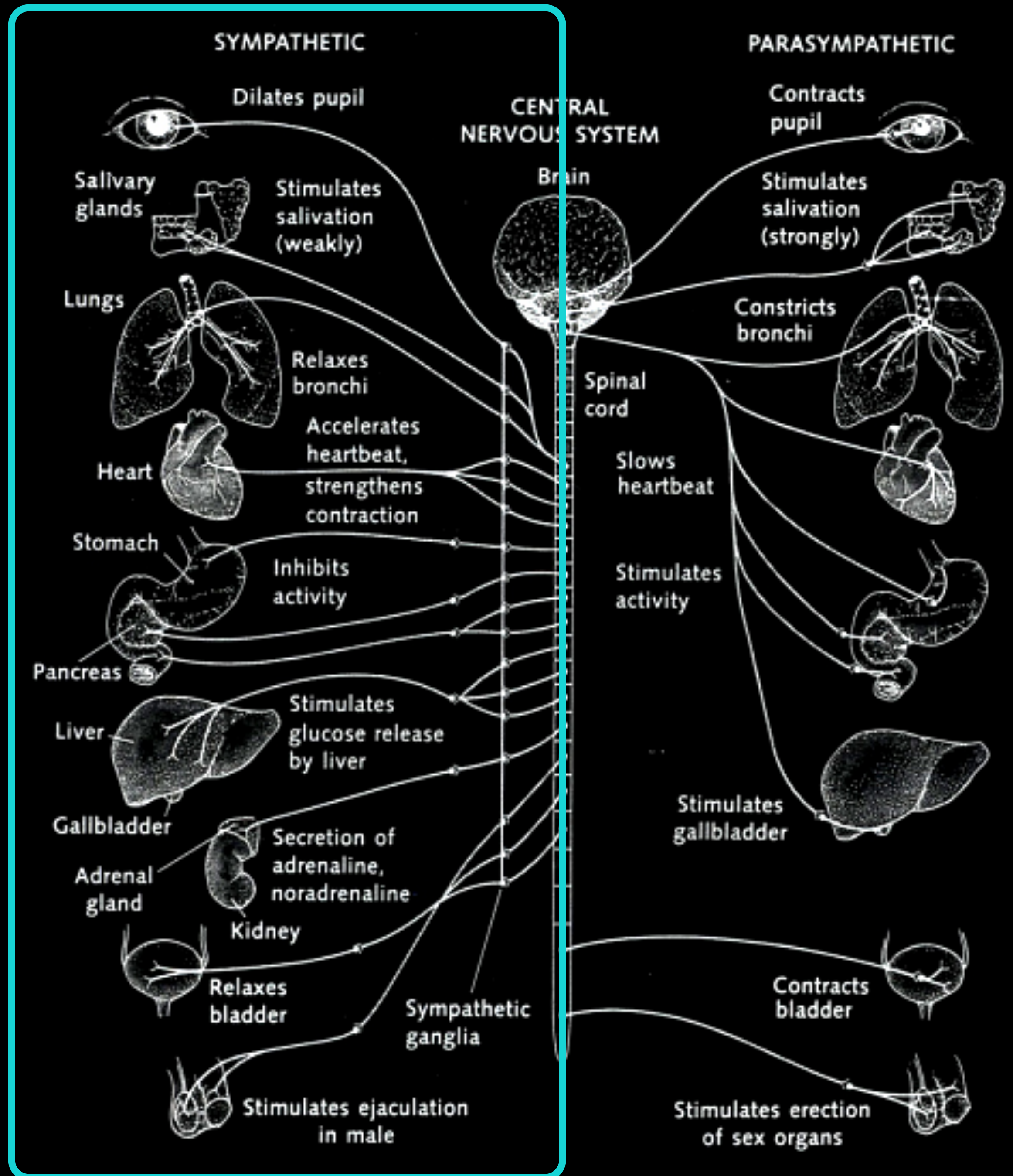
Rest and Digest



Sympathetic Nervous System (SNS)

Fight or Flight, Excitatory

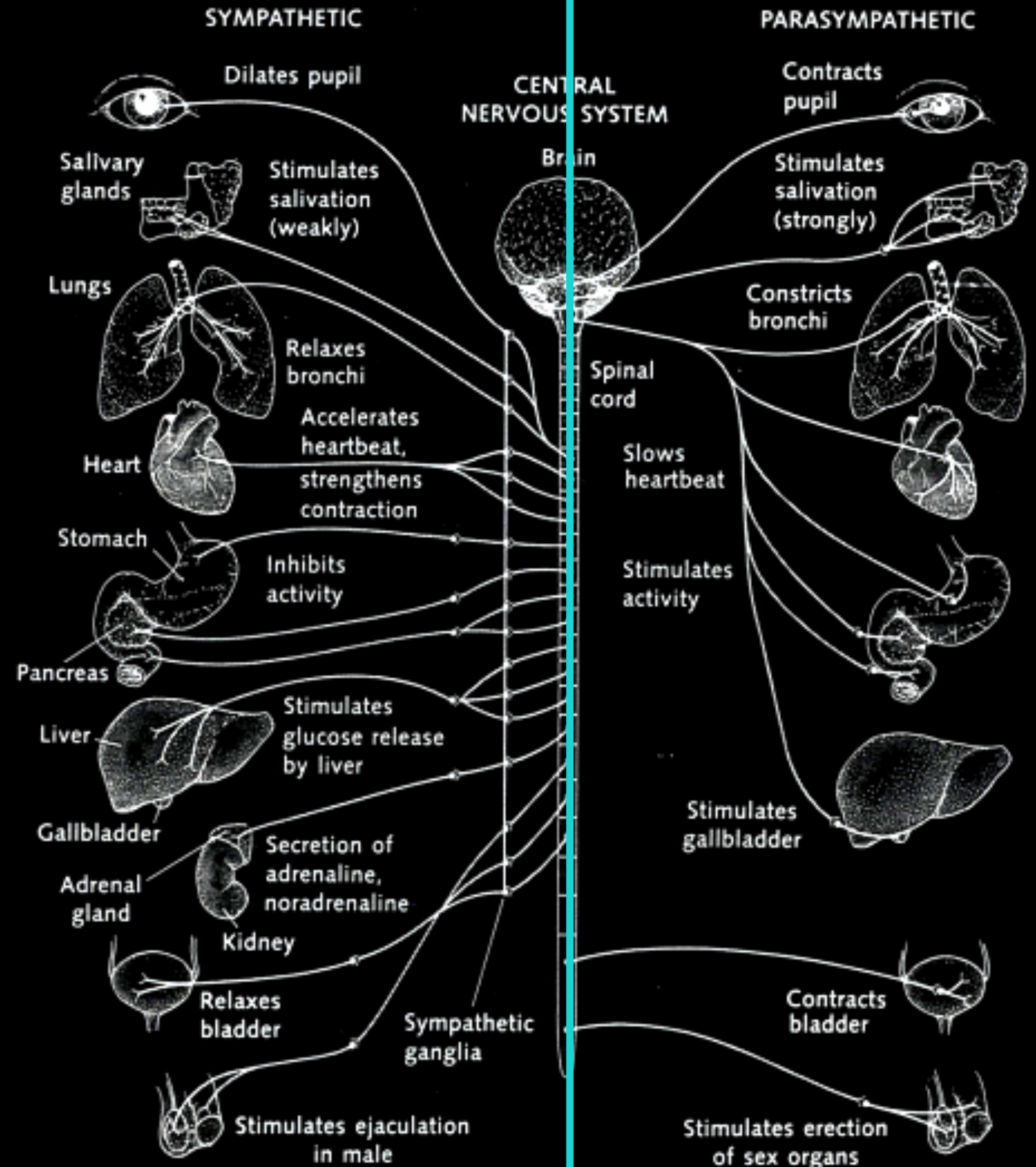
- Causes release of catecholamines (epinephrine and norepinephrine) from adrenal medulla
- Increases heart rate and blood pressure
- Slows digestion
- Dilates pupils



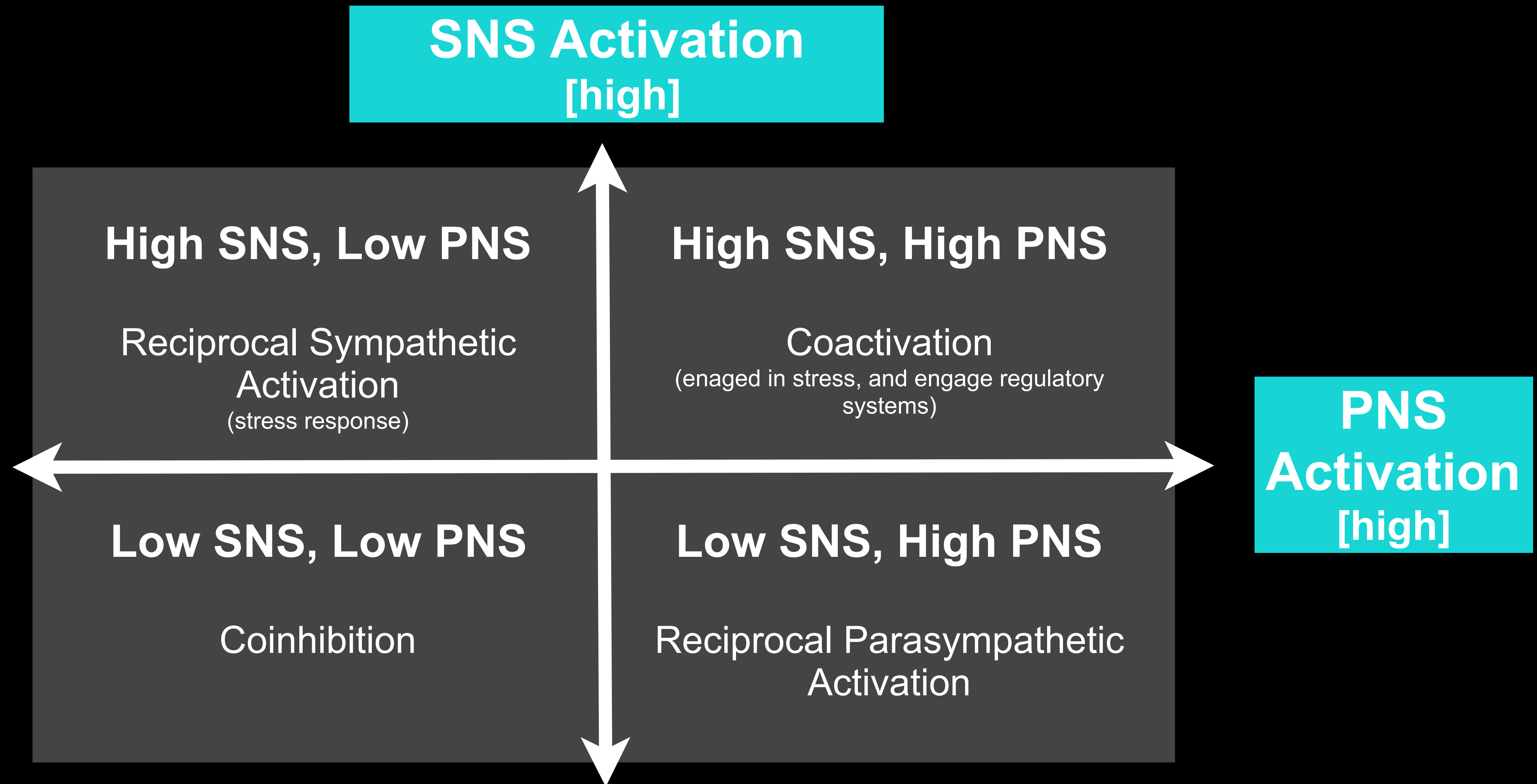
Parasympathetic Nervous System (PNS)

Rest and Digest

- Facilitates energy storage
- Decreases heart rate and blood pressure
- Activates digestion
- Contracts pupils
- Vagus nerve (“wandering”)



ANS INTERACTION PROFILES



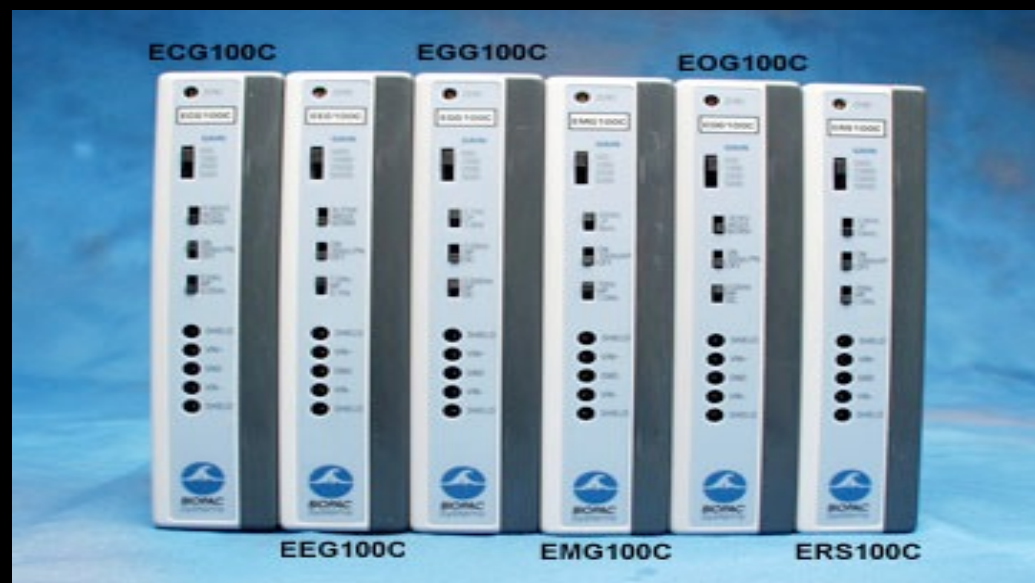
Measurement

Inside the Lab

Grass Model 7

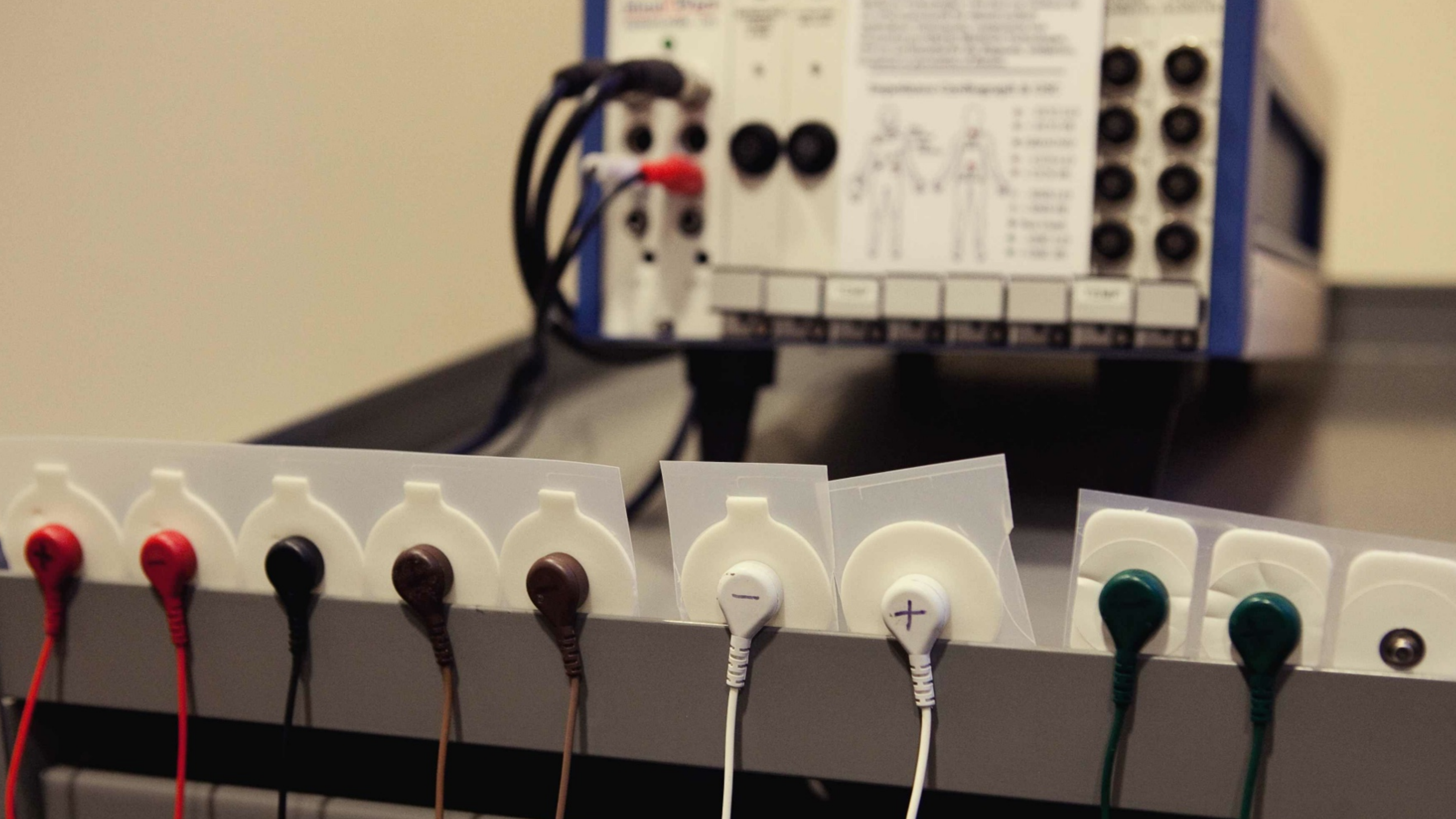


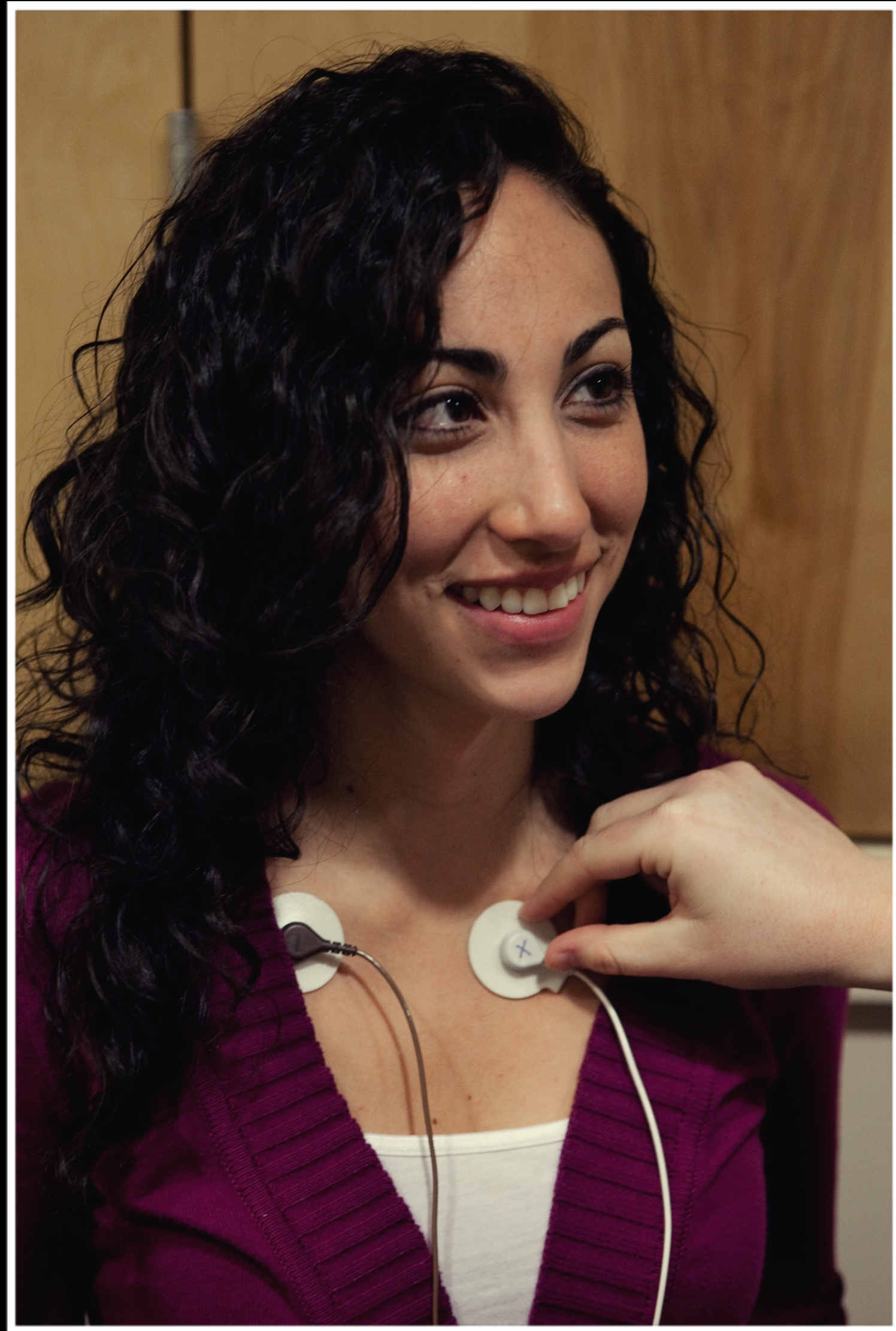
Biopac



MindWare







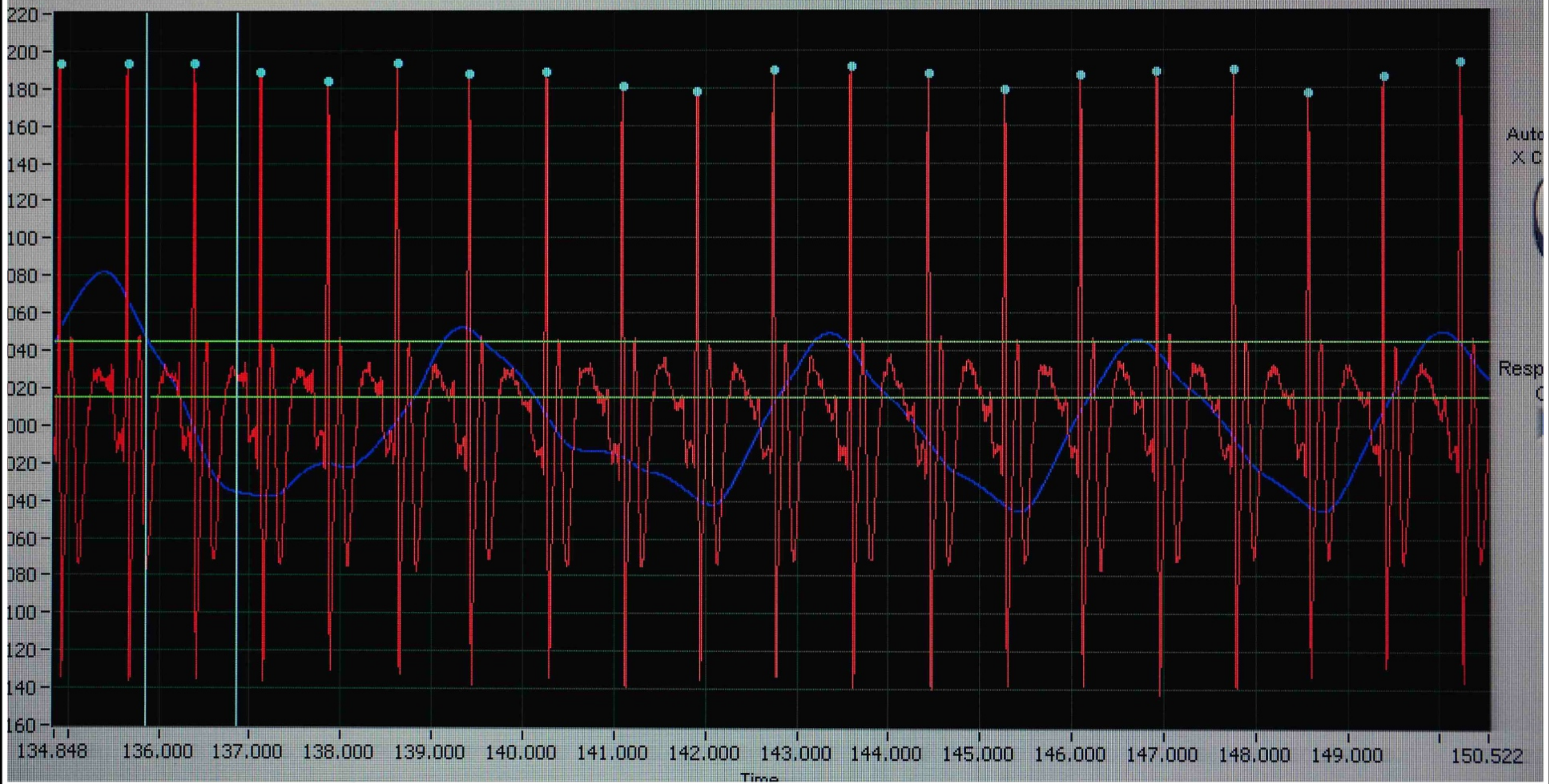


Come on and
twist a little
closer now!
(Twist a little
closer)



15.67
SENSITIVITY High
Snap to Peak ON
Time Window (s) 0.100
Midbeat AutoPeak ON
Midbeat Time Window from R Peaks (s) 0.100
Cursor Pos X High 135.848
Cursor Pos Y High 0.00
Delta X 1.000
Delta Y 0.00
Cursor Pos X Low 135.848
Cursor Pos Y Low 0.00

Delete (F1) Insert (F2) Set X cursors Position Set Y cursors Position Delete all pts between X cursors Delete all pts between Y cursors Remove Data Portion Midbeat Reset Artifact Detect Settings



Outside the Lab

Ambulatory Physiology *Biopac Bioharness (Zephyr)*

Heart Rate (HR)
Skin Temperature (SKT)
Respiratory Sinus Arrhythmia (RSA)
Gross somatic movement



Electrodermal

Cardiovascular

Blood Flow & Temperature

Electrodermal

Cardiovascular

Blood Flow & Temperature

Electric Meter Tests Skin to Gauge Emotion



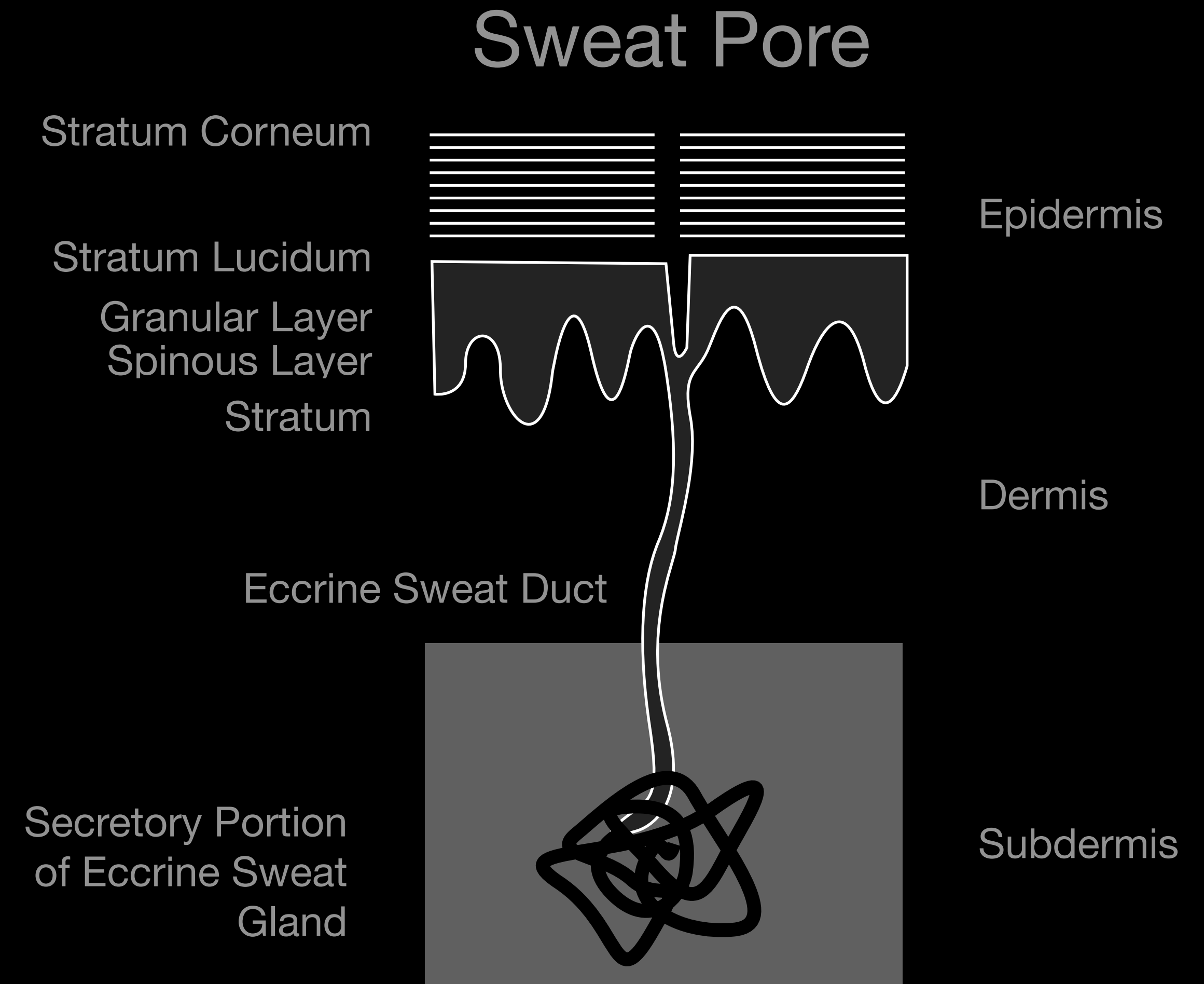
Emotions shown on faces in background are recorded by instrument sensitive to electric resistance of skin. Scientist is testing young women

Call it an emotion meter, lie detector or what you will, an electric device contrived by Dr. D. Urich Greenwald at the University of Iowa draws a curve of your emotions as they run the gamut of joy, horror, fear, surprise, love. As you react to some stimulus that "gets under your skin," the electric needle reacts to emotional changes in resistance in your skin. Used by Dr. Christian A. Ruckmick in studies of emotion, this instrument is called a dermohmograph; *derm* for skin, *ohm* for electrical resistance, *graph* for its record on photographic paper. The scientists theorize that human emotion causes a piling up of positive and negative ions on the walls of skin cells, affecting resistance of the skin to passage of electricity. Essentially the emotion meter consists of dry cells, electrodes, fixed and variable resistances and a galvanometer. By reading the galvanometer while the subject watches a motion picture or reads a letter, his emotional reaction can be seen. For recording purposes, the deflection of the galvanometer guides a beam of light striking a moving roll of sensitized paper.

Fun Sweat Gland Facts

- 2-3 million on body. Most dense in palms of hands and soles of feet.
- Two kinds
 1. Apocrine Glands: armpits, genitals, give off odor
 2. Eccrine Glands: all over body, involved in thermoregulation, respond to stress, **EMOTION**, attention.

***EMOTION RESEARCHERS MEASURE ECCRINE GLANDS ON PALMS OF HANDS**



	Sympathetic	Parasympathetic
Electrodermal Activity (EDA)	Increase sweating <i>(provides firm grip in fight-flight situation)</i>	None

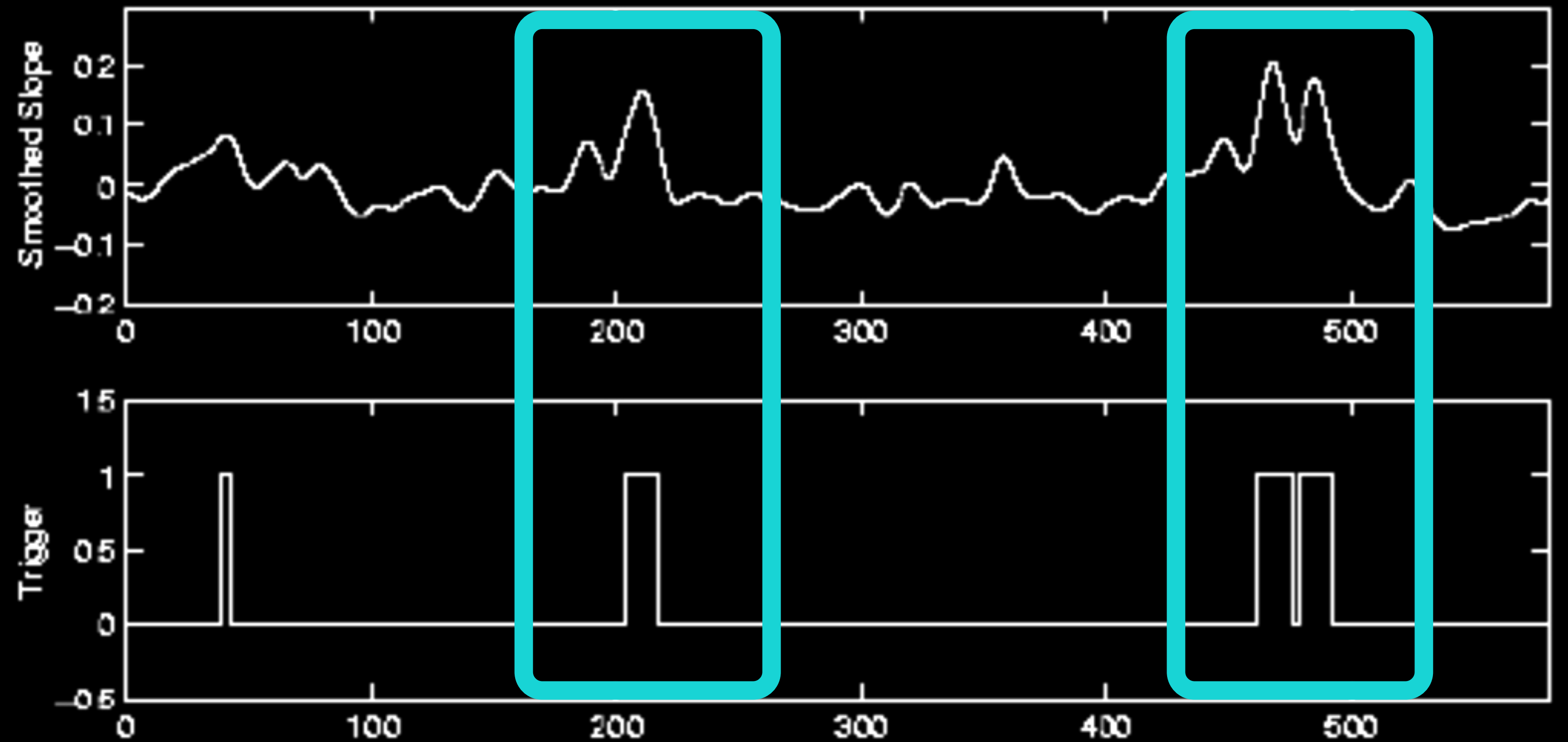
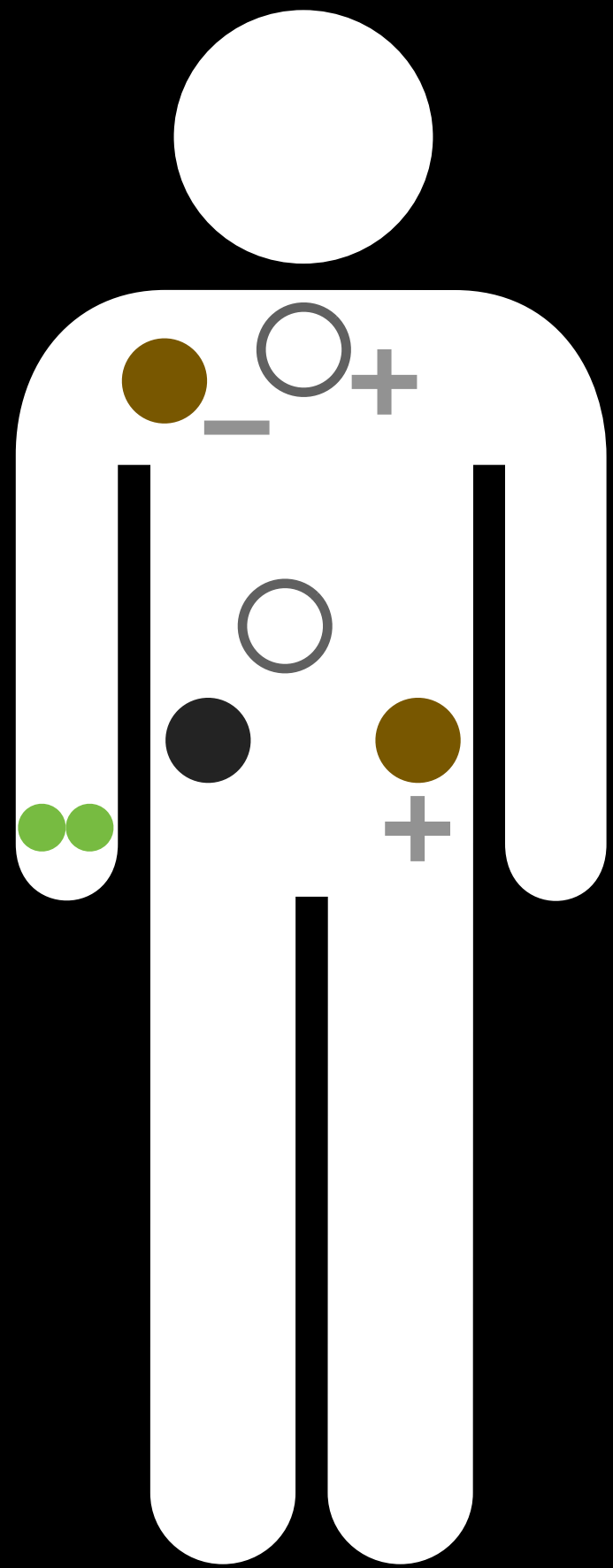
EDA: Also referred to as Galvanic Skin Response (GSR) or Galvanic Skin Conductance (GSC). Relatively undiluted measurement of SNS activity. Assesses secretion of sweat from the eccrine glands which are directly innervated by the SNS. Amount of sweat increases as SNS activity escalates.

How it works:

- **2 sensors** placed on hand palms (or finger phalanges) with a saline (NaCL) conductive paste.
- Pass a **0.5v current** between two sensors.
- As sweat increases, provides a more **conductive path**, and thus greater current (proportional to amount of sweat released).
- This signal is transmitted through a transducer and appears in digital display on computer monitor.
- Measured in units called “**micro siemens**”



EDA (GSR) Signal

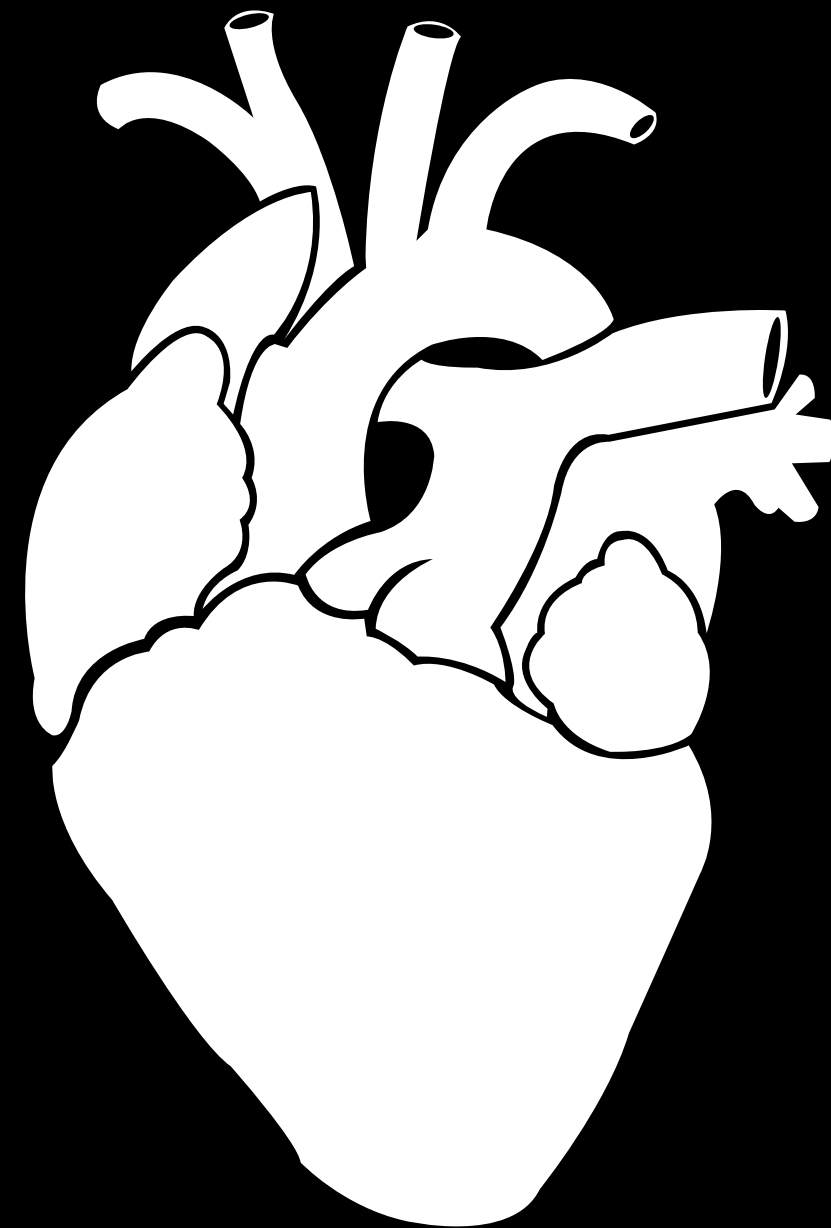


Electrodermal

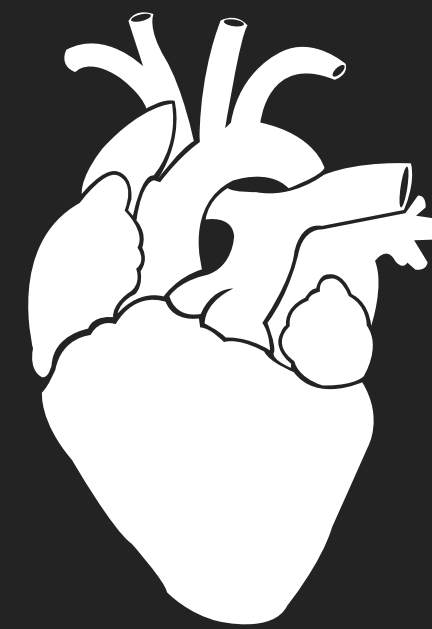
Cardiovascular

Blood Flow & Temperature

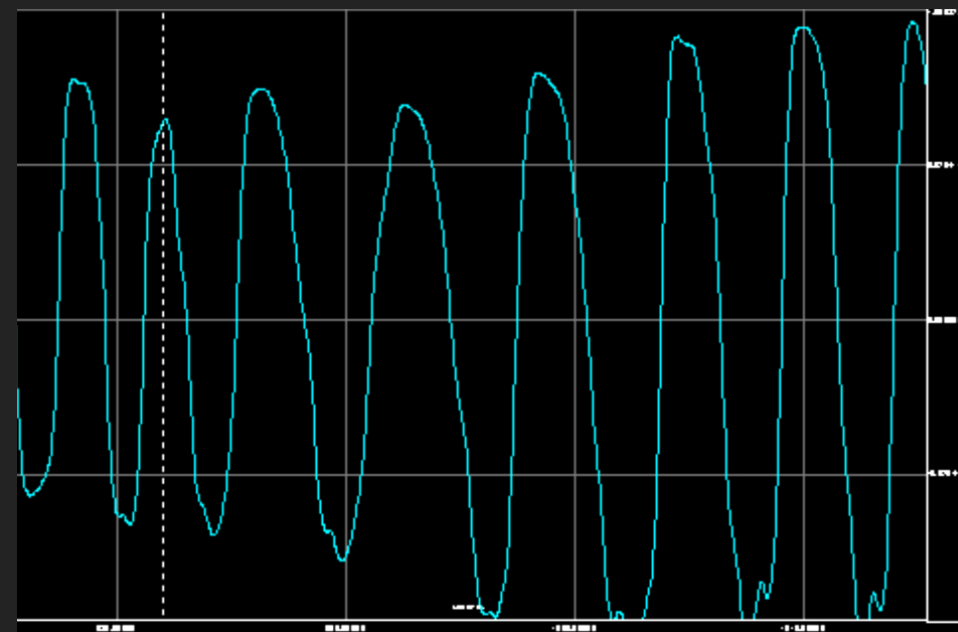
Heart Rate Variability



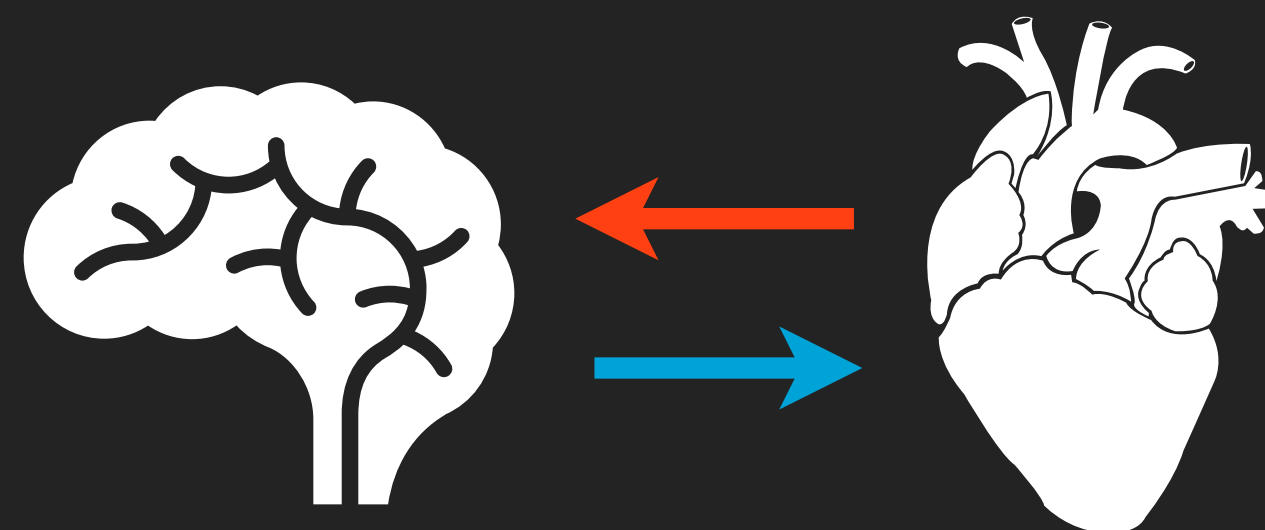
Cardiovascular Measures



Heart Rate (HR)
Inter-beat Interval (IBI)

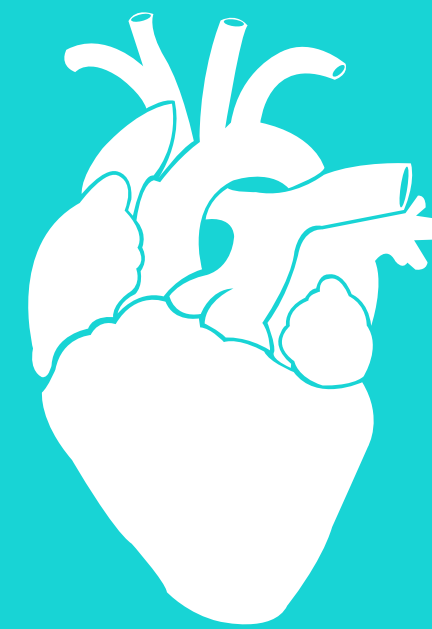


Respiratory Frequency

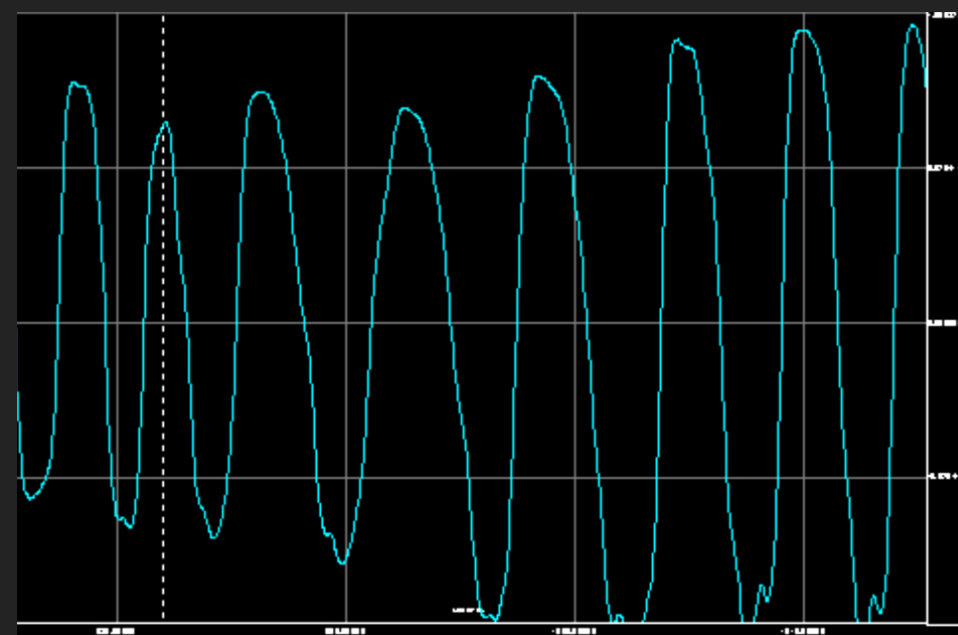


Respiratory Sinus Arrhythmia (RSA)
High Frequency Heart Rate Variability (HRV)

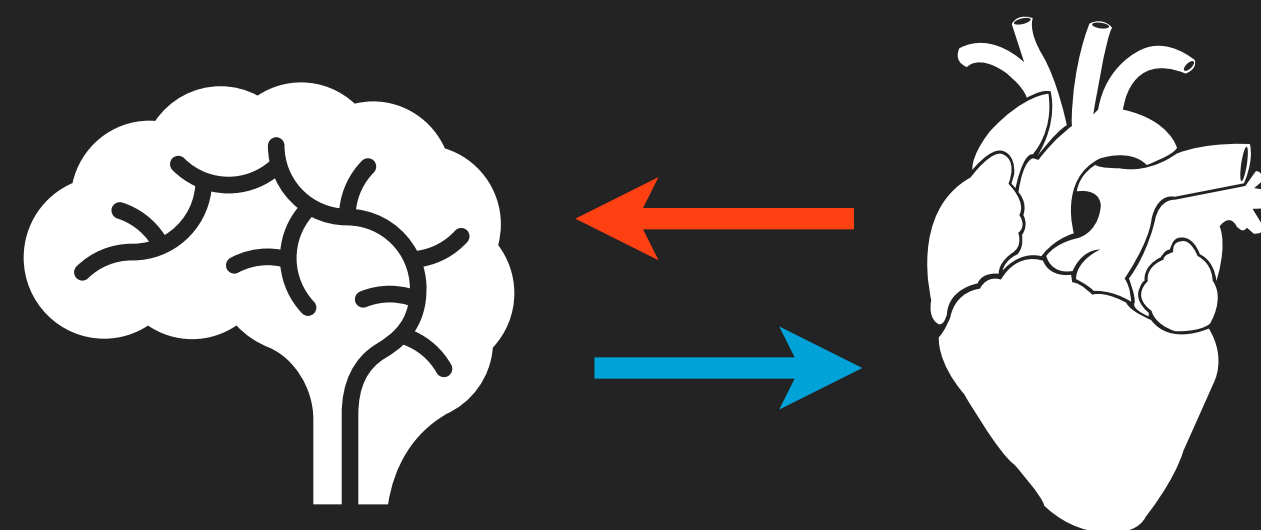
Cardiovascular Measures



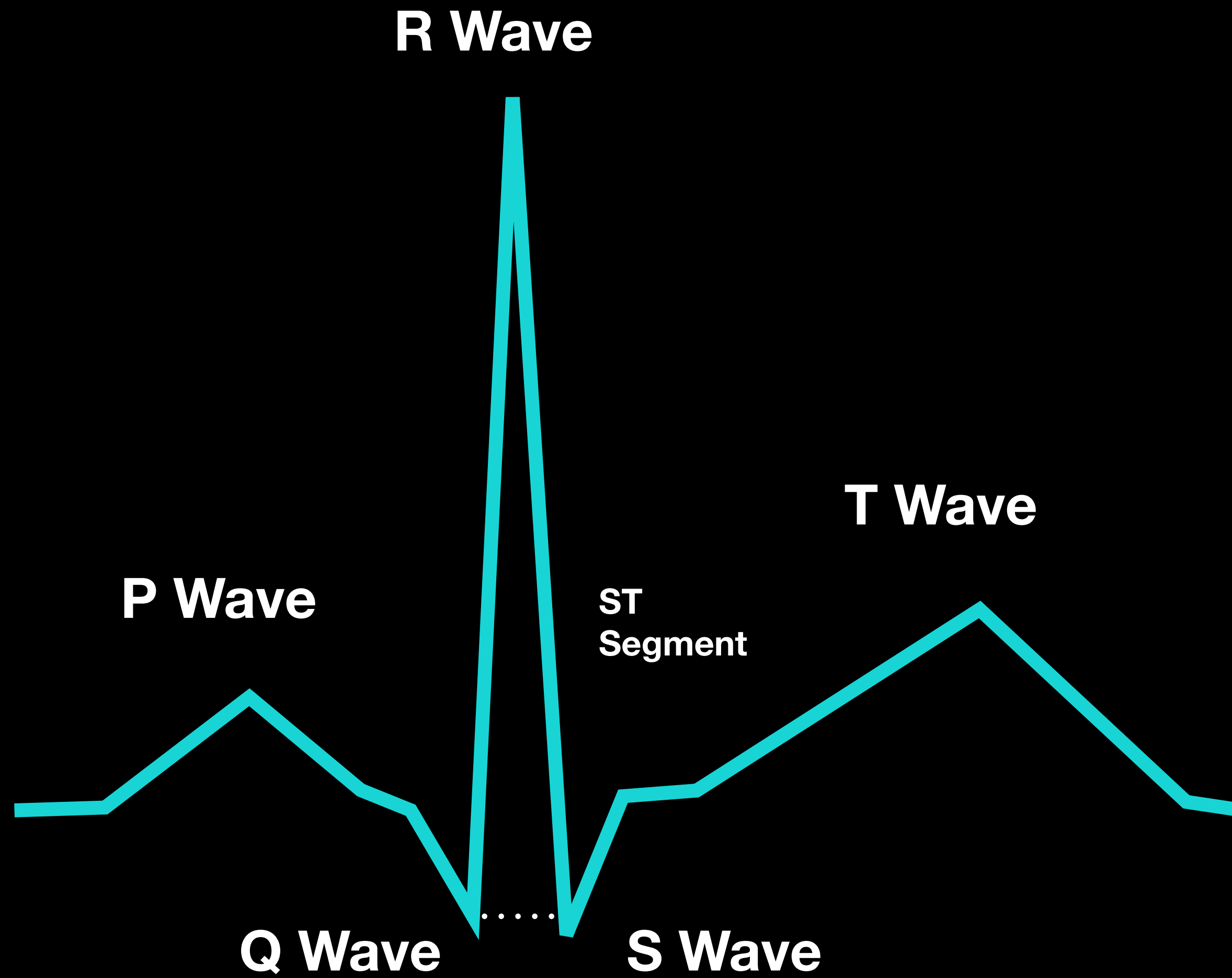
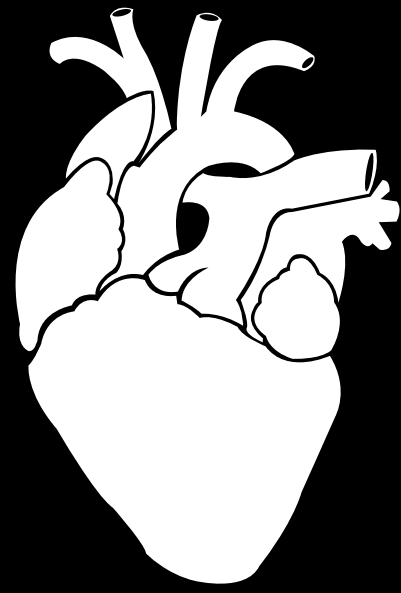
Heart Rate (HR)
Inter-beat Interval (IBI)



Respiratory Frequency



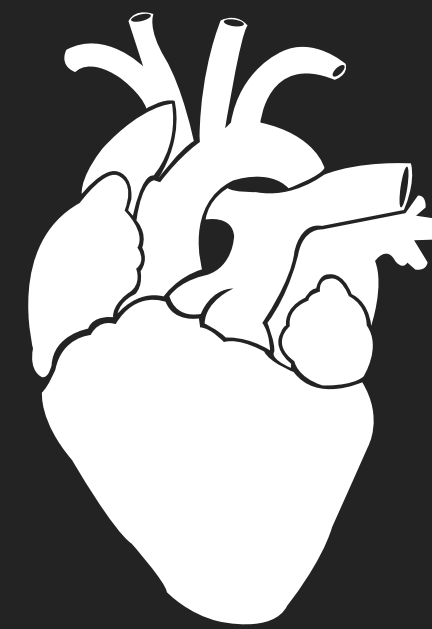
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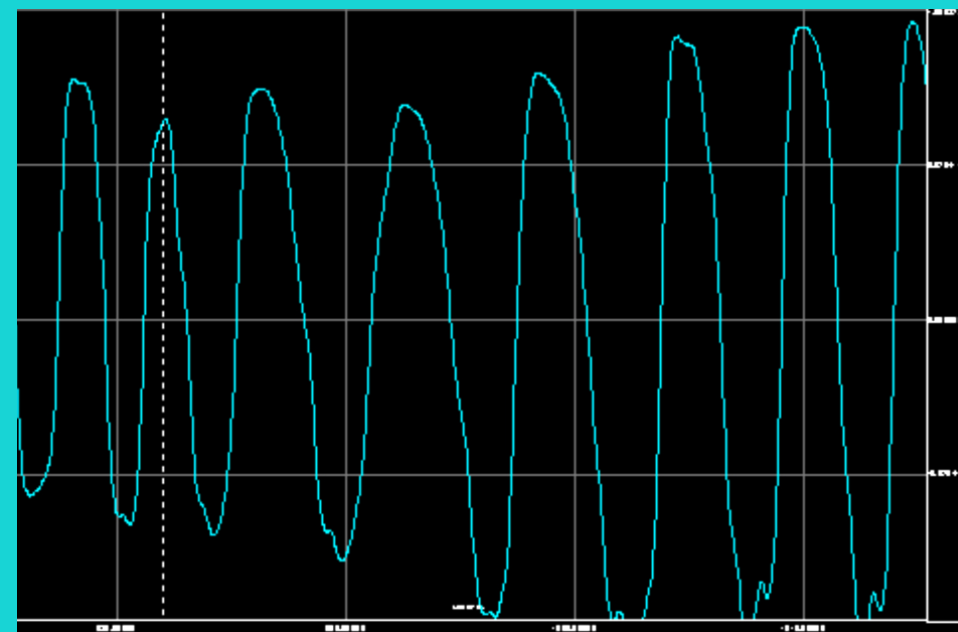
P = Atrial depolarization
QRS = Ventricular depolarization
T = Ventricular repolarization

Measure	Physiological System	Correlated Psychological Constructs	Units
Heart Rate (HR)	Sympathetic and Parasympathetic, Cardiac	Effort, Activation, Emotional Arousal	Beats per minute
Inter-beat Interval (IBI)	Sympathetic and Parasympathetic, Cardiac	Effort, Activation, Emotional Arousal	Milliseconds (time between R-spikes in ECG signal, or time between successive heartbeats). It bears a direct relationship with HR, such that a HR of 60 will be equal to an IBI of 1000 msec (1 second in between beats).

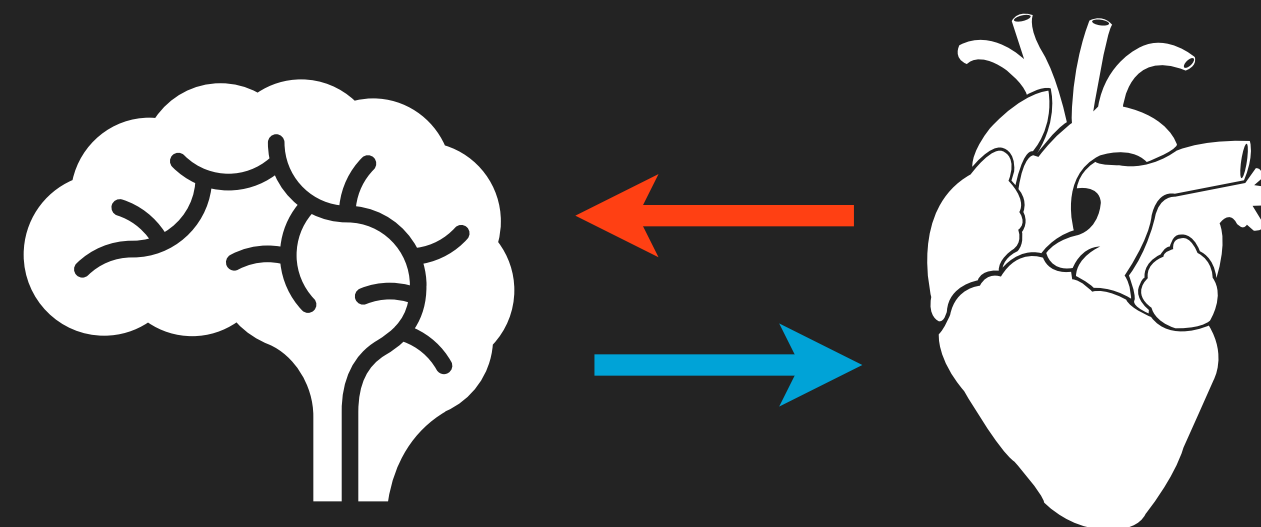
Cardiovascular Measures



Heart Rate (HR)
Inter-beat Interval (IBI)



Respiratory Frequency



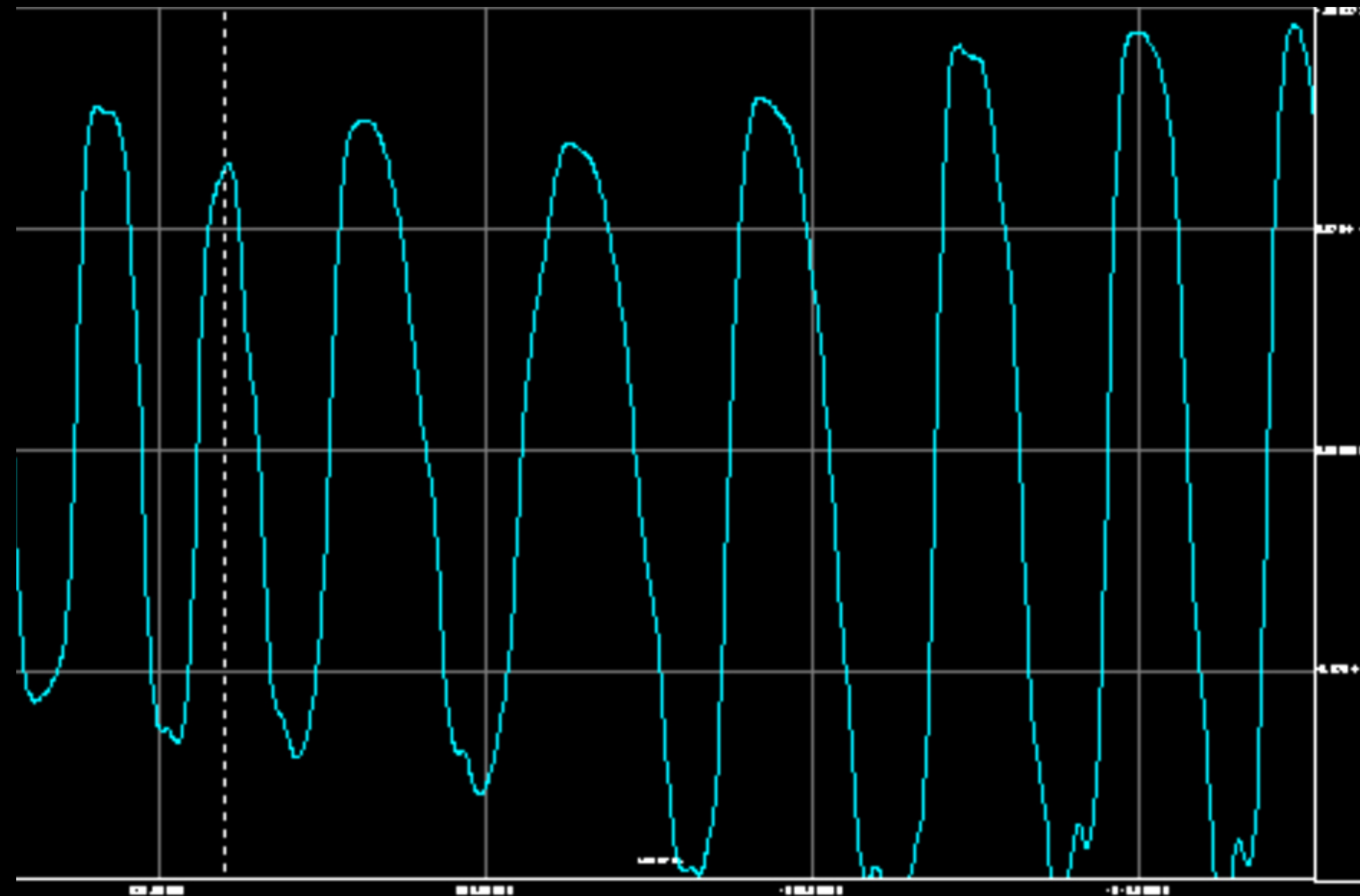
Respiratory Sinus Arrhythmia (RSA)
High Frequency Heart Rate Variability (HRV)
(Vagal Tone/Parasympathetic Nervous System)

Measure	Physiological System	Correlated Psychological Constructs	Units
Respiration Rate (RESP)	Sympathetic	Effort, Active Coping, Challenge Appraisals	Breaths per minute (freq. of an entire respiratory inspiration & expiration cycle)

INHALATION



EXHALATION

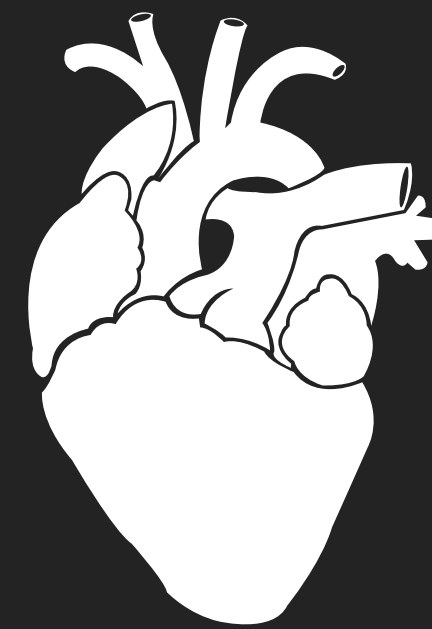


Measured as:

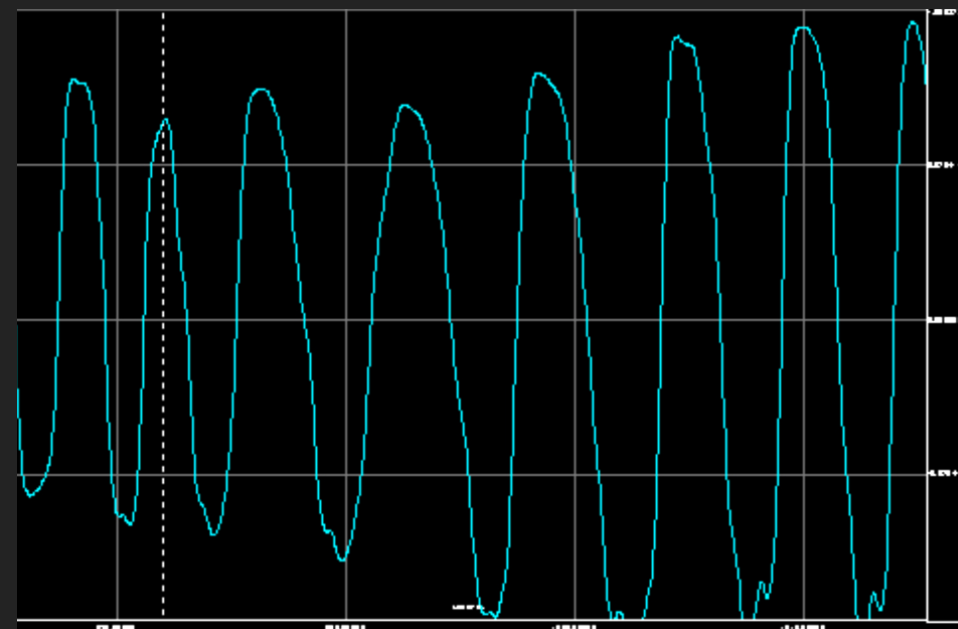
Frequency: Breaths Per Minute

Volume: Tidal Volume of Air

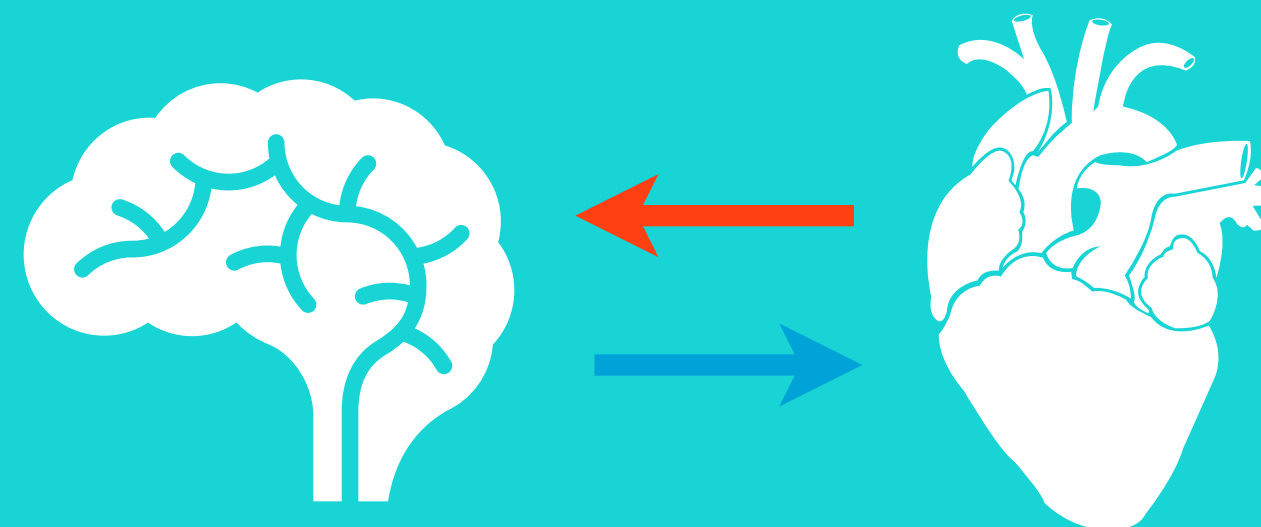
Cardiovascular Measures



Heart Rate (HR)
Inter-beat Interval (IBI)

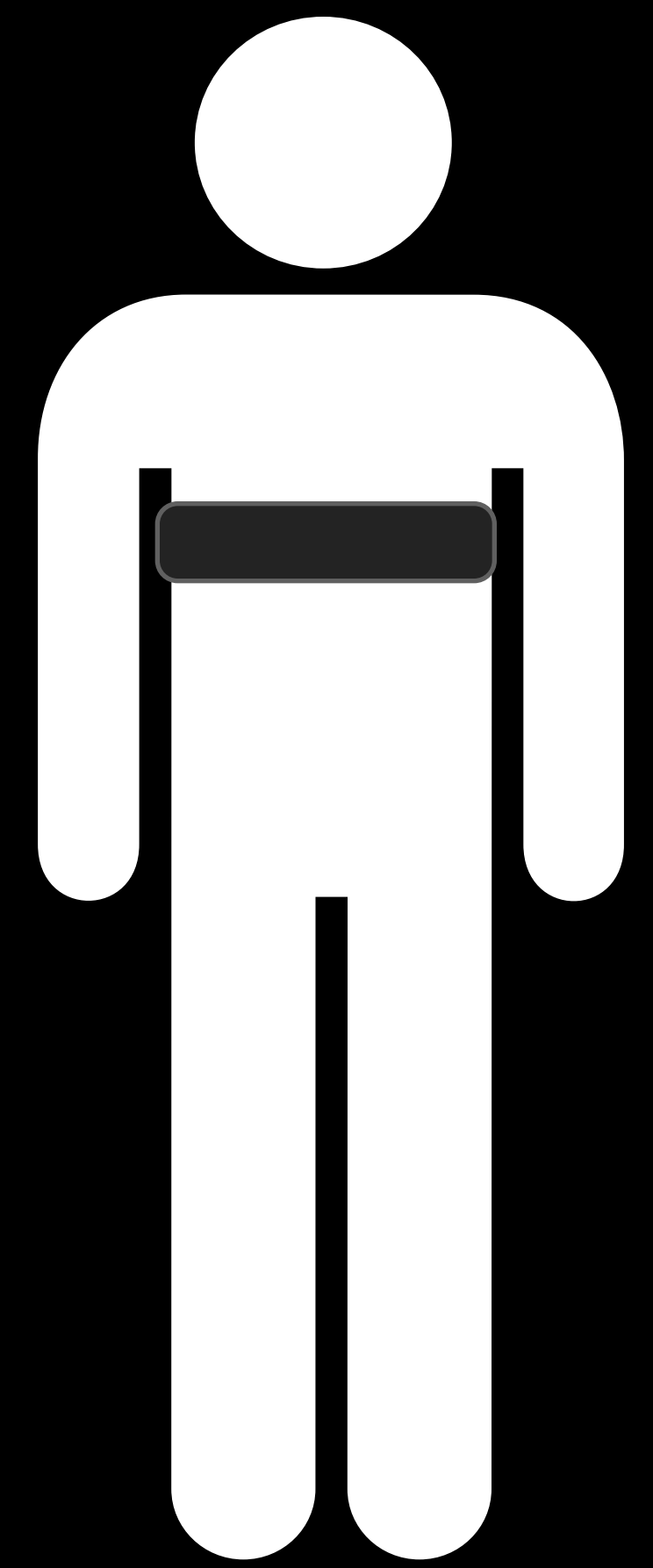
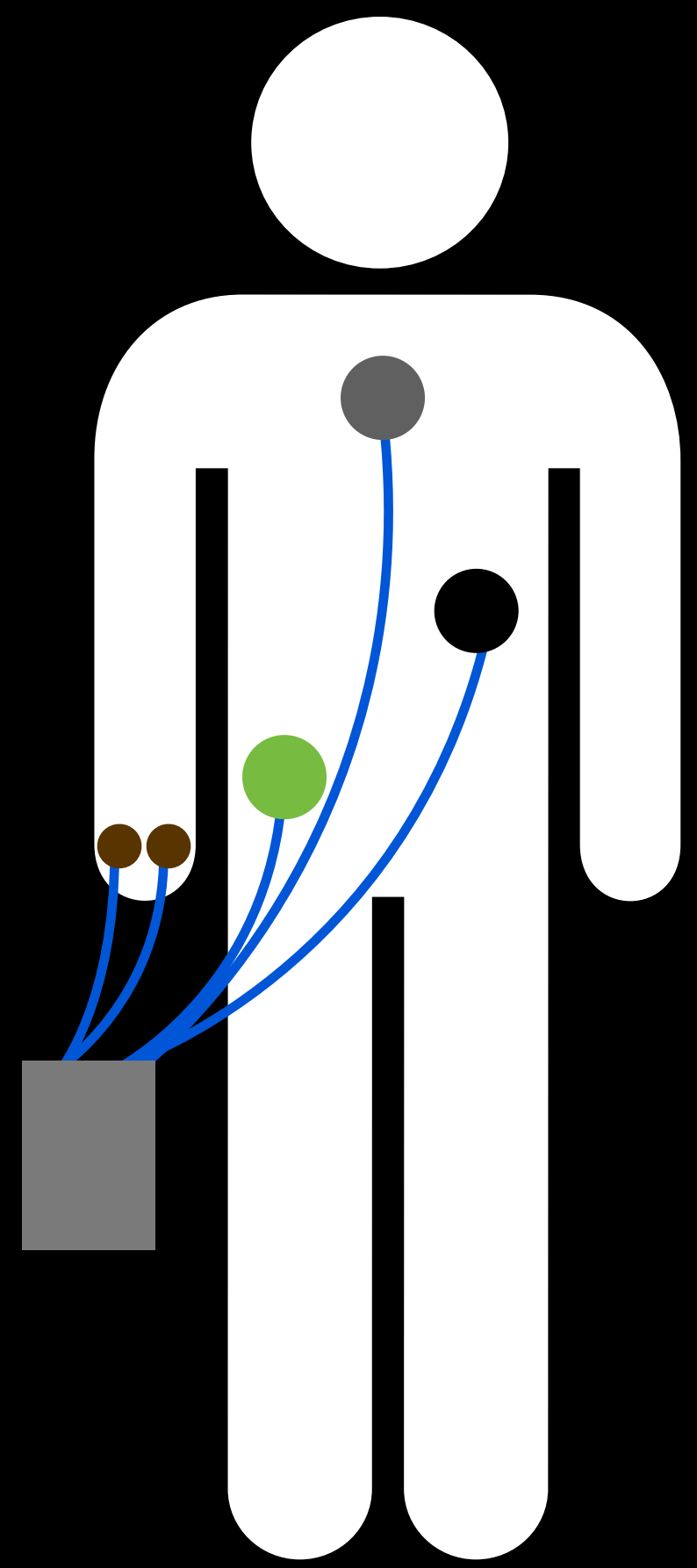


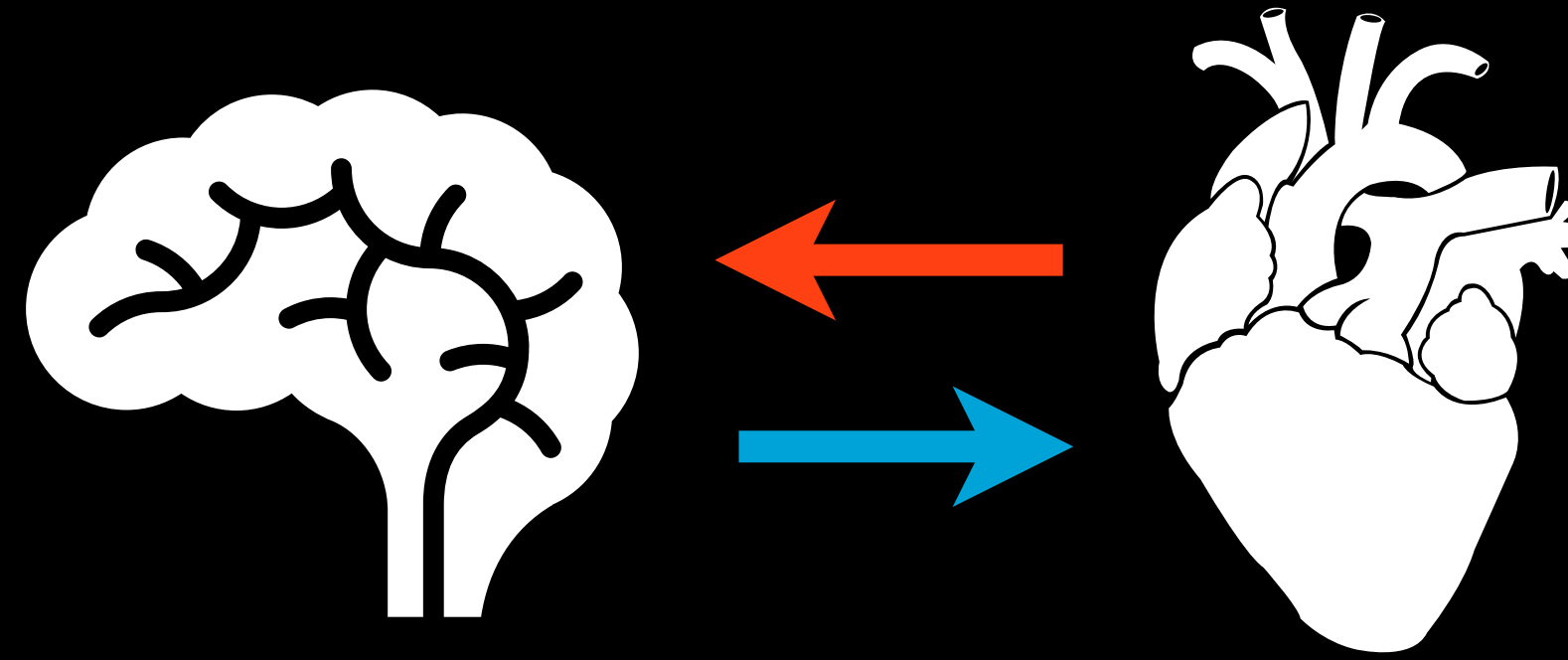
Heart Rate (HR)
Inter-beat Interval (IBI)



Respiratory Sinus Arrhythmia (RSA)
High Frequency Heart Rate Variability (HRV)
(Vagal Tone/Parasympathetic Nervous System)

Measure	Physiological System	Correlated Psychological Constructs	Units
<p>Heart Rate Variability (HRV)</p>	<p>Parasympathetic (Time Domain Approach: High Freq. Bandwidth - 0.15-0.40Hz) Porges Approach</p>	<p>Examination of physiological rhythms that exist in the beat-to-beat interval of the ECG signal that covary with respiration. HRV involved performing frequency domain analysis of human ECG data to extract standard HRV measures.</p>	<p>msec² in high frequency bandwidth</p>
<p>Respiratory Sinus Arrhythmia (RSA)</p>	<p>Parasympathetic (peak valley approach) Grossman Approach</p>	<p>RSA refers to the natural variation in heart rate due to respiratory factors. During inspiration, the heart period (distance between R-spikes) becomes smaller; during expiration, the heart period increases.</p>	<p>msec</p>





RSA & HRV: Measure of PNS Activity (Porges, 1998; 2001)

Vagal tone = PNS activity. Quantified as either RSA or HRV (High Freq.)

RSA/HRV = Measure of heart rate variability linked to breathing

↑ Vagal tone = PNS; positive mood and relaxation (*apply vagus nerve brake*)

↑ Vagal Tone

Positive emotion

(Oveis, et al., 2009; Porges, 1992)

Emotion regulation

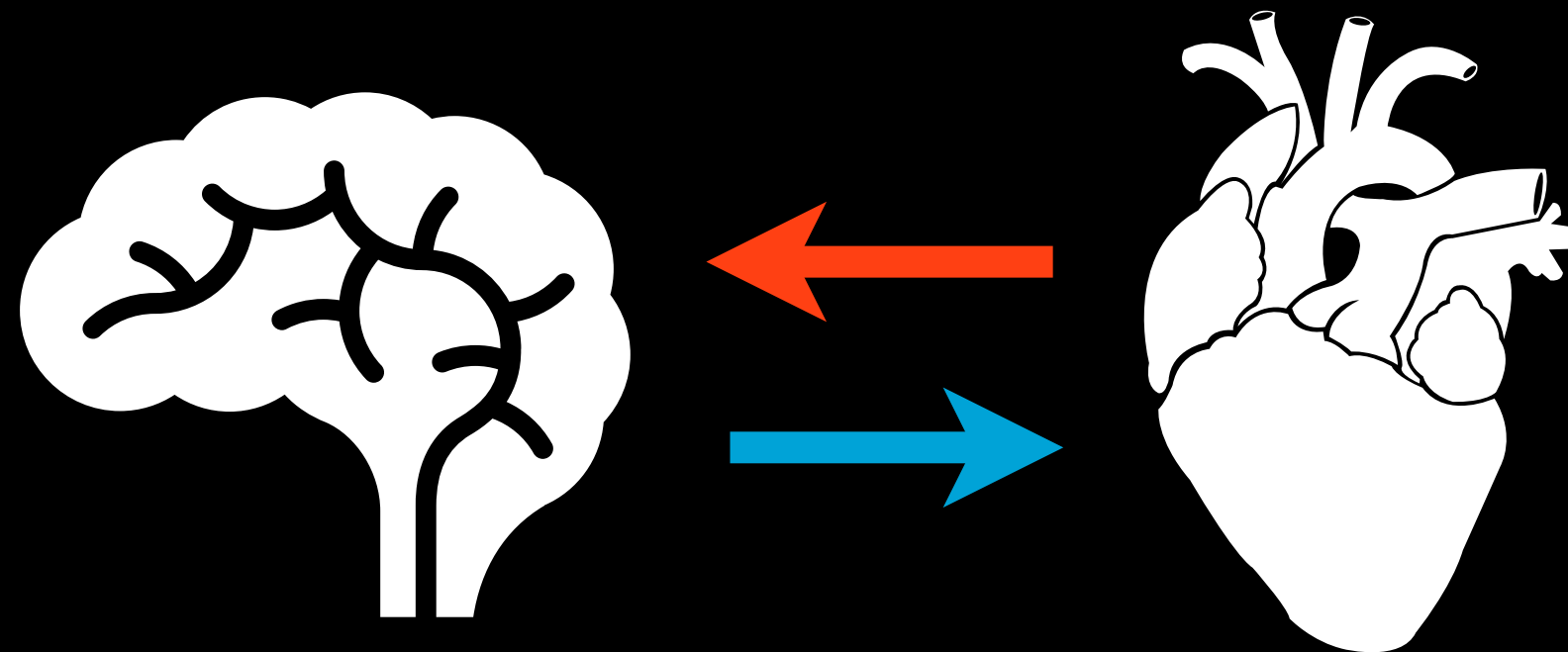
(Butler et al., 2006)

Resiliency to stressors

(Fabes & Eisenberg, 1997)

Decreased depression

(George, 2000).



Electrodermal

Cardiovascular

Blood Flow & Temperature

Blood Flow Parameters:

1. Skin Temperature (SKT)

2. Finger Pulse Transit Time (FPTT)

3. Finger Pulse Amplitude (FPA)

Blood Flow Parameters:

1. Skin Temperature (SKT)

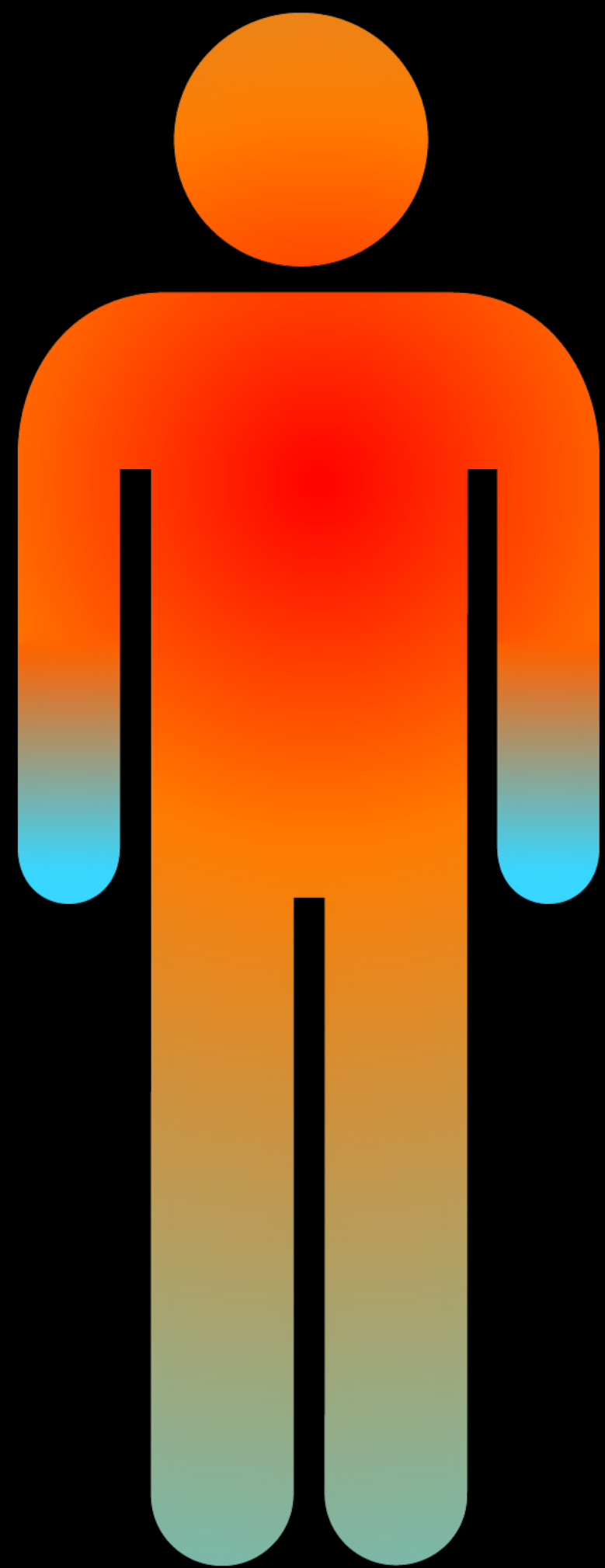
2. Finger Pulse Transit Time (FPTT)

3. Finger Pulse Amplitude (FPA)

	Sympathetic	Parasympathetic
Skin (SKT)	Increased blood transported to region, skin temperature decreases	None

SKT: Blood is transported to an area of the skin which then becomes heated (i.e., more blood = higher SKT). When SNS activated, blood directed away from peripheral systems (e.g., finger, ear) and towards large locomotive muscle groups. Increased SNS = lower SKT in peripheral systems.

SNS activation -> Vasoconstriction --> Less blood flow --> Lower SKT.





Finger Skin Temperature

- Fingertip skin has arterioles
- Arterioles: smallest branches of arterial tree (.3-.4mm)
- Arterioles on the fingertips only have sympathetic constrictor nerves -> **Useful measure of SNS activity**



Pros

- Clean measure of SNS activity
(arterioles on fingertip only have sympathetic nerves)

Cons

- Difficult to determine cause
- Slow in onset (SNS --> finger SKT change ~15 sec)
- Small changes in magnitude (~1 deg.)
- External factors influence (room temp)



SKT Decrease

- Negative emotions
(sad, disgust, fear, embarrassment)
- Crying

SKT Increase

- Positive emotions (excitement)
- Anger (approach oriented)

(Boudewyns, 1976; Bugental & Cortez, 1988; Graham, 1962; Gross, Frederickson, and Levenson, 1994; Kistler, Hirota & Hirai, 1990; Mariauzouls & Berlepsch, 1998; Mittleman & Wolff, 1939; Schachter, 1957; Thyer et al., 1984)

How it works

- Sensor placed on peripheral body extension (e.g., distal phalange of finger).
- Sensor called a THERMISTOR
- Voltage that is generated by thermistor varies systematically with skin temperature changes.
- On a computer, can convert these voltage signals to degrees (Fahrenheit)



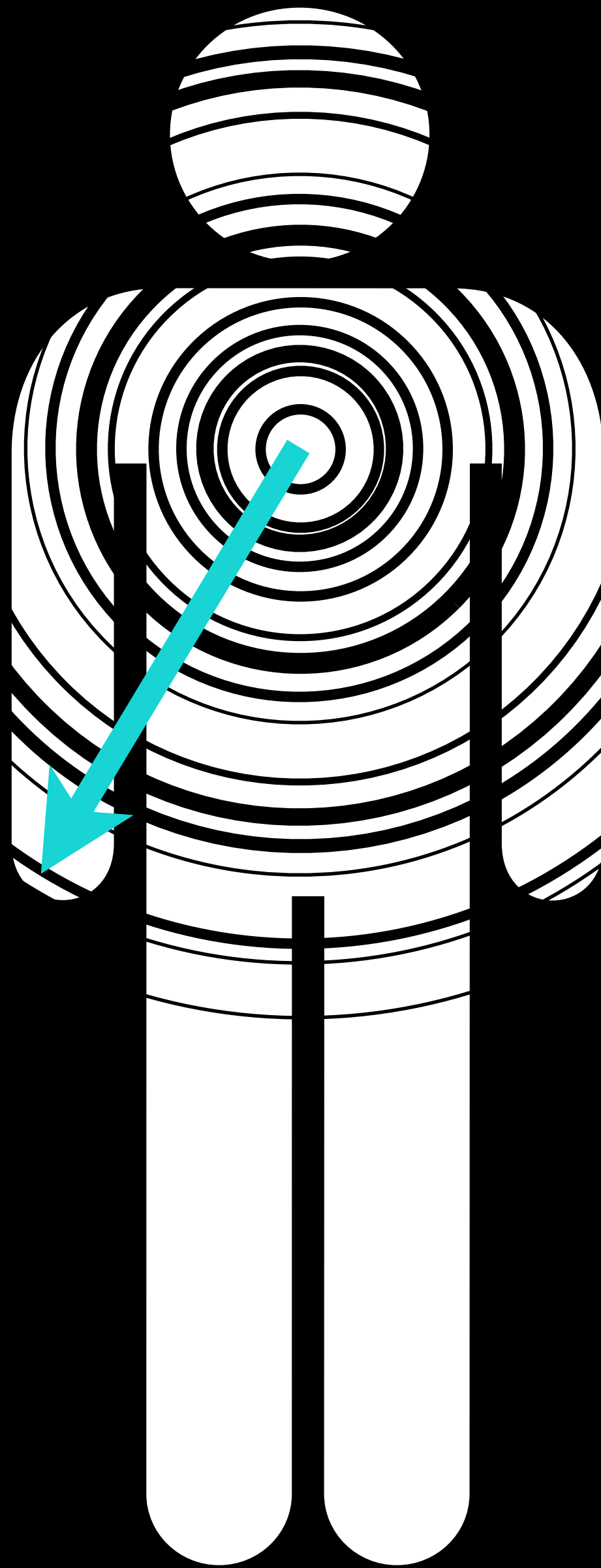
Blood Flow Parameters:

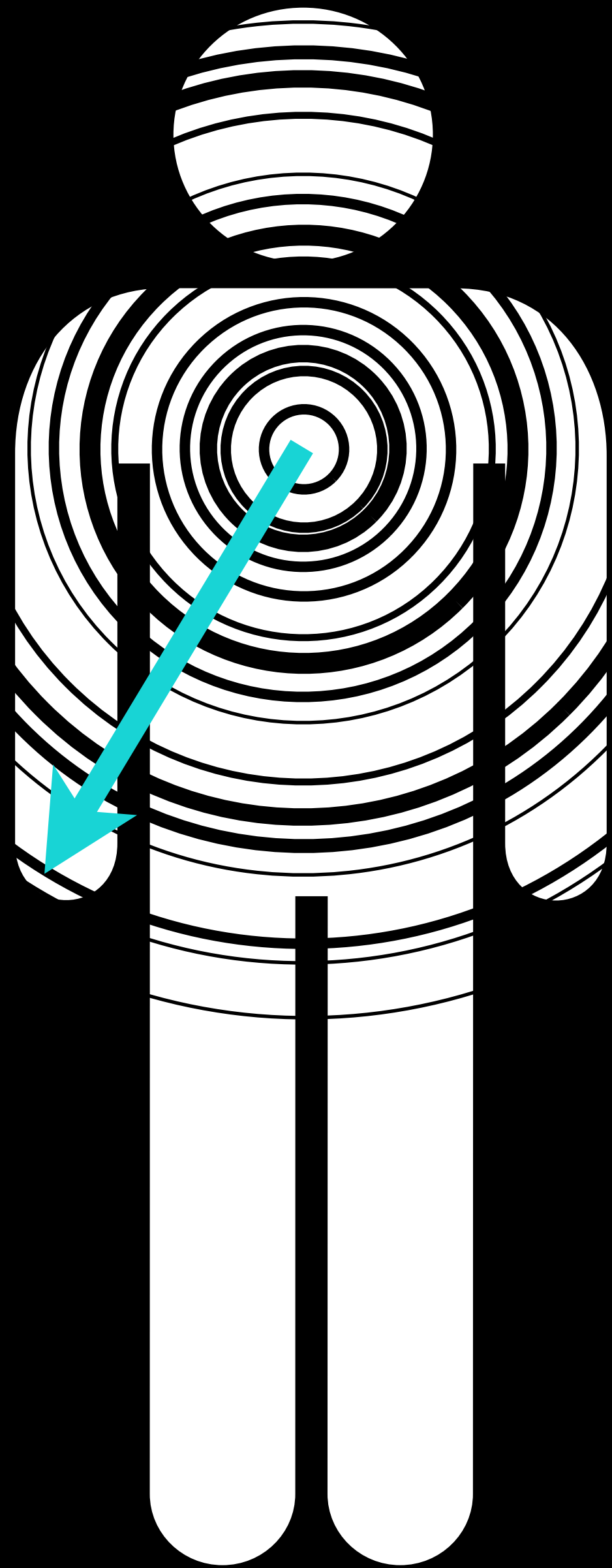
1. Skin Temperature (SKT)

2. Finger Pulse Transit Time (FPTT)

3. Finger Pulse Amplitude (FPA)

Both in
broader family
of Finger
Pulse
measures





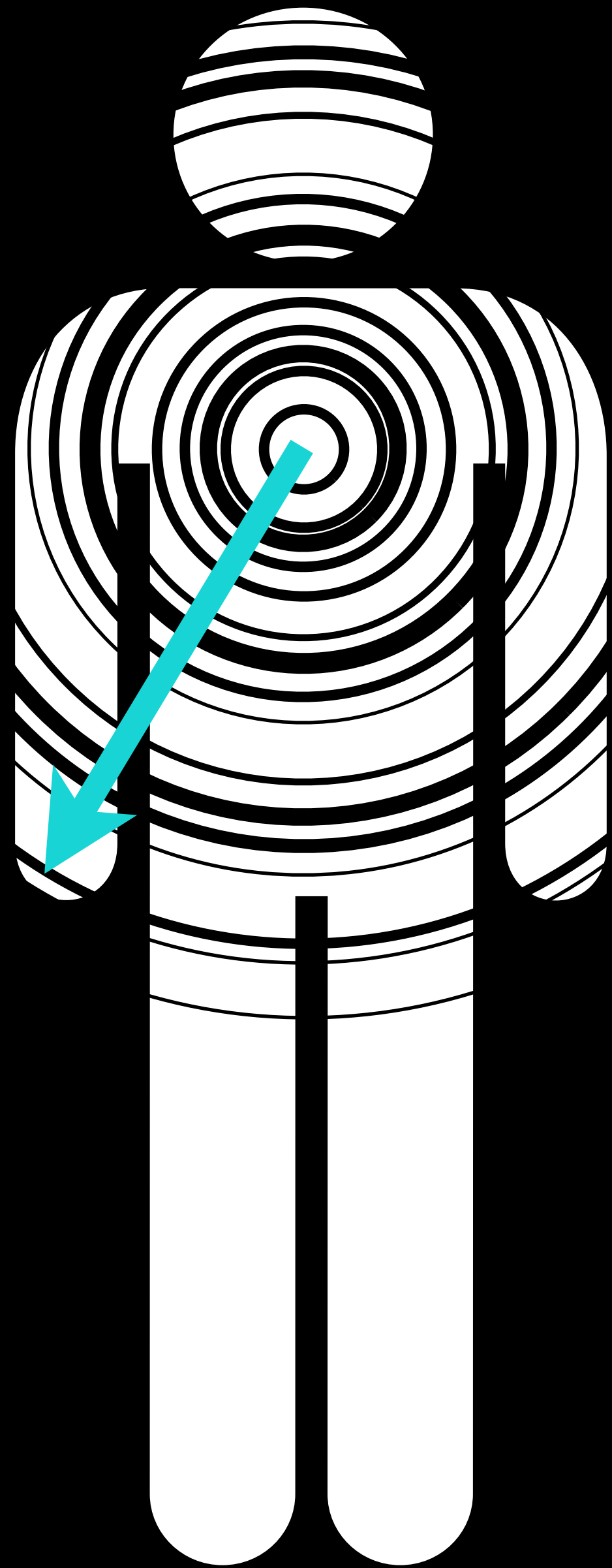
Sympathetic

Parasympathetic

**Finger
Pulse**

**Blood flow to
periphery (often ear
or finger)**

None



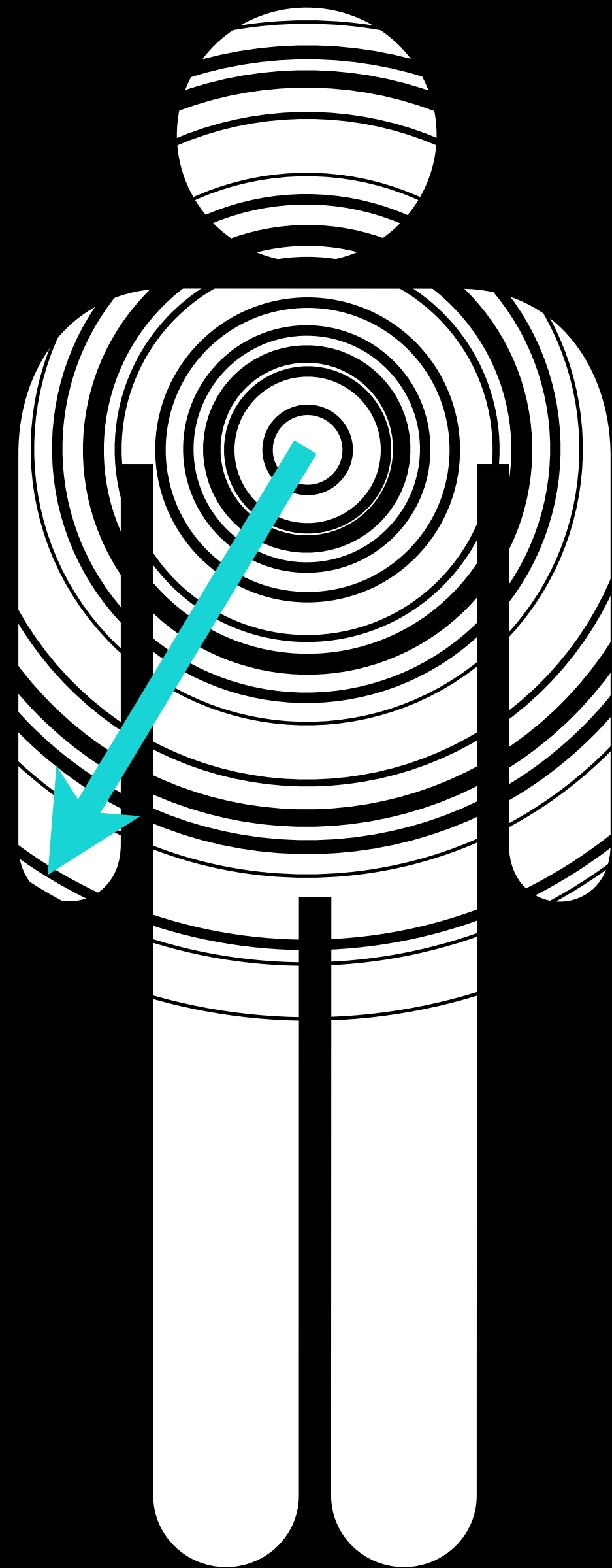
Finger Pulse

What it measures

**Blood flow to
periphery (often ear
or finger)**

How?

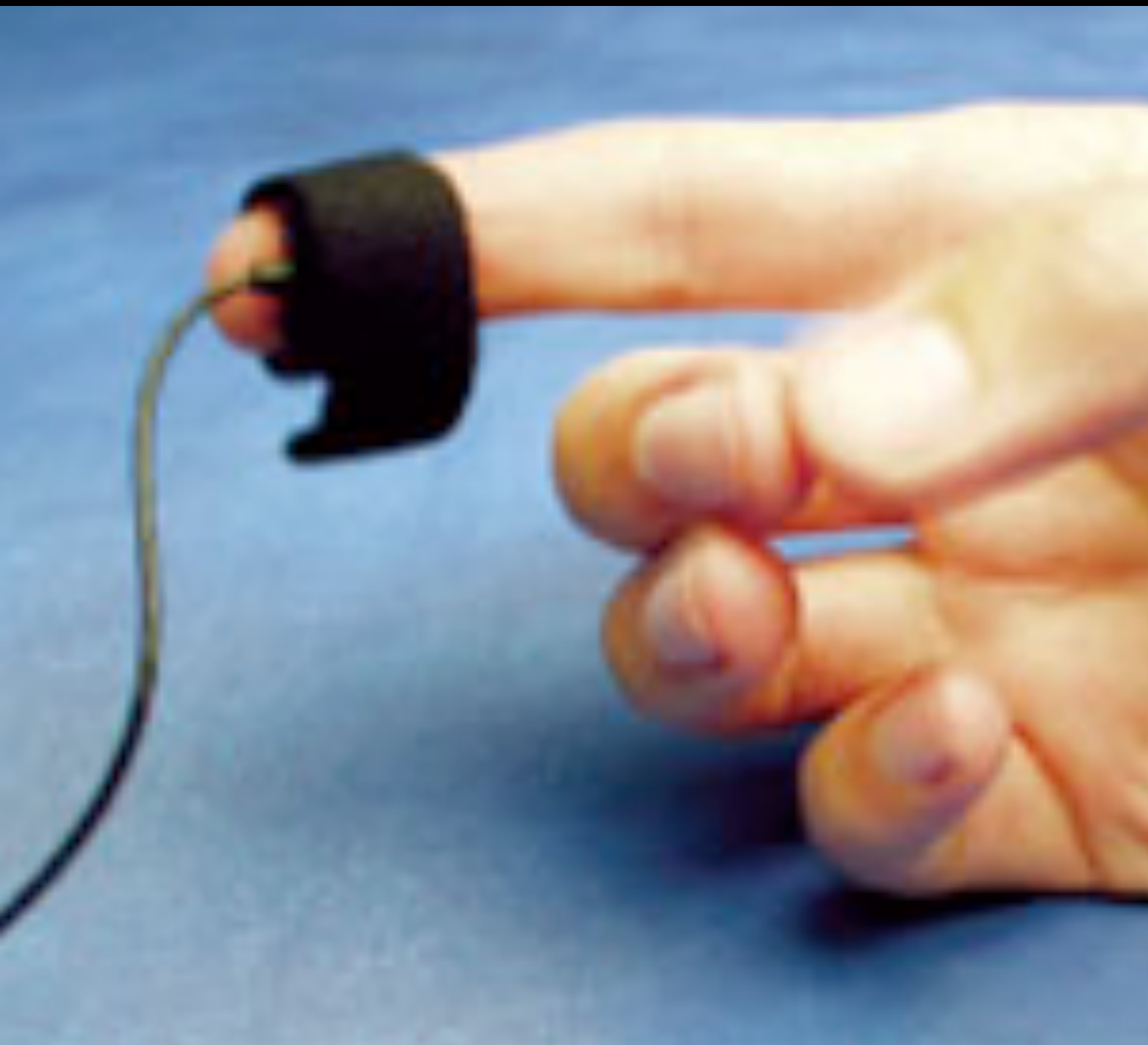
**Indirect;
Reflected light on
periphery (finger or
ear) bounces back
when hits blood**



How it works

4 SENSORS

- 1) 3 ECG Sensors: Measure heart rate
- 2) 1 Finger (or Ear) Plethysmograph Sensor: sensor that uses infrared sensor to detect volume and amplitude of blood in finger tip (i.e., measuring mini-pulse in finger).



FINGER PULSE

CAN DERIVE 2 THINGS:

- (1) Pulse Transit Time:** Time takes for blood to flow from heart to extremity (finger or ear).
- (2) Pulse Amplitude:** Blood volume in extremity (finger or ear).

	What it Measures	How?	Facts
FPTT	Time takes for blood to flow from heart to extremity (e.g., finger).	Time difference (msec) between heart beat (R-Spike in ECG signal) and Finger Pulse Spike (upstroke of pulse pressure wave at fingertip)	<p>Affected by 2 factors</p> <ol style="list-style-type: none"> 1. Heart pumping -SNS increase --> HR increase --> FPTT decrease 2. Vasoconstriction (resistance to blood flow in vessels) -SNS increase -> Vasoconstriction -> FPTT decrease



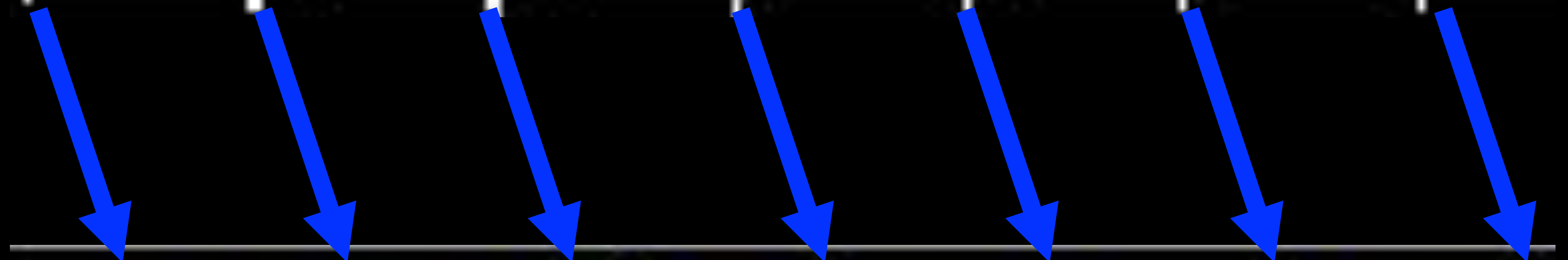
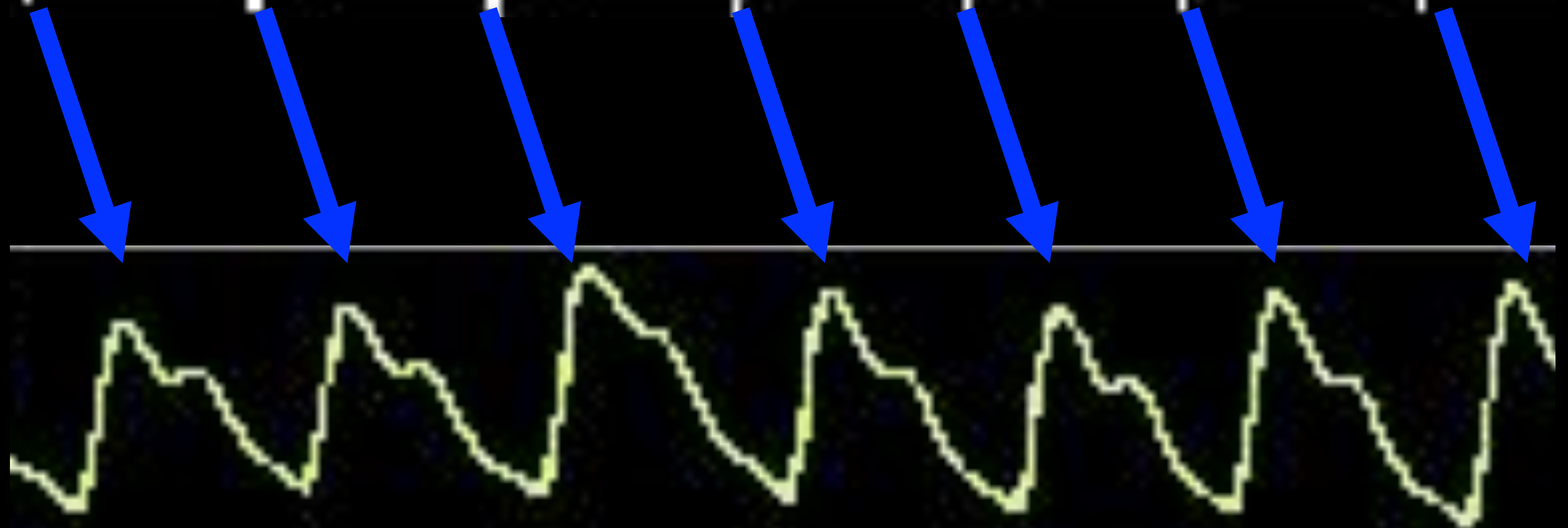
	What it Measures	How?	Facts
<p>FPA</p>	<p>Blood volume in finger tip</p>	<p>Amplitude of Finger Pulse Spike signal (calculate distance between trough and peak).</p>	<p>Affected by 2 factors</p> <p>1. Heart pumping -SNS increase --> HR increase --> FPA decrease</p> <p>2. Vasoconstriction (resistance to blood flow in vessels) -SNS increase -> Vasoconstriction -> FPA decrease</p>

FPTT

ECG



FPLE



FPA



Summary	What measures?	How?
Electrocardiogram (ECG/EKG)	Heart rate	Direct; Electrodes placed on skin
Skin conductance (GSC/GSR)	Sweat	Indirect; Applied voltage or current and more sweat increases conductance
Electromyogram (EMG)	Muscular Movement/Contraction	Direct; Electrodes placed on skin
Respiration	Breathing frequency, tidal volume	Indirect; Transducer (measured by amount respiration belt moves)
Skin Temperature (SKT)	Skin Temperature	Indirect; Thermistor (resistance varies as function of SKT)
Finger/Ear Blood Pulse	Blood flow to periphery (ear, finger)	Indirect; Reflected Light on finger or ear lobe that bounces back when hits blood

Other Measures: Hemodynamic

1. Pre-Ejection Period (PEP)

2. Left Ventricular Ejection Time (LVET)

3. Stroke Volume (SV)

4. Cardiac Output (CO)

Time Interval:
How quickly is
blood flowing?

Volume Interval
How much blood
is pumping?

Roadmap

Course Logistics

Definitions and Measurement

Emotion Specificity

Emotion Coherence

Take-Away Qs & Expert Interview





Robert Levenson



Lani Shiota

Are there different patterns of
autonomic nervous system activity
for different emotions?

Are there different patterns of
autonomic nervous system activity
for different emotions?

Negative Emotions

Emotion	ANS Basis	Change
Anger	Vasodilation Pupils	Reddening in skin, Blood vessels bulge, Constriction
Fear	Vasoconstriction Sweat Glands	Pale/blanching Sweaty, Clammy palms Higher skin conductance
Sad	Lacrimal Glands	Tearing, Crying
Disgust	Salivary Glands	Salivate, Drool

Are there different patterns of
autonomic nervous system activity
for different emotions?

Positive Emotions

Emotion	ANS Basis	Change
Anger	Vasodilation	Reddening in skin, Blood vessels bulge, Constriction
Fear	Vasoconstriction Sweat Glands	Pale/blanching Sweaty, Clammy palms Higher skin conductance
Sad	Lacrimal Glands	Tearing, Crying
Disgust	Salivary Glands	Salivate, Drool
Happiness	Vagus Nerve	Tightness in chest, Goosebumps

Resting Respiratory Sinus Arrhythmia Is Associated With Tonic Positive Emotionality

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Resting respiratory sinus arrhythmia (RSA_{REST}) indexes important aspects of individual differences in emotionality. In the present investigation, the authors address whether RSA_{REST} is associated with tonic positive or negative emotionality, and whether RSA_{REST} relates to phasic emotional responding to discrete positive emotion-eliciting stimuli. Across an 8-month, multiassessment study of first-year university students ($n = 80$), individual differences in RSA_{REST} were associated with positive but not negative tonic emotionality, assessed at the level of personality traits, long-term moods, the disposition toward optimism, and baseline reports of current emotional states. RSA_{REST} was not related to increased positive emotion, or stimulus-specific emotion, in response to compassion-, awe-, or pride-inducing stimuli. These findings suggest that resting RSA indexes aspects of a person's tonic positive emotionality.

Keywords: vagal tone, positive temperament, heart rate variability, biological marker

**What about differences among
positive emotions?**

What about differences among positive emotions?

Enthusiasm

Attachment
Love

Nurturant
Love

Amusement

Awe

	ENTHUSIASM	LOVE (attachment)	LOVE (nurturant)	AMUSEMENT	AWE
Heart Rate (IBI)		↑	↑		
PEP					↑
SCR (GSR/GSC)	↑				
RESP			↑	↑	↑
RSA	↓	↓			↓
MAP					

Roadmap

Course Logistics

Definitions and Measurement

Emotion Specificity

Emotion Coherence

Take-Away Qs & Expert Interview



Iris Mauss

What is an emotion: Six Features



Paul Ekman UCSF

Brief

Unbidden

Cross-Species

Coherent Really?

Fast

Automatic Appraisal/Evaluation

What is an emotion: Six Features

Subjective

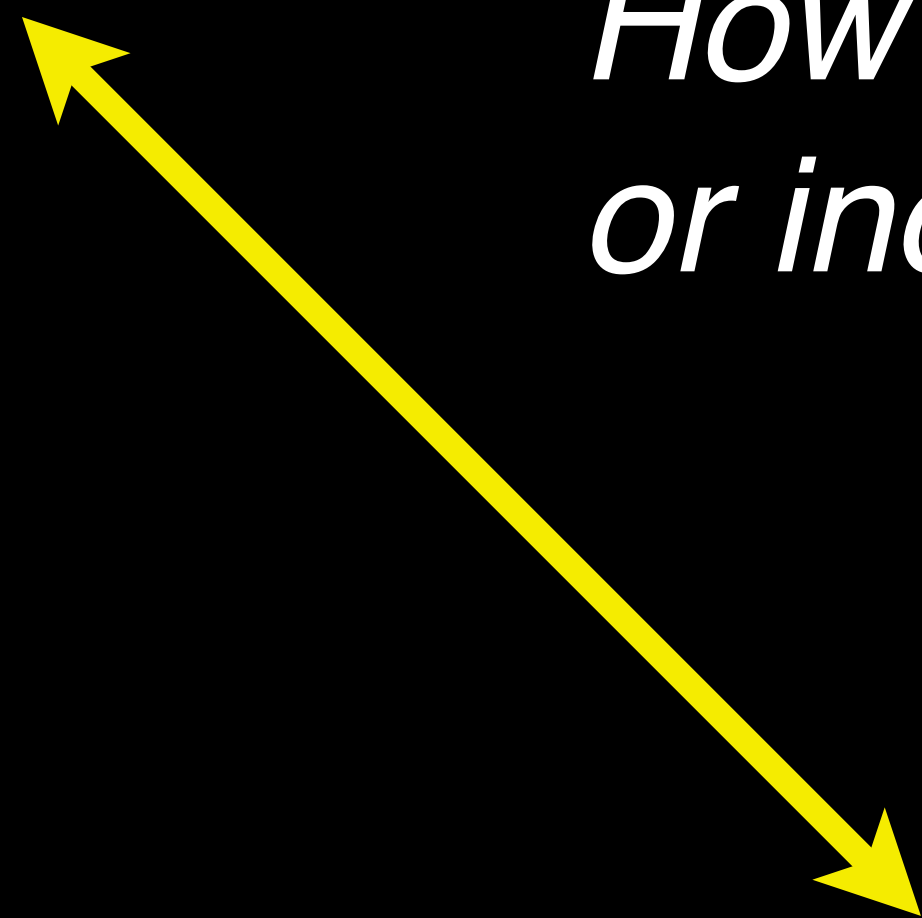
Qualia

What it's like to feel an emotion

*How well do they actually cohere,
or increase/decrease together?*

Physiology

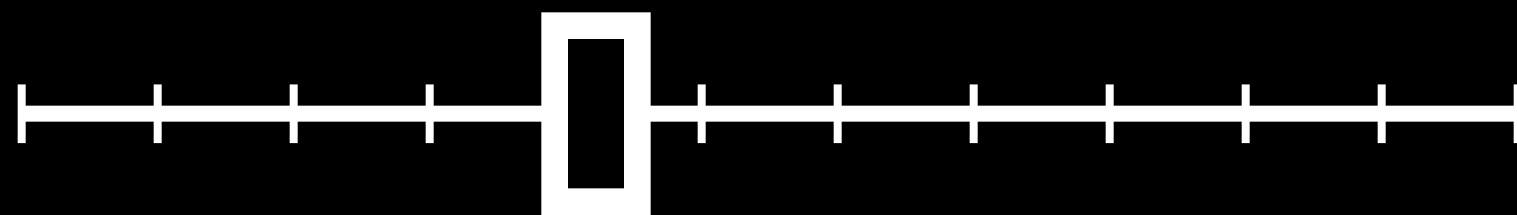
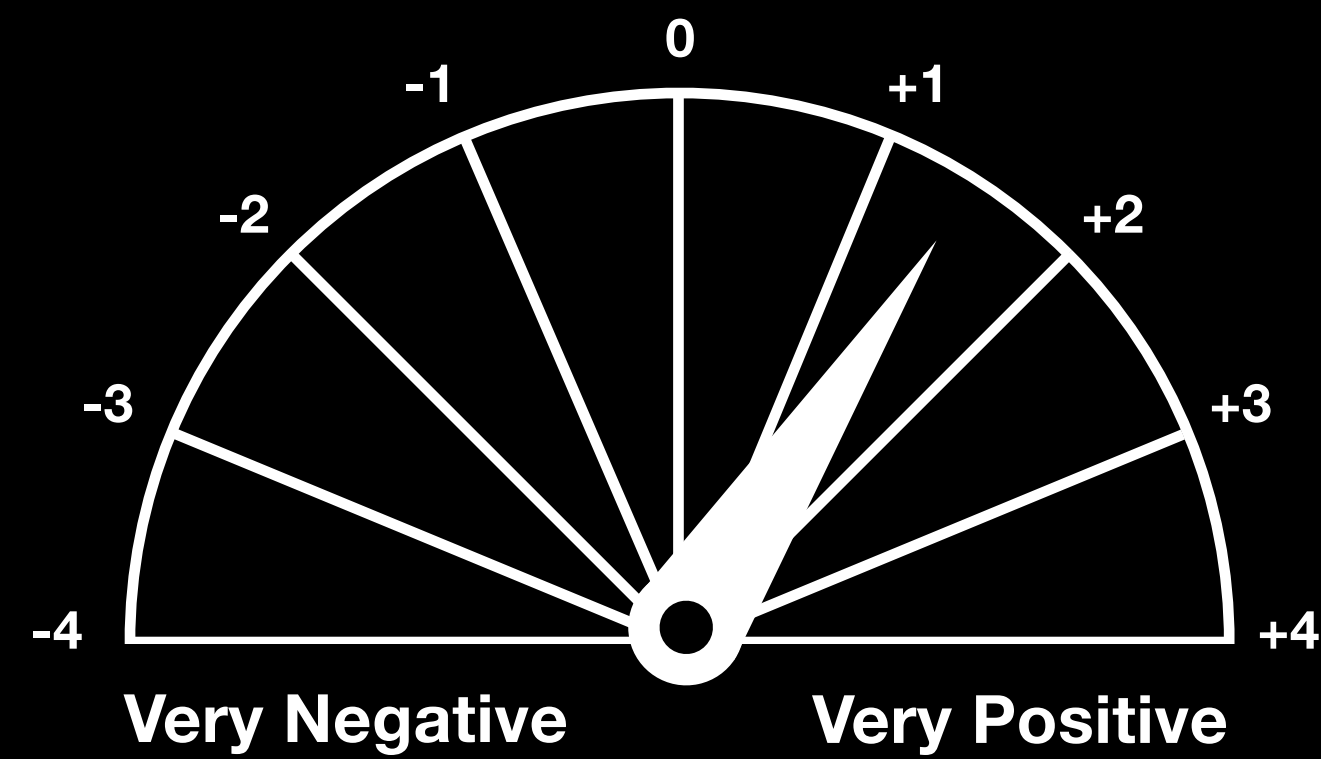
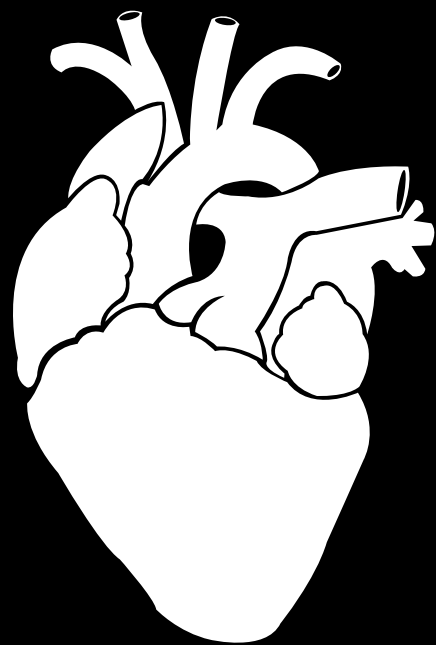
Internal Physical Sensations



Are emotions coherent?



Where's the Evidence?



	Amusement Facial Behavior	Cardio	SCL
Amusement Experience	.73*** [.89***]	.22*** [.25***]	.51*** [.57***]
Amusement Behavior		.34*** [.37***]	.47*** [.51***]
Average Absolute <i>r</i> for Amusement			.39 [.52]

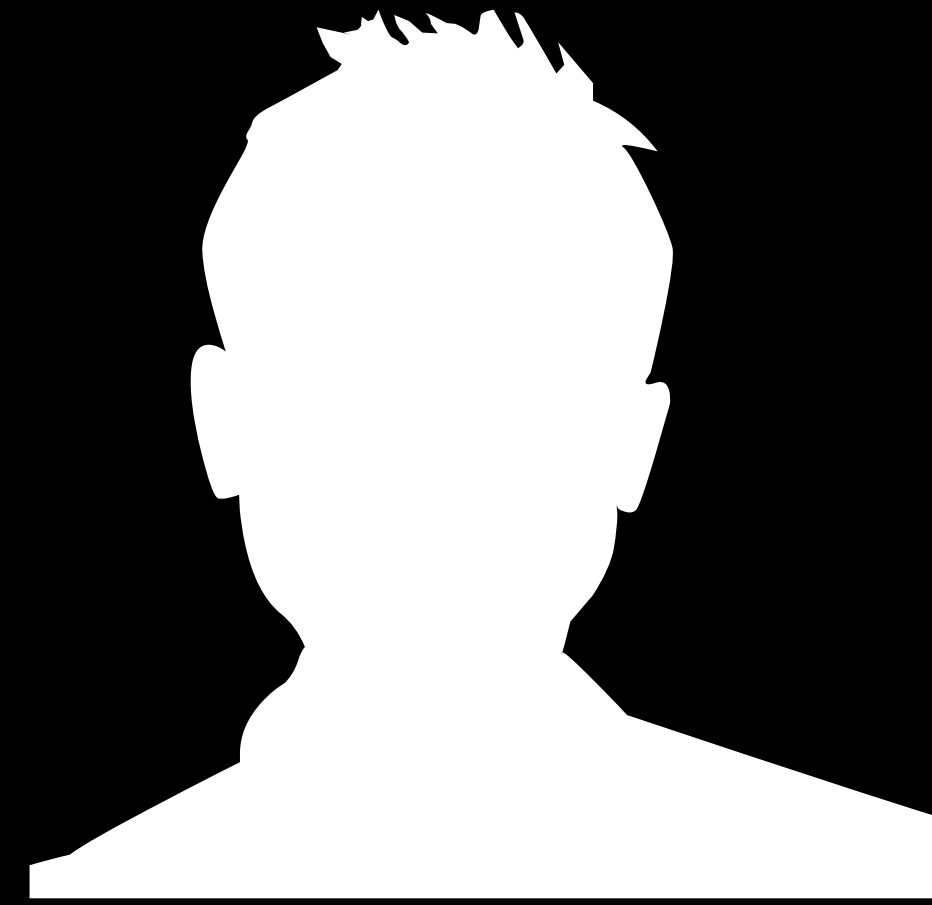
	Sadness Facial Behavior	Cardio	SCL
Sadness Experience	.74*** [.97***]	.00 [.00]	-.39*** [-.53***]
Sadness Behavior		-.05 [-.06]	-.52*** [-.58***]
Average Absolute <i>r</i> for Sadness			.36 [= .53]

Upshot

Moderate coherence on average

Highest between **experience & behavior**

Almost NO coherence between physiology and either experience or behavior



Controls

Dancers

Meditators

COHERENCE
between heart rate &
self-reported emotion

Lowest

Middle

Highest

Roadmap

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Experts In Emotion Interview

Dr. Robert Levenson

Professor of Psychology
University of California, Berkeley

**Blood, tears, sweat and
fears? Autonomic nervous
system and emotion**



Experts In Emotion Interview

Dr. Wendy Berry
Mendes

Sarlo/Ekman Endowed Chair in the Study of Emotion
Associate Professor
Department of Psychiatry
University of California, San Francisco

**Psychophysiology
Measurement and Health**



Experts In Emotion Interview

Dr. John T. Cacioppo

Tiffany & Margaret Blake Distinguished Service Professor
Director, Center for Cognitive and Social Neuroscience
University of Chicago

**Psychophysiology: Scope and
promise for emotion research**



Thank You!

Psychology 3131
Professor June Gruber

