

Physiology of Sport and Exercise

Stress and Autonomic System

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Learning Objectives



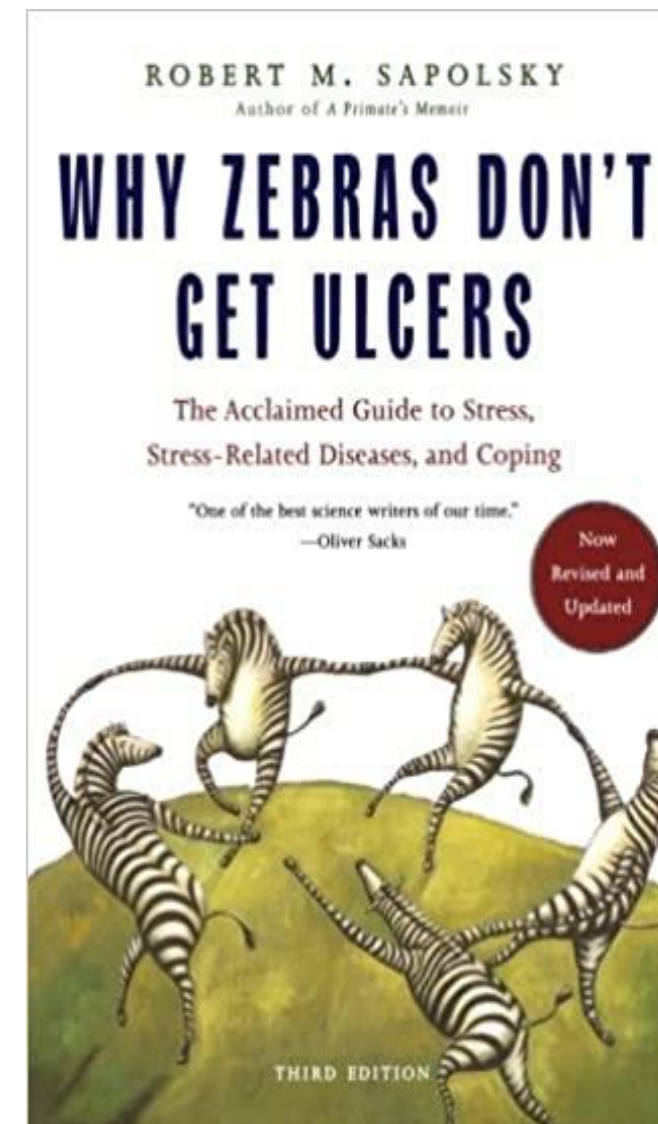
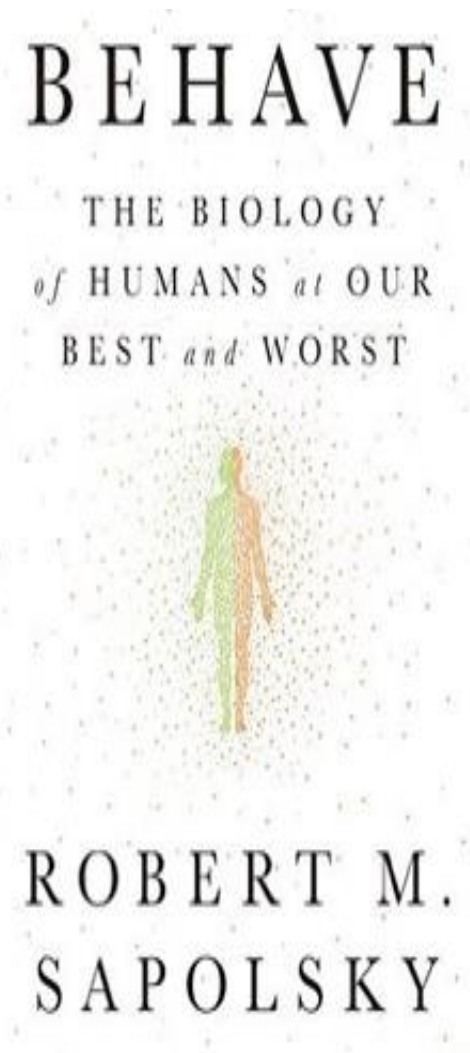
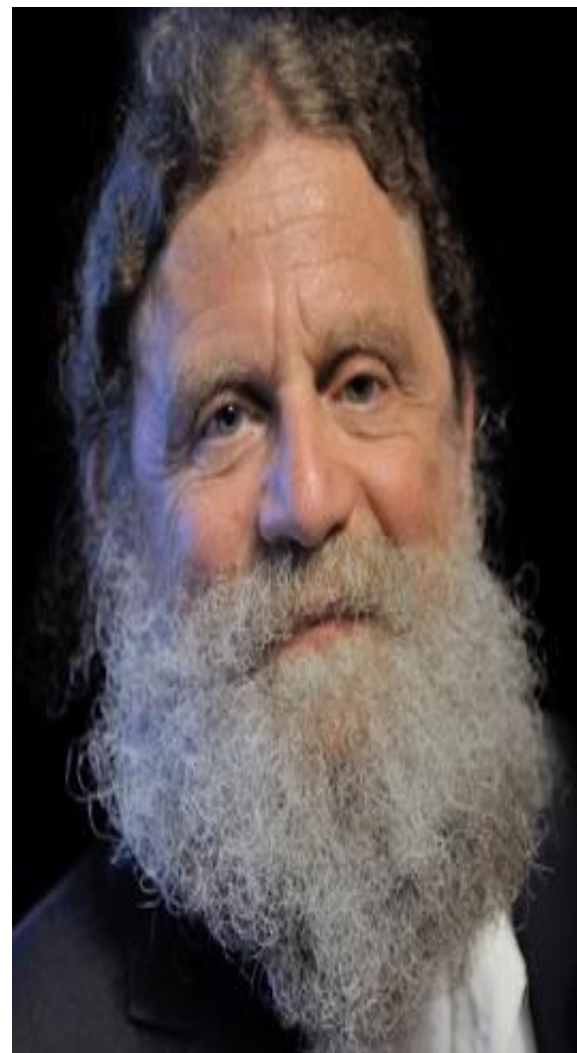
The basic structures of the autonomic system

Stress and autonomic system

Example of study in HRV and sport

Stress...

- Robert Sapolski “Why Zebras don’t get ulcers
- Sapolsky, R. M. (1992). *Stress, the aging brain, and the mechanisms of neuron death*. the MIT Press.



Stress and Human Being

Stressor

Any factor in the outside world that causes an imbalance in homeostasis

Homeostasis



Reestablish homeostasis

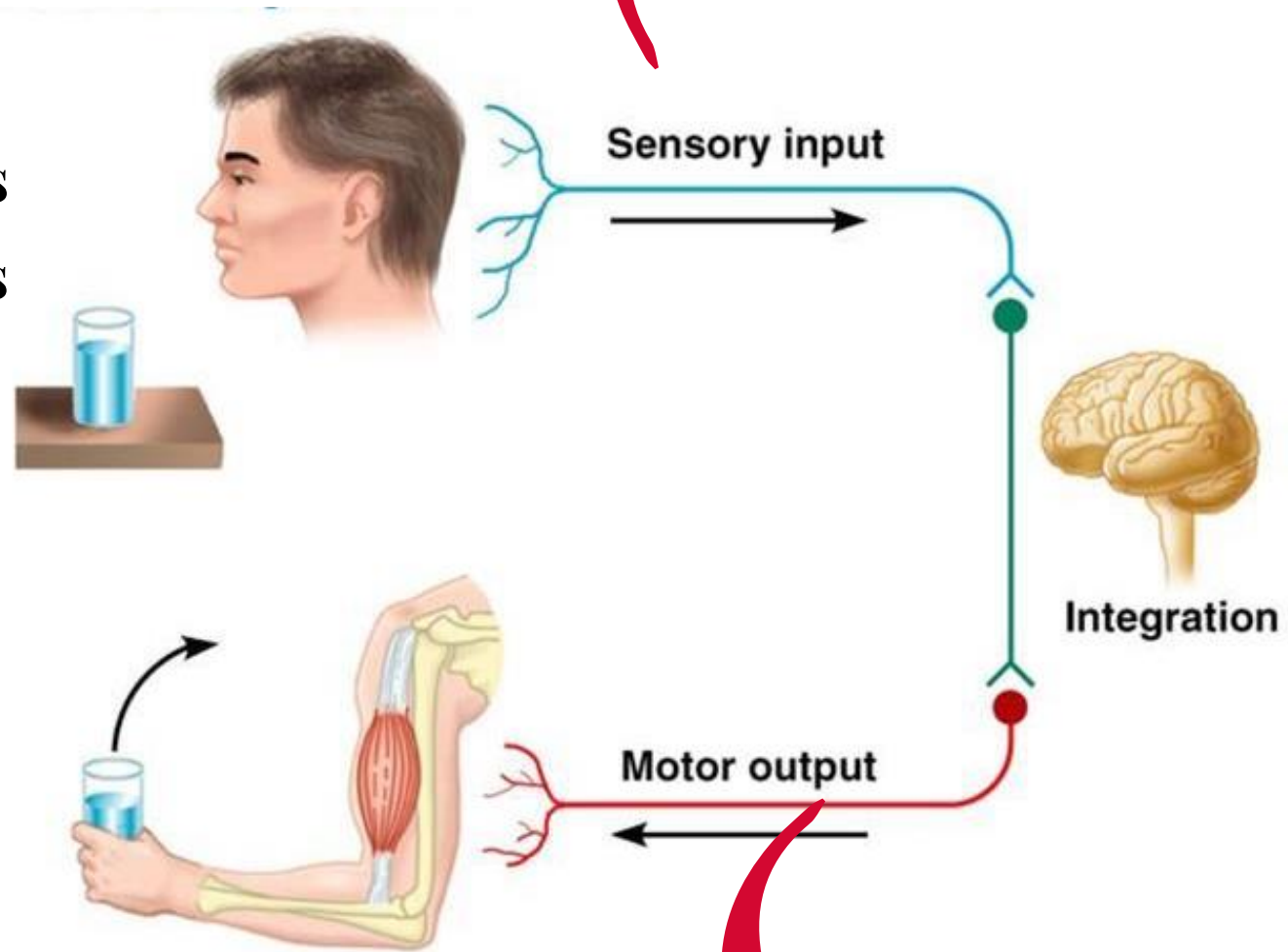


Periferal Nervous System

Somatic System

Allows coordinating actions and responses to the external environment. Conscious control of the movement.

- Mechanoreceptors**
- Thermoreceptors**
- Nociceptors**
- Photoreceptors**
- Chemoreceptors**



**Afferent
Neurons**

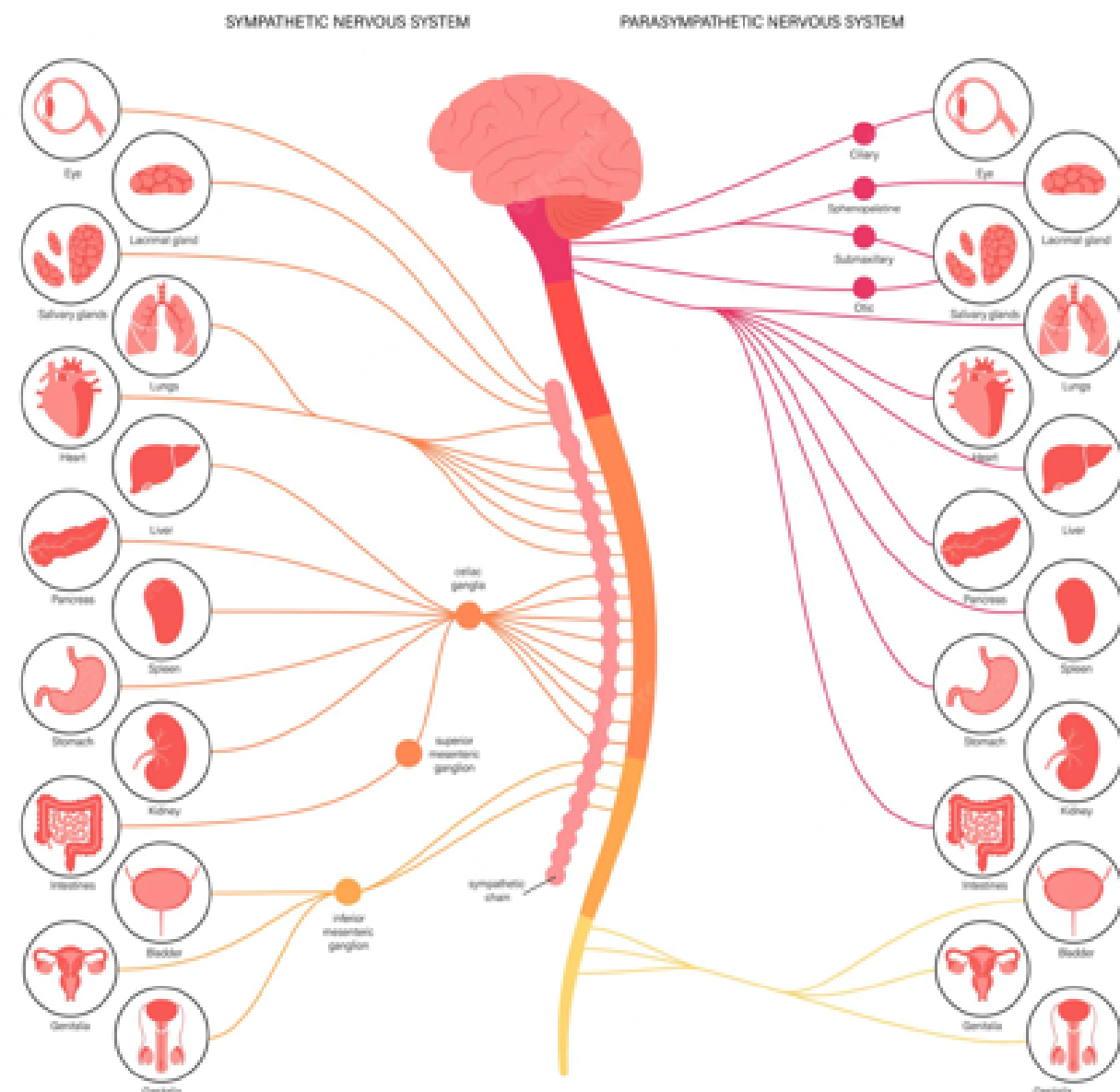
**Movimen
t**

**Efferent
Neurons**



Peripheral Nervous System

Control the physiological functions that are **unconscious** in nature.



Autonomic System

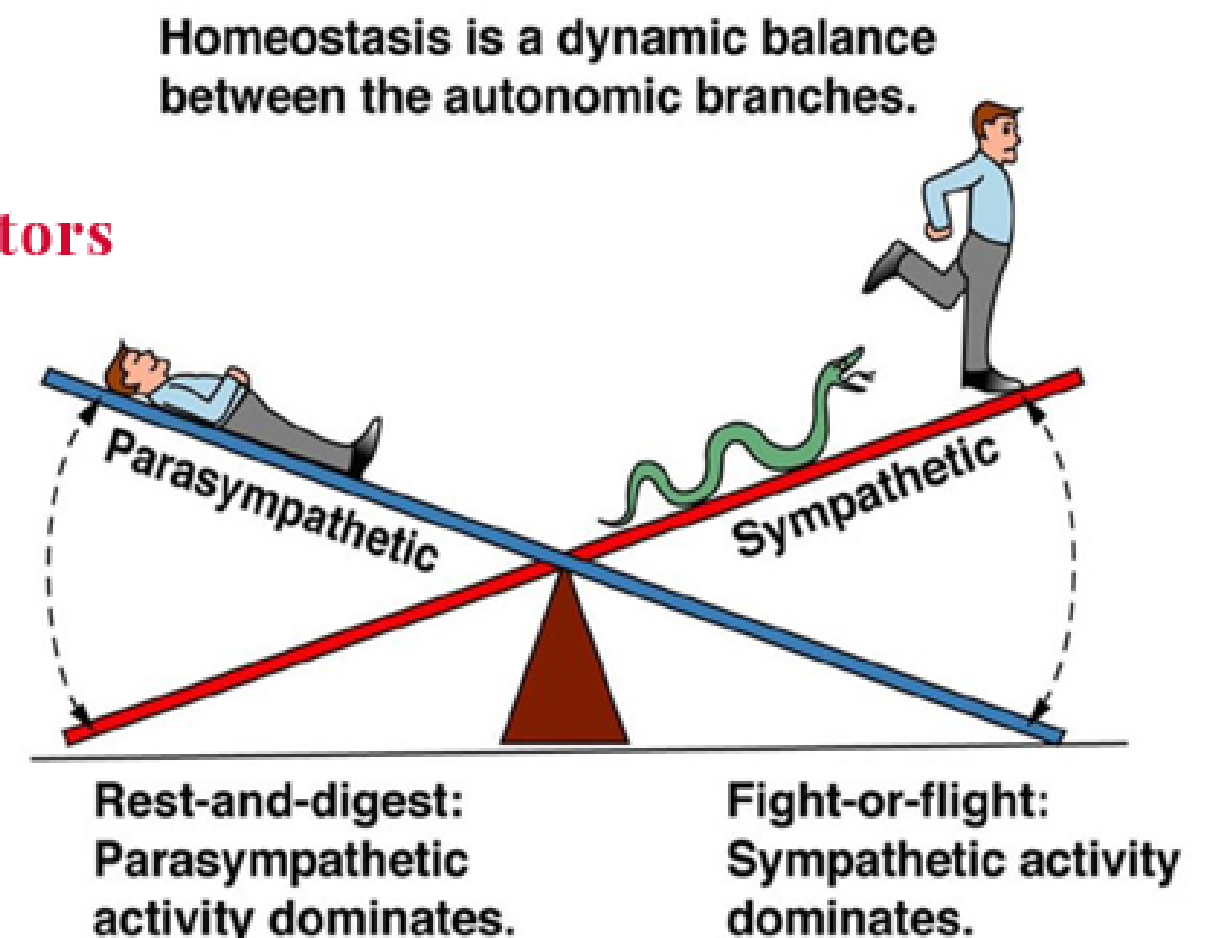
Sympathetic

Stimulate the physiological systems. Activate under the stress. 'Fight-or-flight'

Parasympathetic

Responsible for the body's constant or resting homeostatic state.

- 1 Input from internal receptors
- 2 Output to smooth muscles and glands



Stress Response

Mobilize energy to help the muscle to run

Suppression of digestion

Growth suppression

Suppression of the reproductive system

Secretion of some hormones

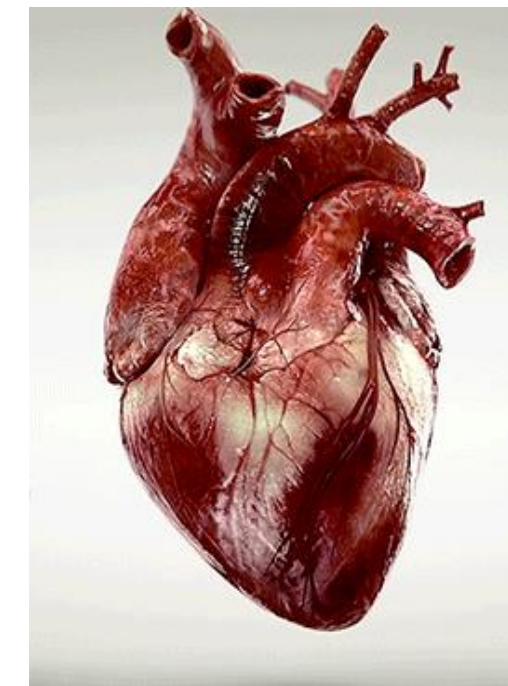
Increase Cardiovascular Tone

Increased activation of the immune system



Blood pressure

Respiratory frequency



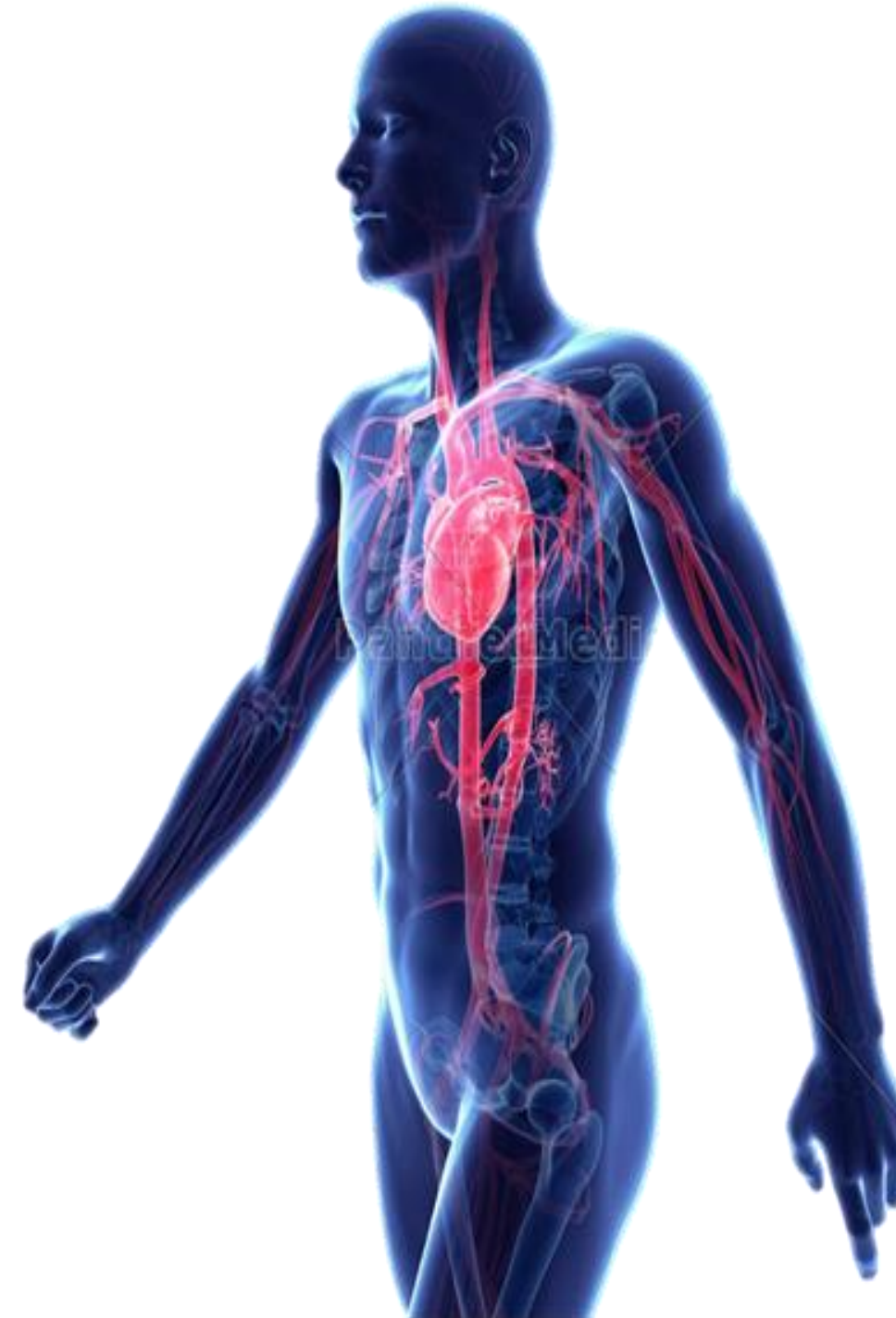
Glucose

Oxygen

Get the energy to muscles as fast as possible

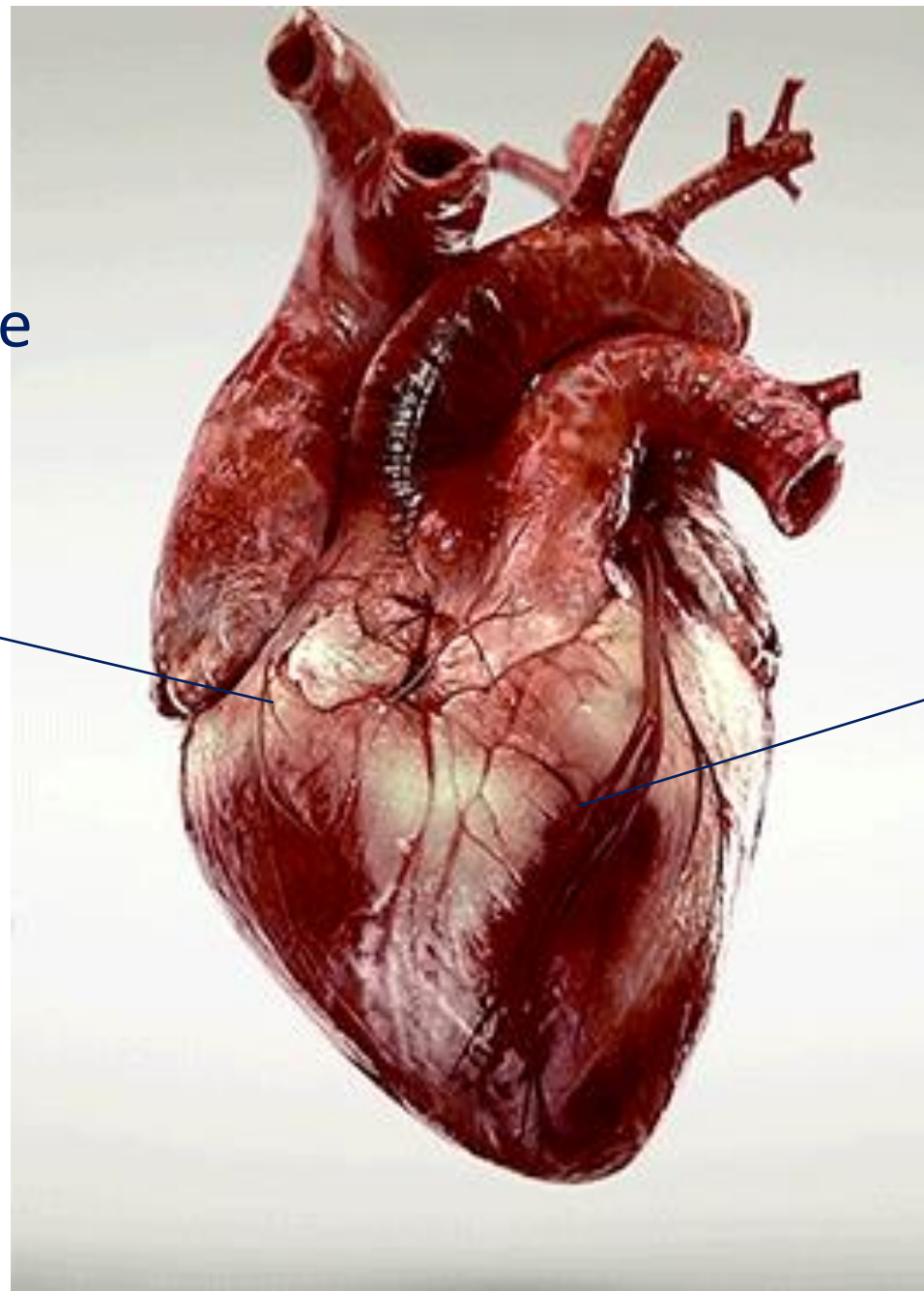
Stress Response

Same system is activated for psychological reasons



Heart Rate Variability

Sinoatrial node
(Pacemaker)



Excitatory ↑ Heart Rate

Sympathetic Fibers

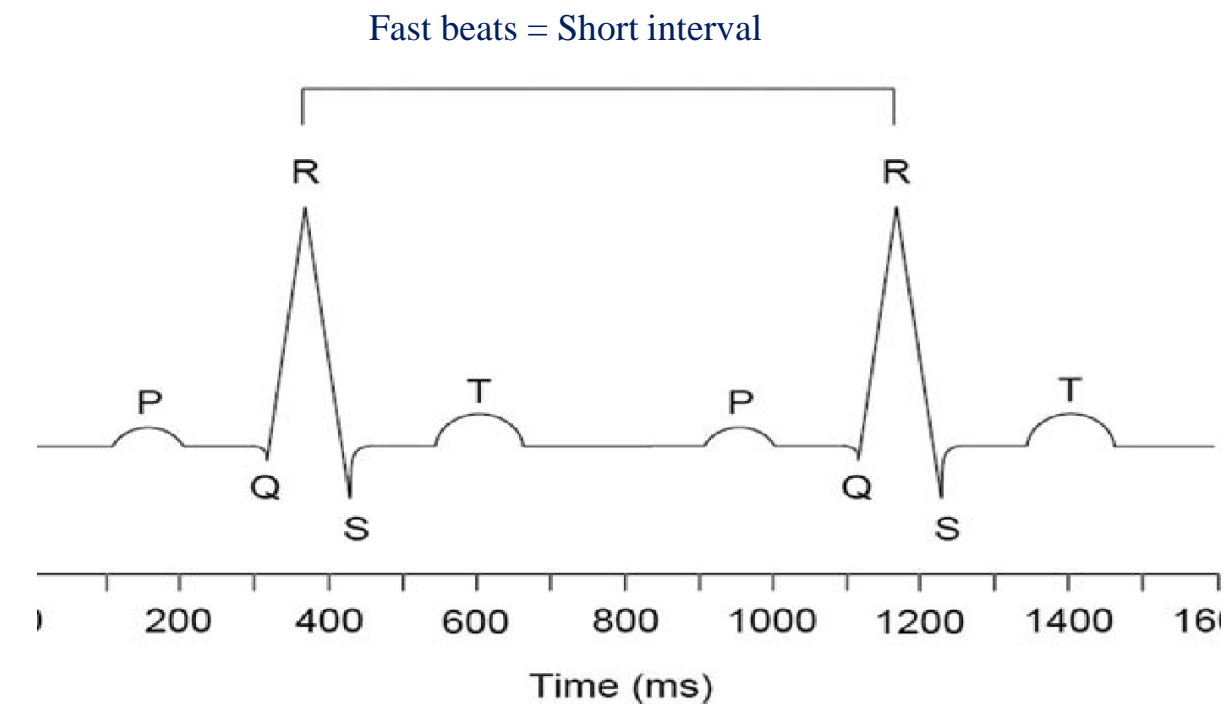
norepinephrine

Inhibitory ↓ Heart Rate

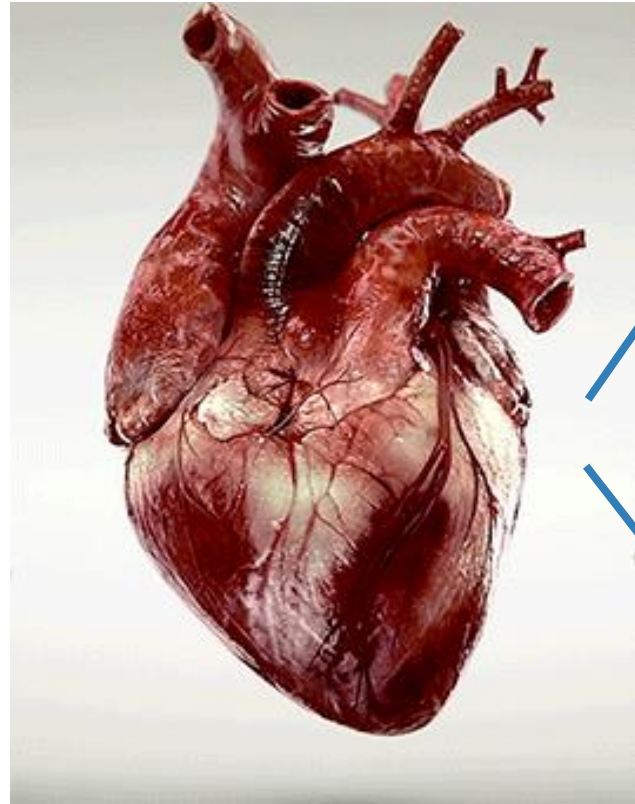
Parasympathetic Fibers

acetylcholine

Heart Rate Variability Beat Length/Time Interval (RR)



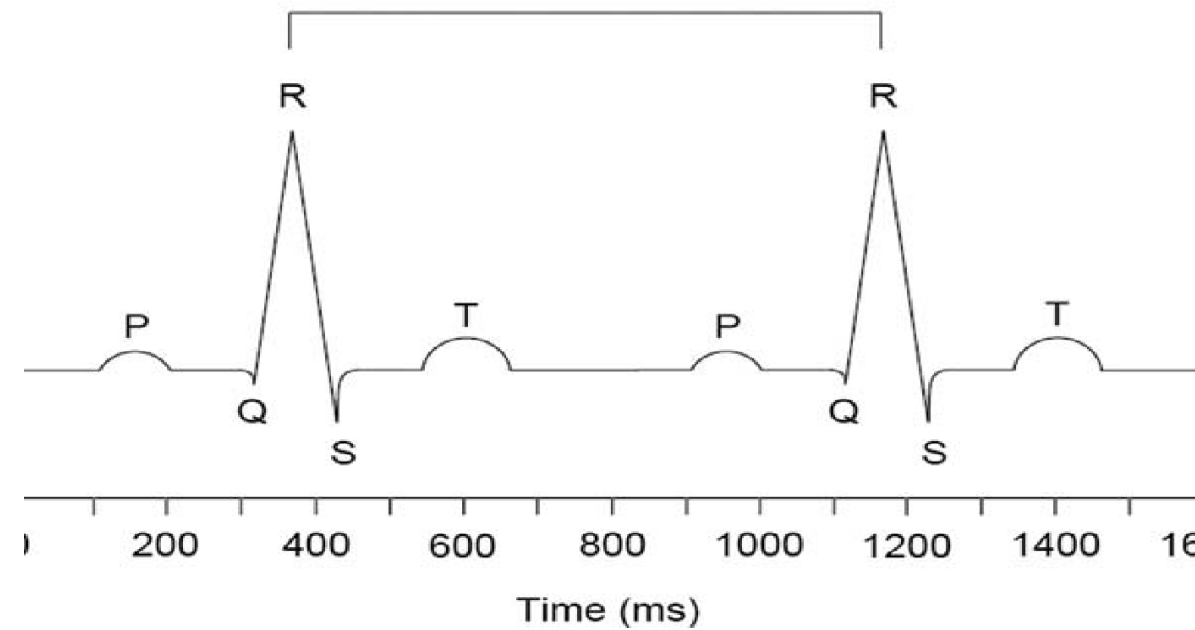
Heart Rate Variability



Accelerated/Fast beats

Shortest interval between beats

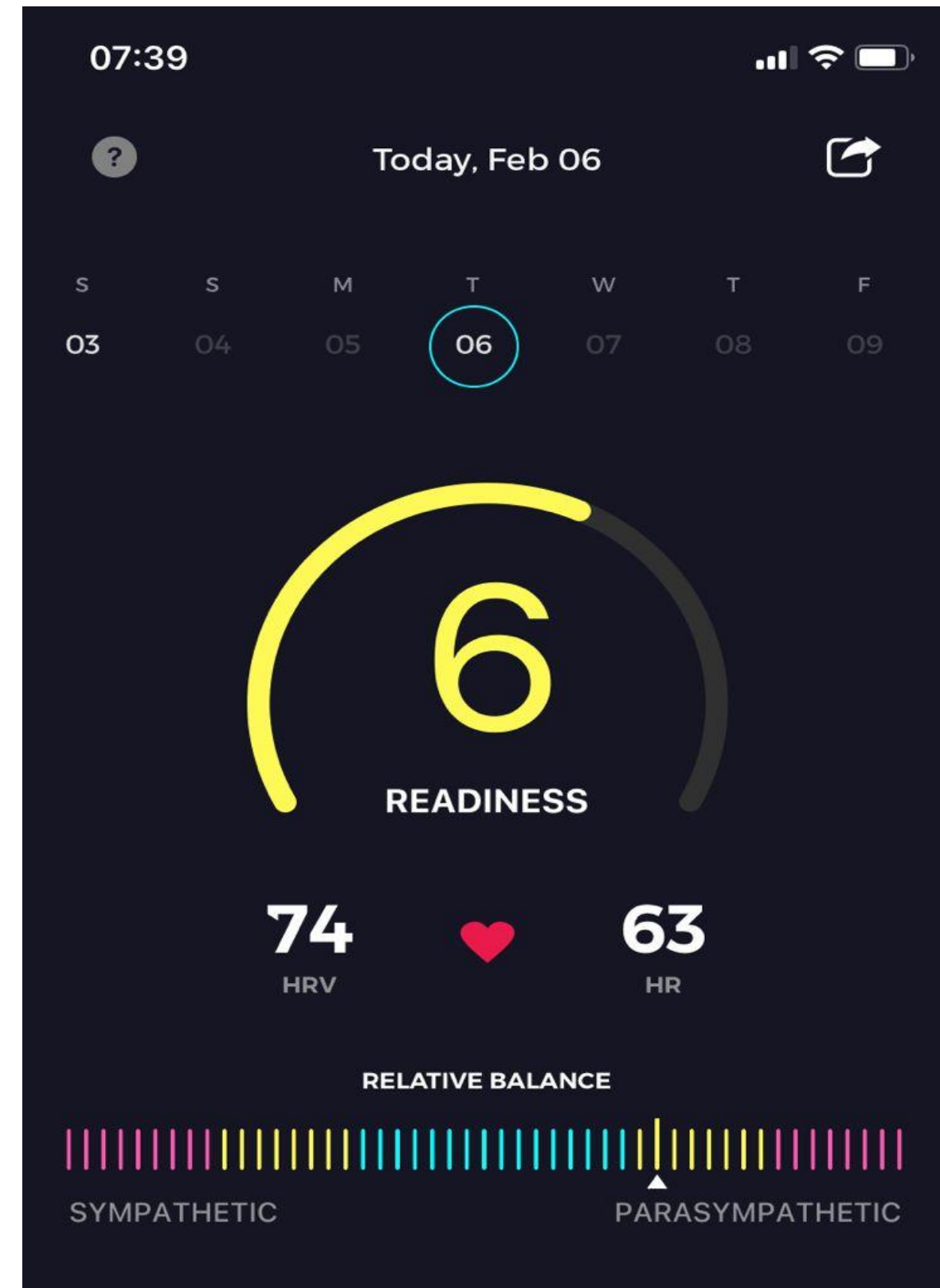
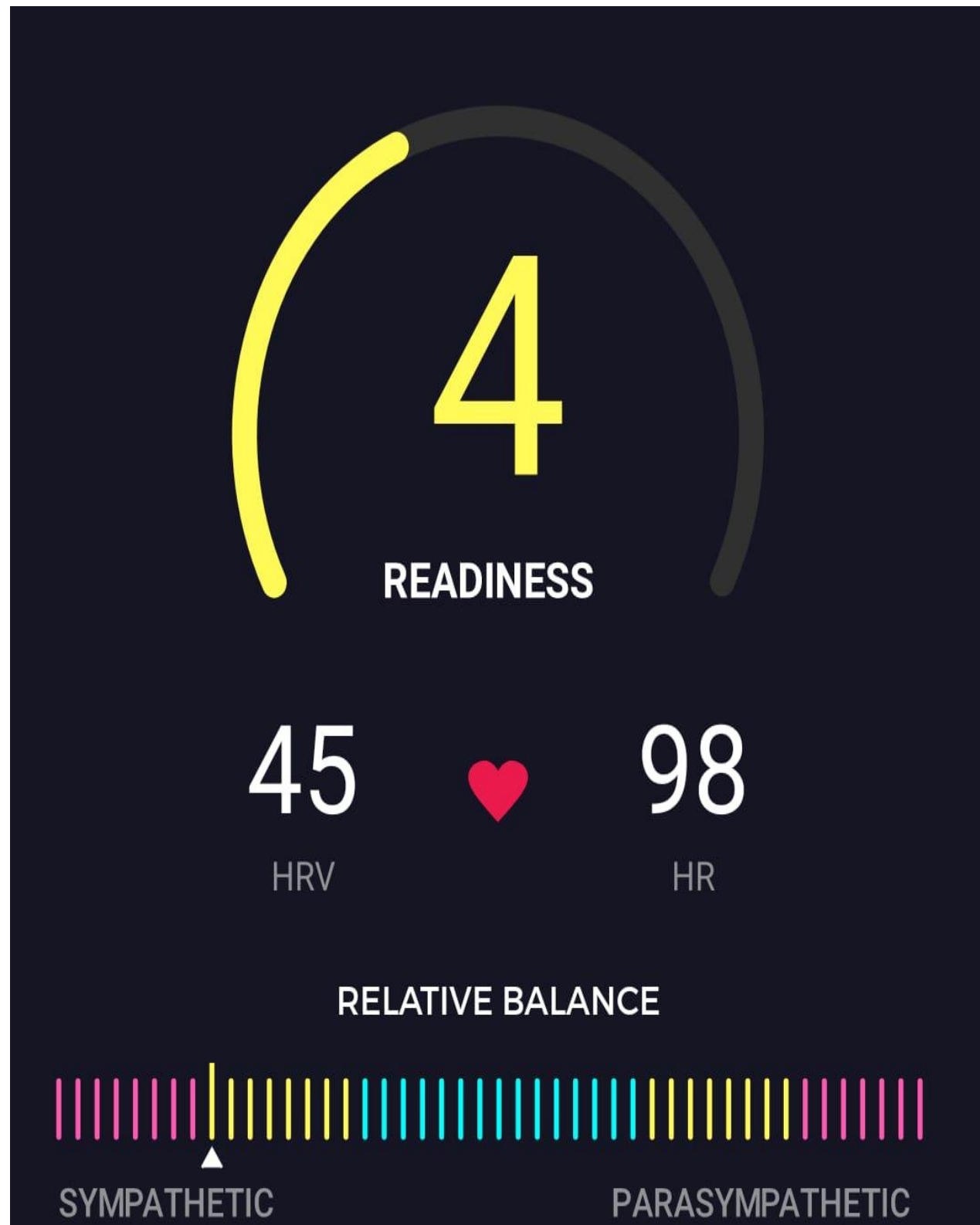
↑ Heart Rate



Normal/Rest Heartbeat

Longer interval between beats

↓ Heart Rate



Heart Rate Variability (HRV)

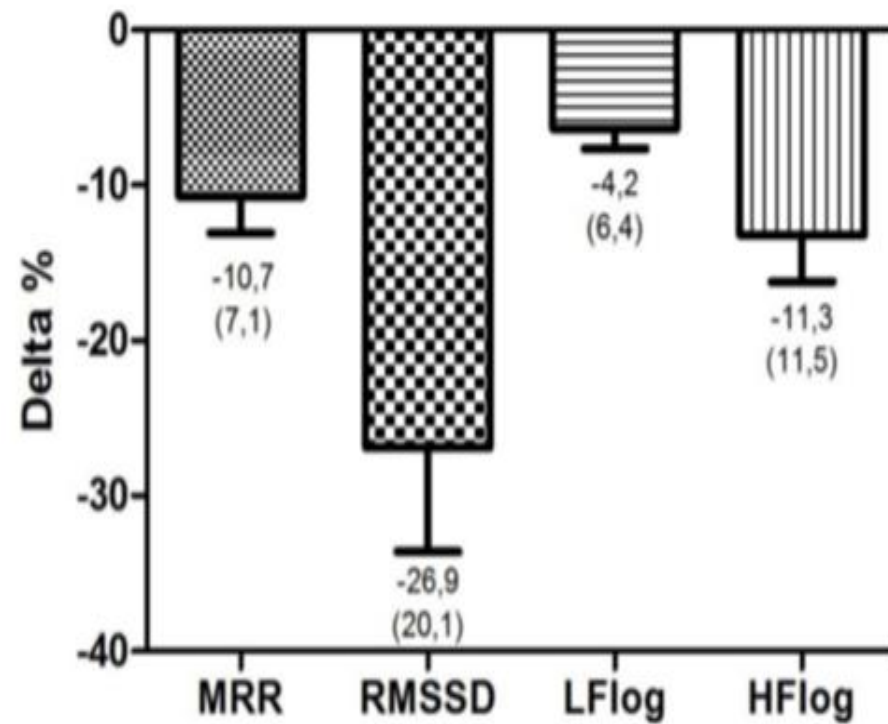
- Rest: parasympathetic dominance over the sympathetic system
- Health: ↓ HRV ↑ Risk of death from all causes
- Training/sport settings: ↑ VFC ↑ Better physical performance

HRV in Sport Context

Acute effect of one futsal training session in cardiac autonomic modulation of young players



Lower HRV values after training
(greater autonomic stress)



Ana Carolina PALUDO*
 Felipe Nunes RABELO**
 Bernardo MILOSKI*
 Enio Ricardo Vaz RONQUE***
 Helio SERASSUELO JUNIOR***
 Antônio Carlos SIMÕES*

Relationship to Training Load

TABELA 3 - Correlação (r) entre o percentual de mudança da VFC e métodos de CT.

	PSE (au)	TRIMP (au)	sPSE
MRR (ms)	0,579	0,460	0,579
RMSSD (ms)	0,286	0,550	0,286
LF (log)	-0,263	0,694*	-0,263
HF (log)	0,179	0,471	0,179

HRV in Sport Context

Seasonal Changes in Physical Performance and Heart Rate Variability in High Level Futsal Players

Increased HRV after a period of training (better heart function)

Table 3 Cardiac autonomic responses at the beginning of the pre-season period (M1), at the end of a 3-week pre-season (M2) and in the middle of the regular season (M3) for futsal players (n = 10).

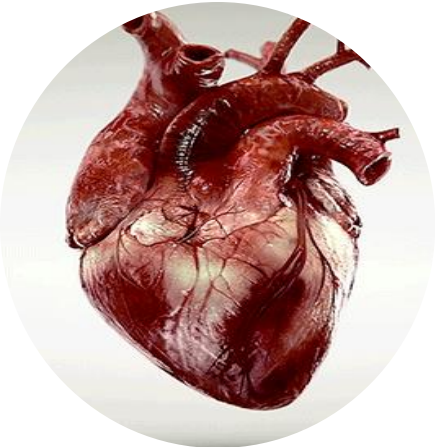
	M1	M2	M3	M1 vs. M2 ES [95% CI] – Rating	M1 vs. M3 ES [95% CI] – Rating	M2 vs. M3 ES [95% CI] – Rating
RRmean (ms)	808 (124.1)	880 (112.9)*	872 (85.7)	0.53 [0.28–0.78] small	0.47 [–0.23–1.17] small	–0.06 [–0.60–0.48] trivial
RMSSD (ms)	33 (16.8)	48 (20.8)*	42 (12.9)	0.80 [0.51–1.09] moderate	0.49 [–0.15–1.12] small	–0.31 [–0.98–0.35] small
HF (ms ²)	234 (210)	614 (146)*	496 (90)	0.86 [0.55–1.17] moderate	0.67 [0.23–1.11] moderate	–0.19 [–0.47–0.09] trivial
LF (ms ²)	1240 (150)	1808 (70)	1458 (77)	0.46 [0.02–0.90] small	0.20 [–0.49–0.88] small	–0.26 [–0.72–0.19] small
HF (nu)	18 (9.3)	28 (14.4)	28 (13.6)	0.94 [–0.03–1.91] moderate	0.96 [0.09–1.83] moderate	0.02 [–0.96–1.00] trivial
LF (nu)	82 (9.3)	72 (14.4)	72 (13.6)	–0.94 [–1.91–0.03] moderate	–0.96 [–1.83 – –0.09] moderate	–0.02 [–1–0.96] trivial
LF/HF ratio	7 (5.7)	4 (3.1)	4 (3.4)	–0.48 [–0.9 – –0.07] small	–0.46 [–1–0.08] small	0.02 [–0.24–0.27] trivial

Values are presented as mean (SD). * P<0.05 compared with M1. CI: confidence interval. ES: effect size. Criteria used to interpret the magnitude of the ES were: <0.2 trivial, >0.2–0.6 small, >0.6–1.2 moderate, >1.2 large



Training

Recovery



HEART RATE VARIABILITY

Select time period and parameter to highlight

60 Days No Highlight

HEART RATE VARIABILITY



Clearly identifies periods of **higher chronic stress**, when it can be helpful to hold back and reduce training intensity



HRV4T

Focus on the **big picture**



HRV in Sport Context

Heart-rate variability and precompetitive anxiety in swimmers

Julio César Cervantes Blásquez, Gil Rodas Font* and Lluís Capdevila Ortís
Universitat Autònoma de Barcelona and * Medical Services Futbol Club Barcelona

Training x Competition



Table 1
Comparison between the two conditions of the study for the HRV time domain and the Non Linear Analysis (Poincaré Plot) scores. (n= 10)

HRV	Training condition		Competition condition	
	Mean	SD	Mean	SD
Time Domain				
Mean RR (ms)	0,741	0,084	0,712	0,084
STDRR (ms)	0,032	0,011	0,033	0,016
HR (ms)	82,10	7,91	85,58	10,08
STDHR (ms)	3,56	1,52	3,90	1,18
RMSSD (ms) *	37,69	27,19	21,79	22,47
NN50	5,60	6,04	7,10	9,10
pNN50 (%)	1,41	1,51	1,85	2,59
IND.TRI	0,056	0,018	0,060	0,021
TINN (ms)	346,00	228,21	199,00	0,021
No Lineal Analysis (Poincaré Plot)				
SD1 ms *	27,50	20,01	15,73	16,23
SD2 ms	60,92	29,43	62,45	23,51

* $p < 0,05$. Wilcoxon signed rank test for paired samples

*** Higher HRV in training compared to competition

HRV in Sport Context

Brief communication

Pre-competitive anxiety and autonomic responses in professional U-20 futsal players: Effect of the competition phase and game location

Ana Carolina Paludo*, Tim Woodman, Julian A. Owen, Felipe N. Rabelo, Martina Bernaciková, Antonio Carlos Simões



Table 1

Pre-competition HRV and anxiety considering the game location and playoff stage ($n = 9$).

Variable	Quarter-finals		Semi-finals		Finals		<i>P</i> -value venue	<i>P</i> -value playoff stage	<i>P</i> -value interaction
	Home	Away	Home	Away	Home	Away			
Mean HR	70.3 ± 6.95	65.8 ± 9.26	72.2 ± 6.75	80.3 ± 9.79	74.6 ± 10.3	74.7 ± 7.76	0.603	0.014*	0.095
RMSSD	46.2 ± 17.7	61.6 ± 26.5	47.6 ± 27.0	38.1 ± 19.7	40.9 ± 20.2	48.9 ± 22.6	0.452	0.305	0.246
lnRMSSD	3.77 ± 0.39	3.48 ± 0.85	3.74 ± 0.50	3.31 ± 0.91	3.60 ± 0.70	3.79 ± 0.50	0.335	0.760	0.359
lnLF	7.57 ± 0.82	7.23 ± 0.62	7.34 ± 0.76	7.23 ± 0.87	7.25 ± 0.88	7.30 ± 0.58	0.529	0.852	0.743
lnHF	6.35 ± 0.869	6.77 ± 0.87	6.14 ± 1.01	6.02 ± 0.970	5.96 ± 1.08	6.36 ± 1.03	0.396	0.295	0.645
lnLF/HF	1.20 ± 0.13	1.08 ± 0.14	1.20 ± 0.17	1.21 ± 0.09	1.23 ± 0.09	1.17 ± 0.13	0.097	0.261	0.339
SD1	33.1 ± 12.6	44.1 ± 18.9	34.1 ± 19.2	27.3 ± 14.0	29.0 ± 14.3	34.6 ± 16.0	0.452	0.290	0.244
SD2	107 ± 34.4	135 ± 40.7	102 ± 35.4	95.5 ± 28.1	63.1 ± 20.4	67.2 ± 19.3	0.315	<0.001*	0.234
Anxiety-state									
Somatic	8.67 ± 2.74	9.33 ± 2.96	9.56 ± 3.43	9.78 ± 3.07	10.1 ± 3.76	10.8 ± 3.60	0.564	0.424	0.973
Cognitive	7.78 ± 2.22	7.89 ± 2.20	7.22 ± 2.22	7.56 ± 2.46	7.22 ± 2.22	7.33 ± 2.35	0.767	0.743	0.986
Self-confidence	18.4 ± 2.19	18.6 ± 1.67	18.9 ± 1.83	19.1 ± 1.69	19.3 ± 1.41	19.0 ± 1.73	1.000	0.505	0.883

* Significant difference in playoff stage ($p < 0.05$).

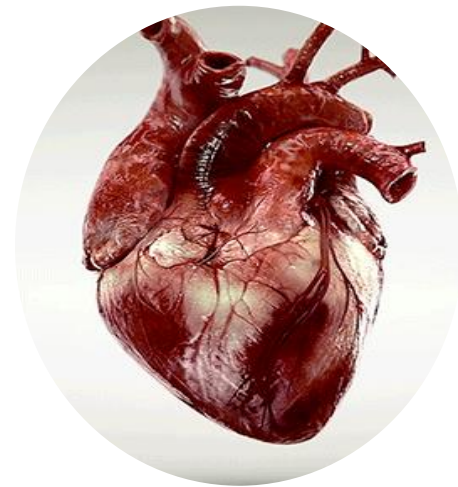
of increased sympathetic tone (or vagal activity) when playing away (*versus* home) and in the final stage (*versus* quarter and semi-final). The main findings of the present study partially corroborate the hypothesis formulated, indicating that playing the final stage was a challenging situation, compared to the quarter and semi-finals, showed by players' higher values of the Mean HR and a decrease in SD2 values. Nonetheless, the hypothesis about the game location, somatic and cognitive anxiety and self-confidence were refuted in the study. No difference amongst the playoff stages venue (home *versus* away) for pre-competition HRV and anxiety-state was verified. This result suggests that the players in the present study consider the final stage a stressful factor independent of the game location.

Chronic Stress

Acute



Chronic



Psychological reasons



- Muscular myopathy (atrophy)
- Inefficient energy use
- Increased likelihood of diabetes
- Increased BP = hypertension
- Damage to the cardiovascular system
(atherosclerosis)

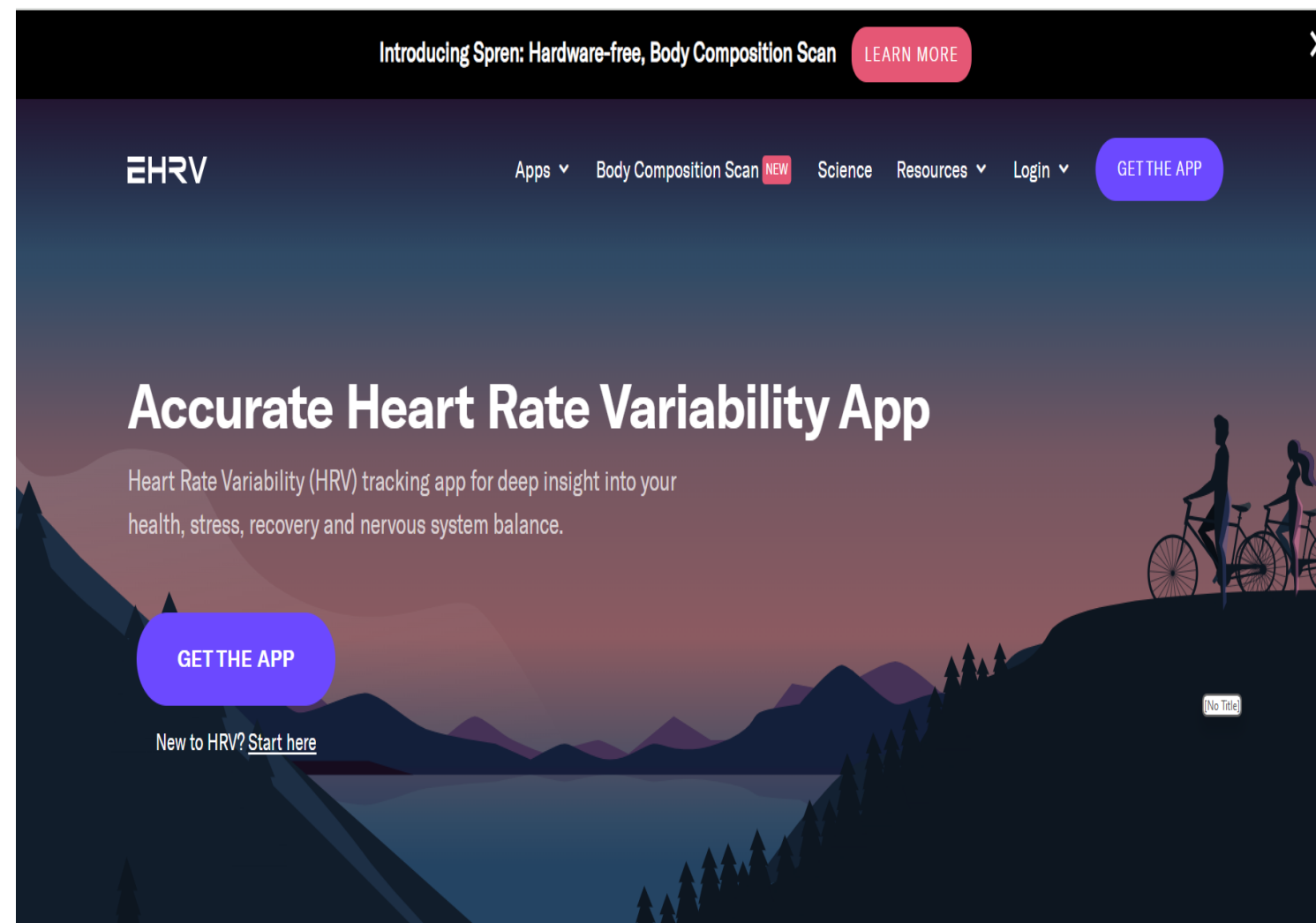


Obrigada



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Homework- next class: download app ELITE HRV (free)



Next class: testing the app