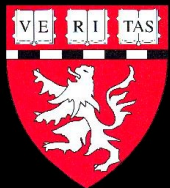


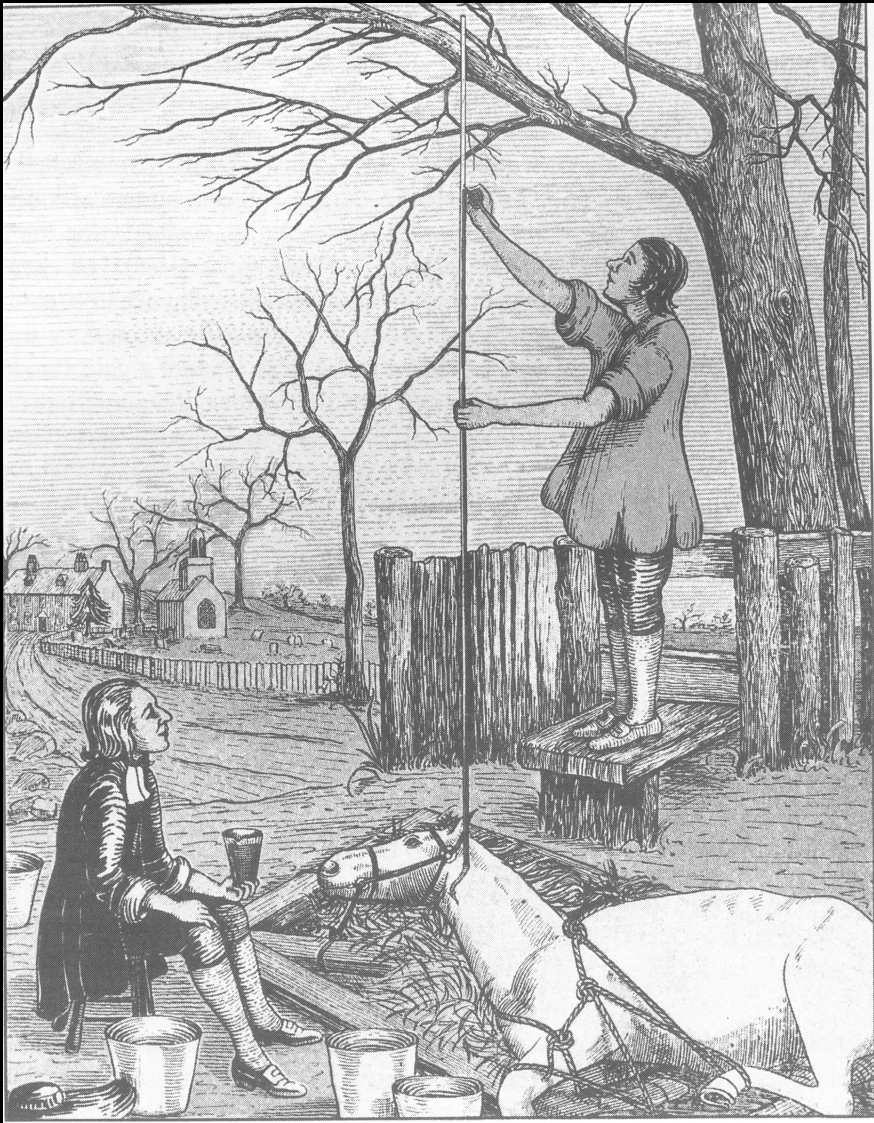
Observation and Estimation of Human Cardiovascular Autonomic Control: When Does the Physiology Coincide?



J. Andrew Taylor, PhD



SRH Cardiovascular Research Laboratory
Dept of Physical Medicine & Rehabilitation
Harvard Medical School



“When it was at its full height, it would rise and fall at and after each pulse two, three or four inches; and sometimes it would fall twelve or fourteen inches, and have there for a time the same vibrations up and down at and after each pulse, as it had when it was at its full height, to which it would rise again, after forty or fifty pulses.”

Stephen Hales, 1733

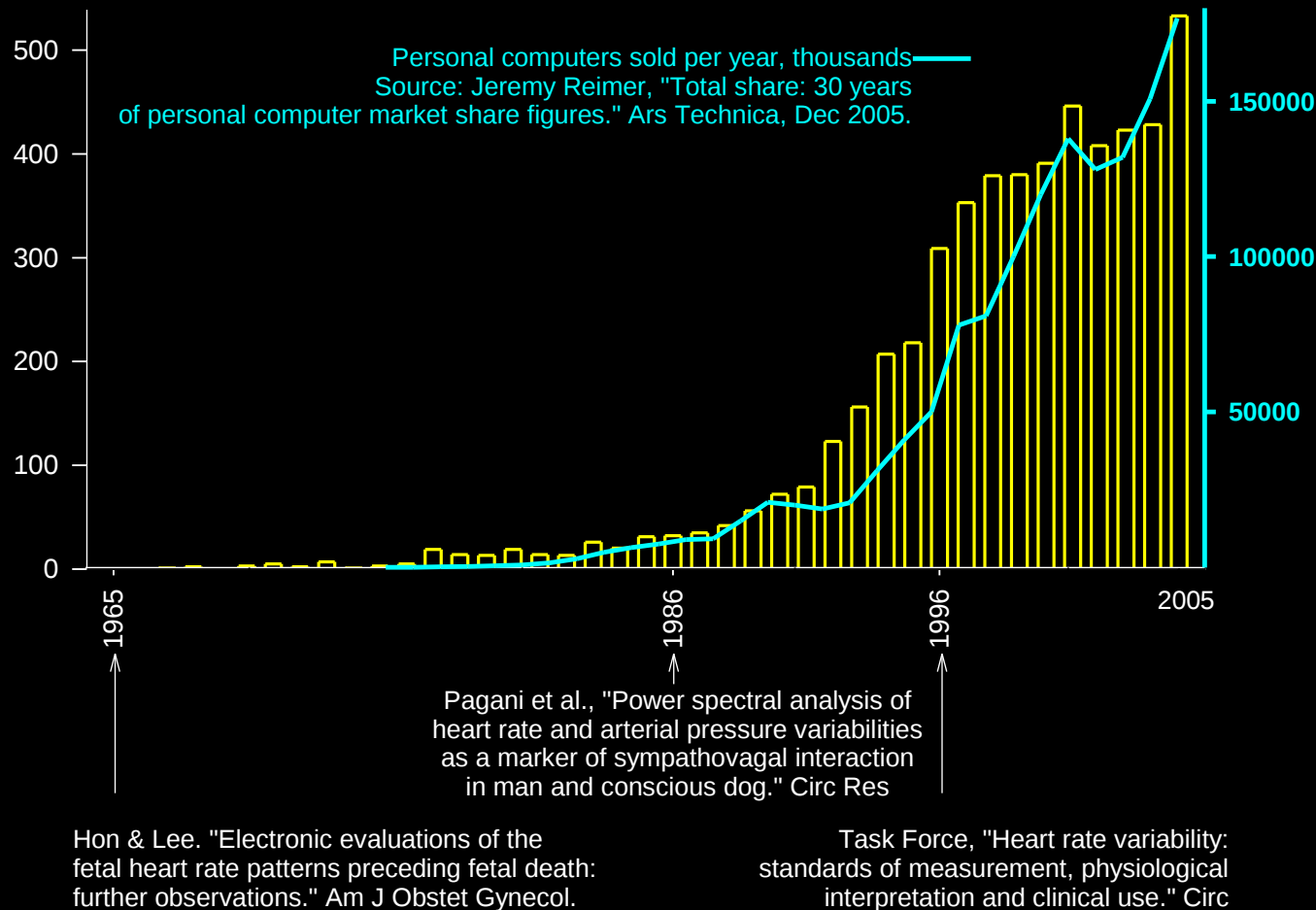
“Heart rate variability represents one of the most promising quantitative markers for autonomic activity.”

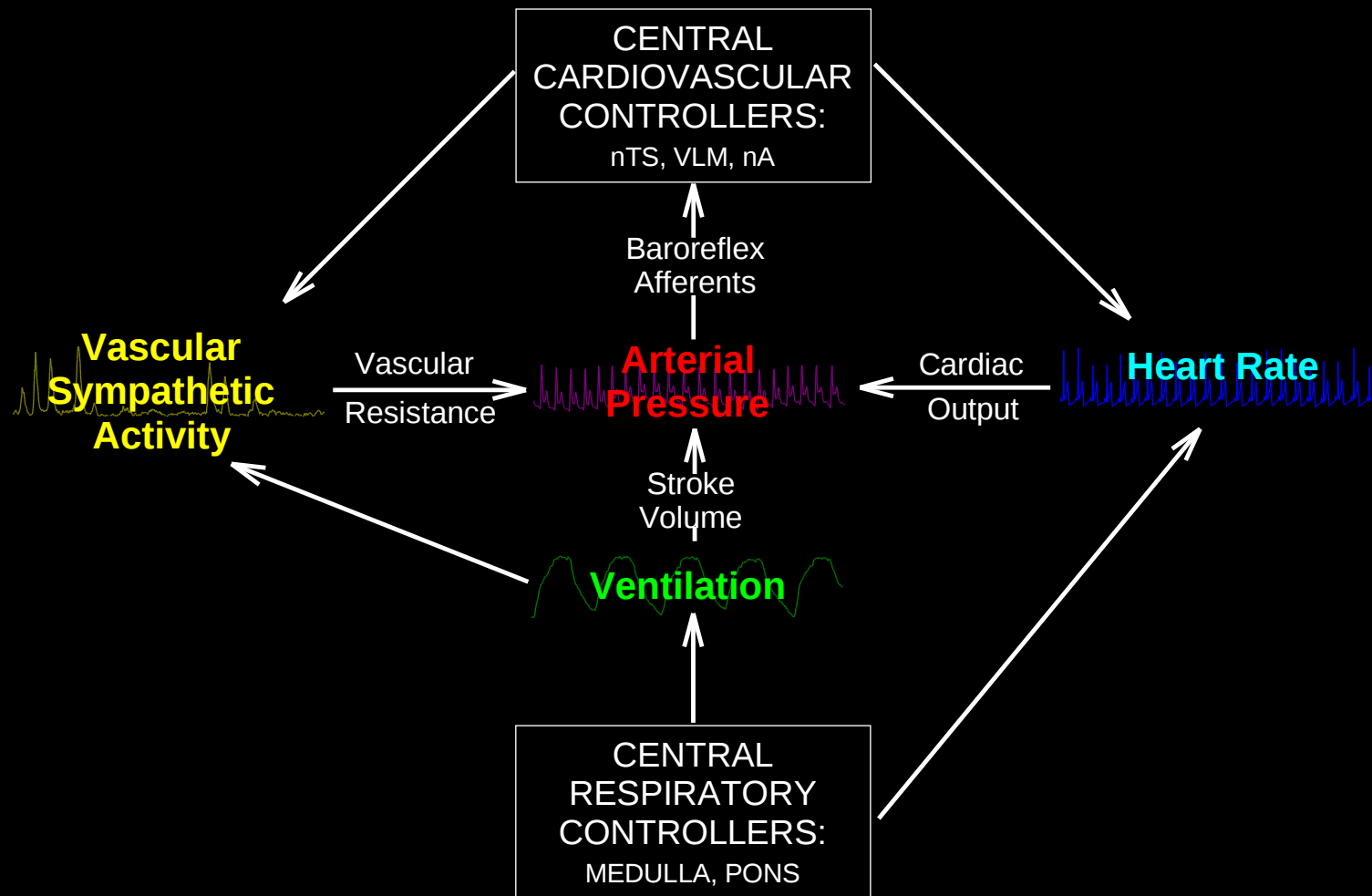
Heart rate variability: Standards of measurement, physiological interpretation, and clinical use.
Circulation, 1996

“This report recognizes the importance of heart rate variability as a tool for assessing the integrity of the autonomic nervous system . . .”

Committee Report. Heart rate variability: Origins, methods, and interpretive caveats.
Psychophysiology, 1997

Publications/year
(PubMed search:
"heart rate variability")



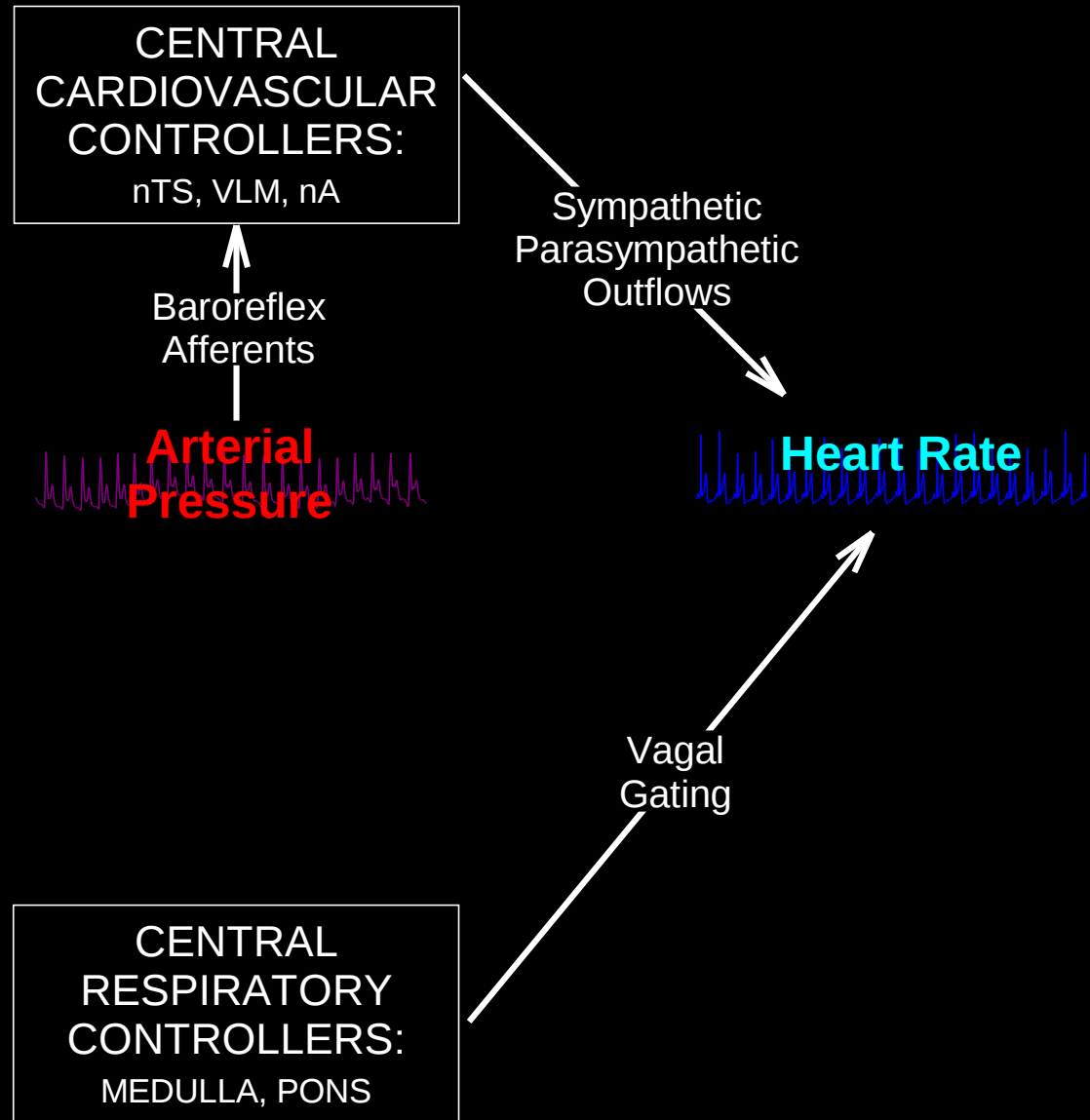


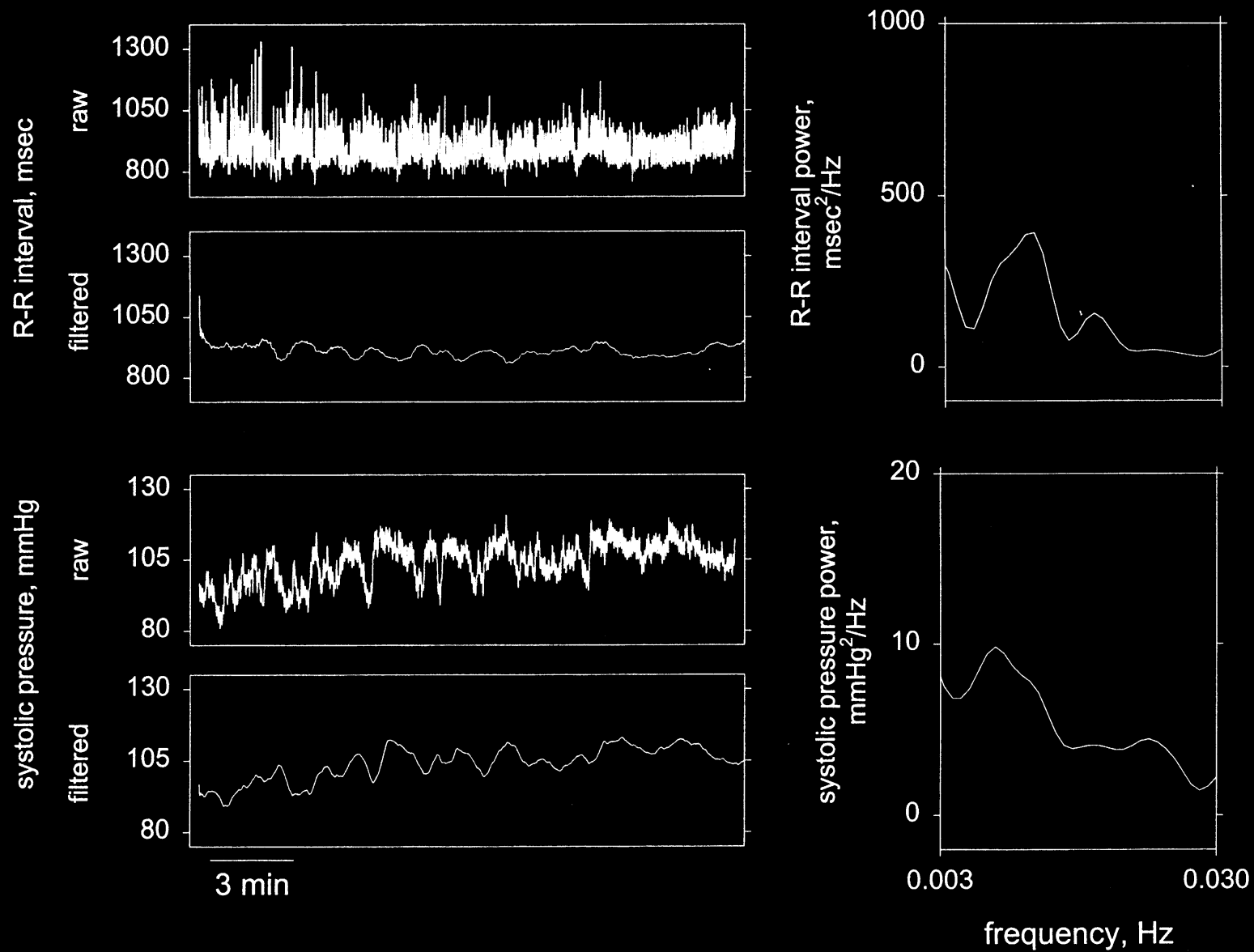
Determining the Autonomic Control of Heart Rate Oscillations

The importance of cardiac vagal outflow
and the role of cardiac sympathetic outflow

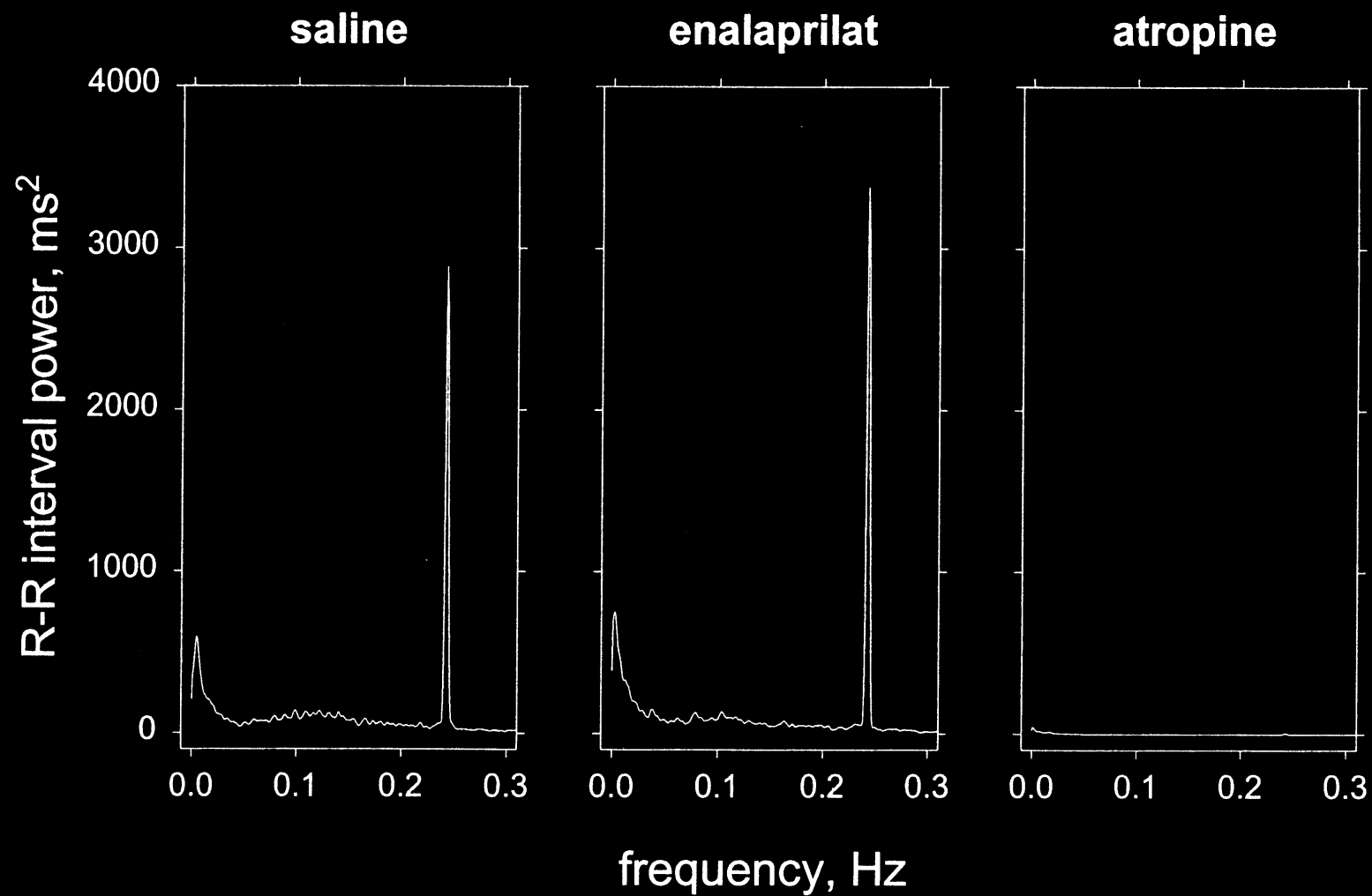
Taylor, Carr, Eckberg.
Circulation 1998

Taylor, Myers, Halliwill, Seidel, Eckberg.
American Journal of Physiology 2001

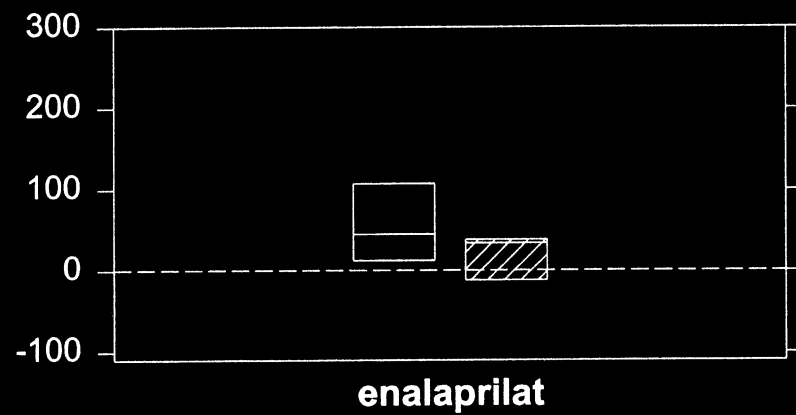
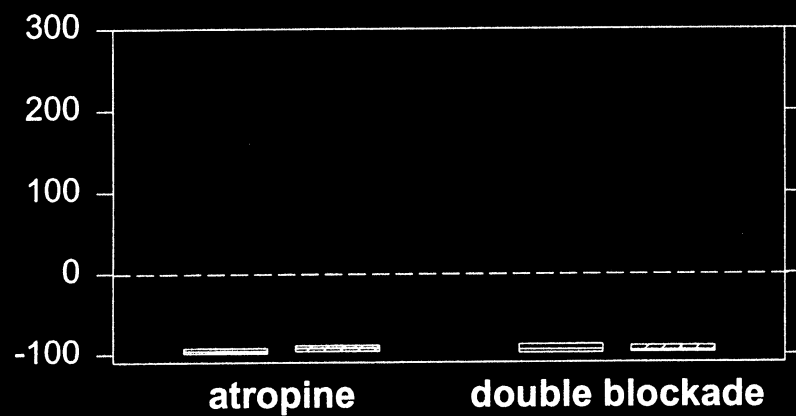
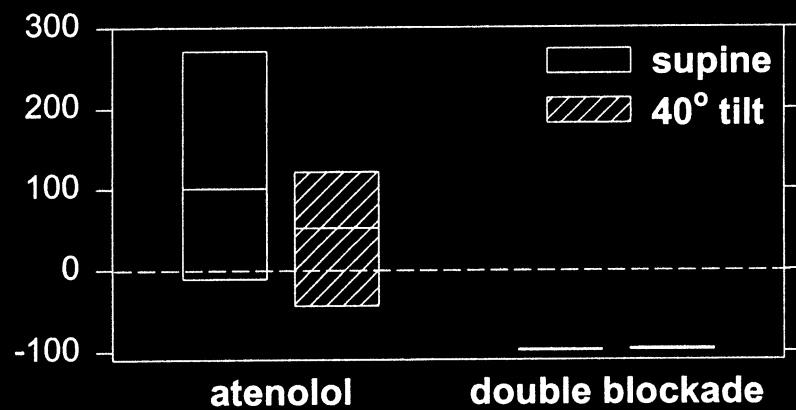


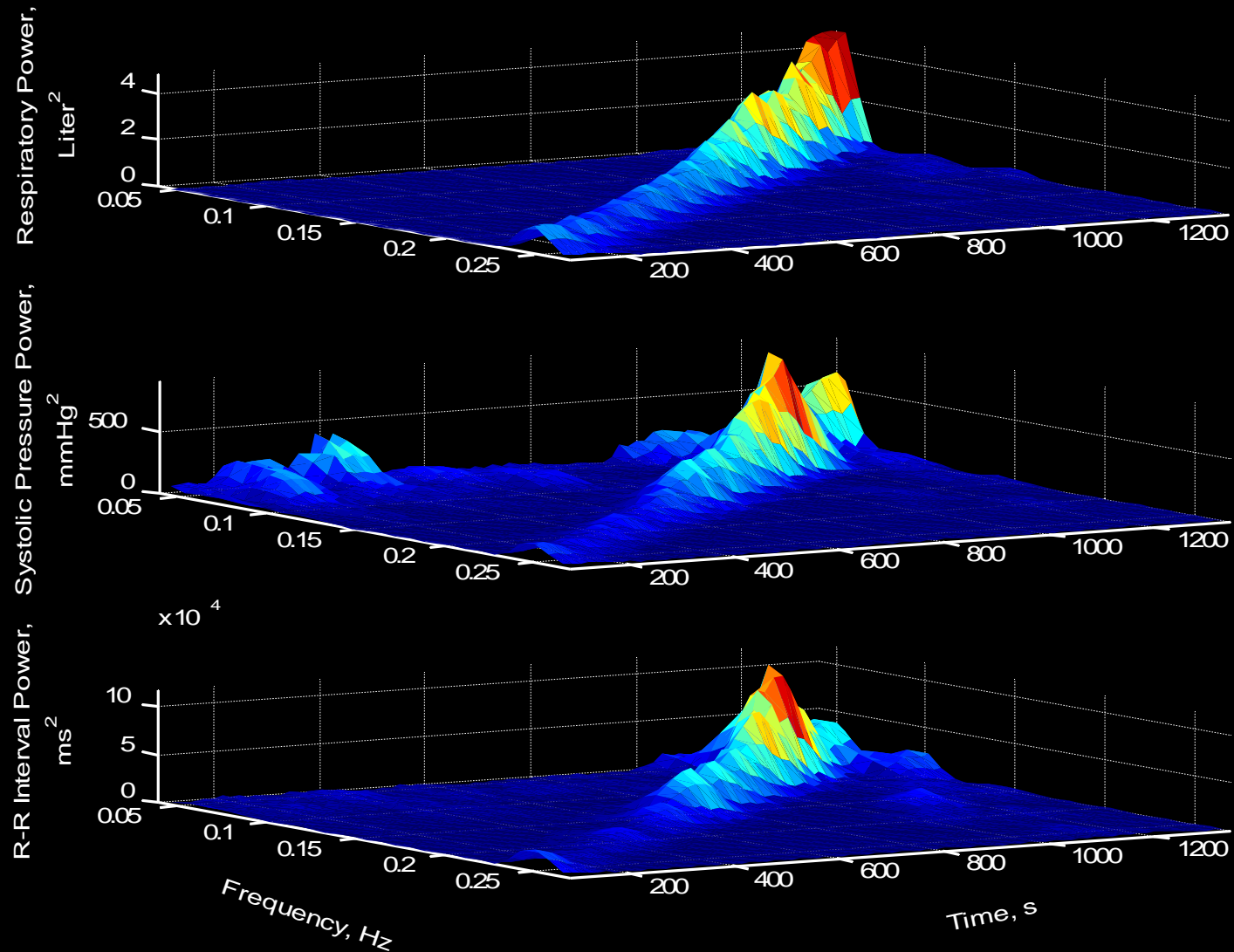


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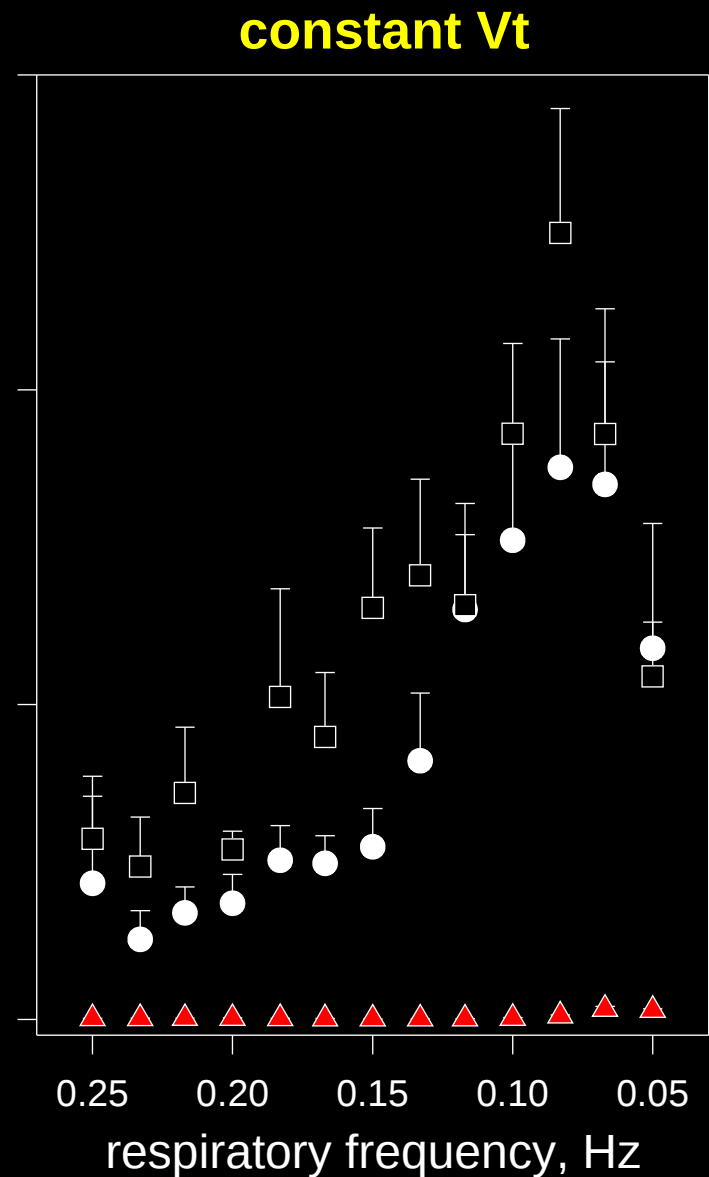
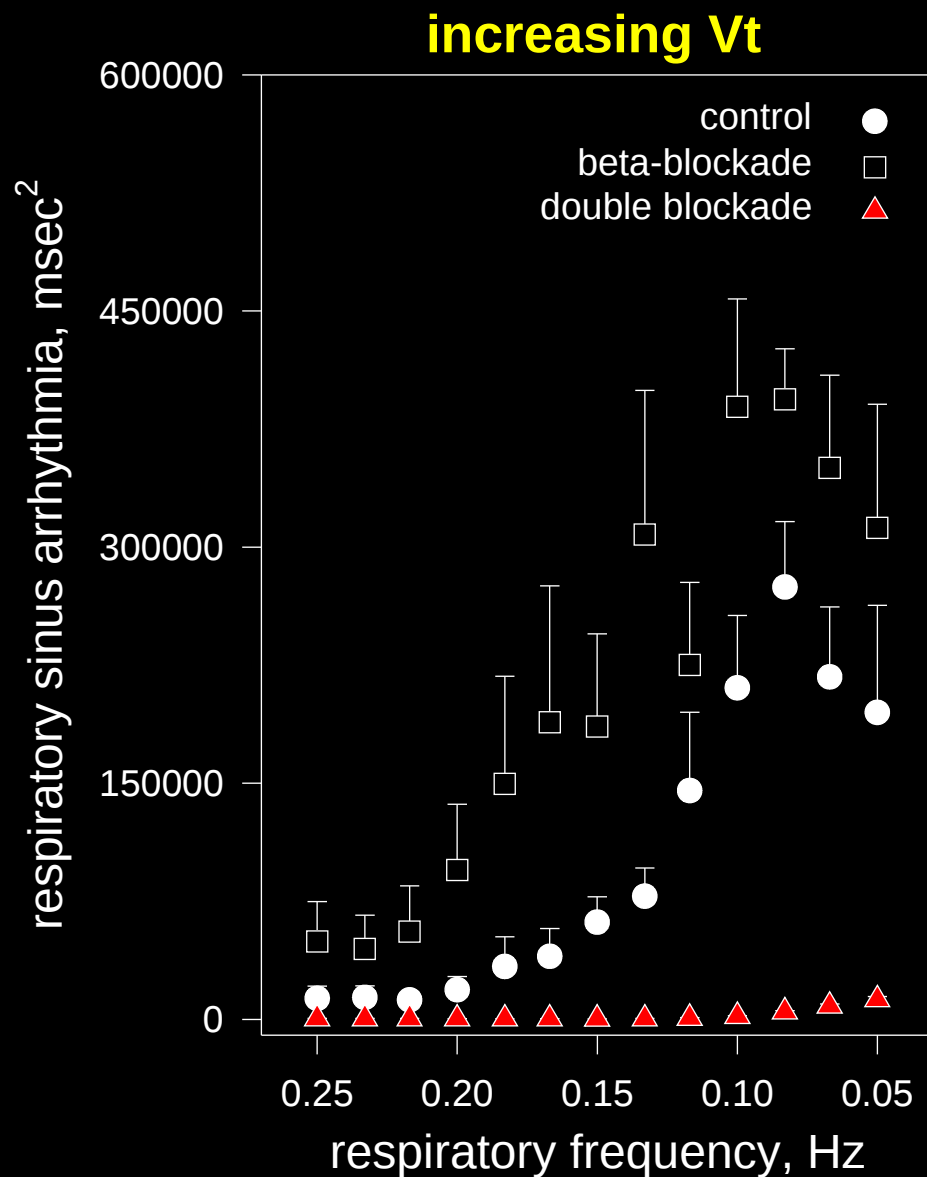


Δ 0.003-0.030 Hz R-R interval spectral power, %

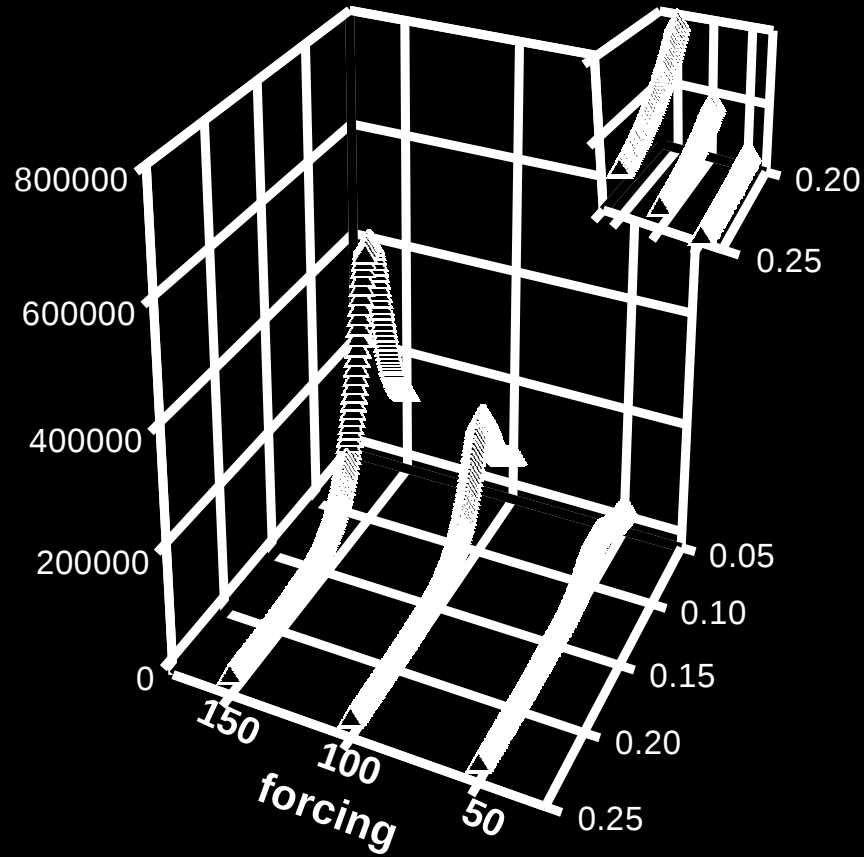




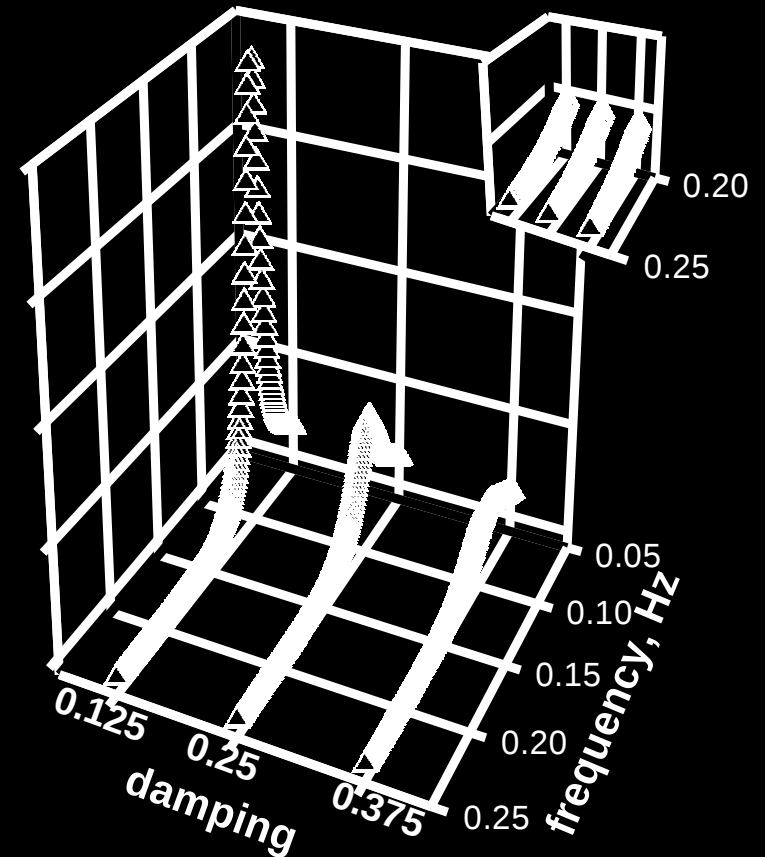
Taylor, Myers, Halliwill, Seidel, Eckberg. American Journal of Physiology 2001

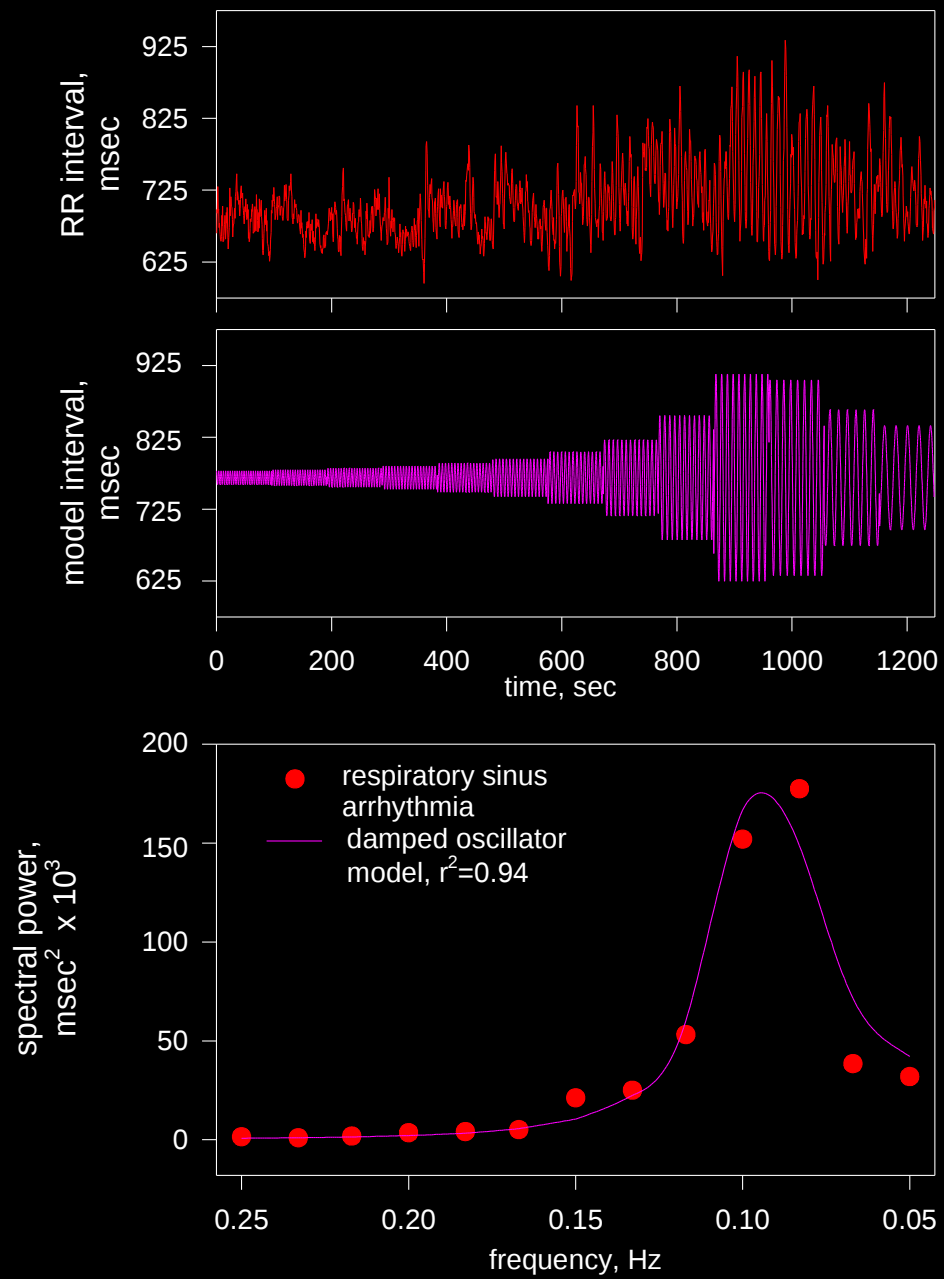


EFFECT OF FORCING
(Damping at 0.25)

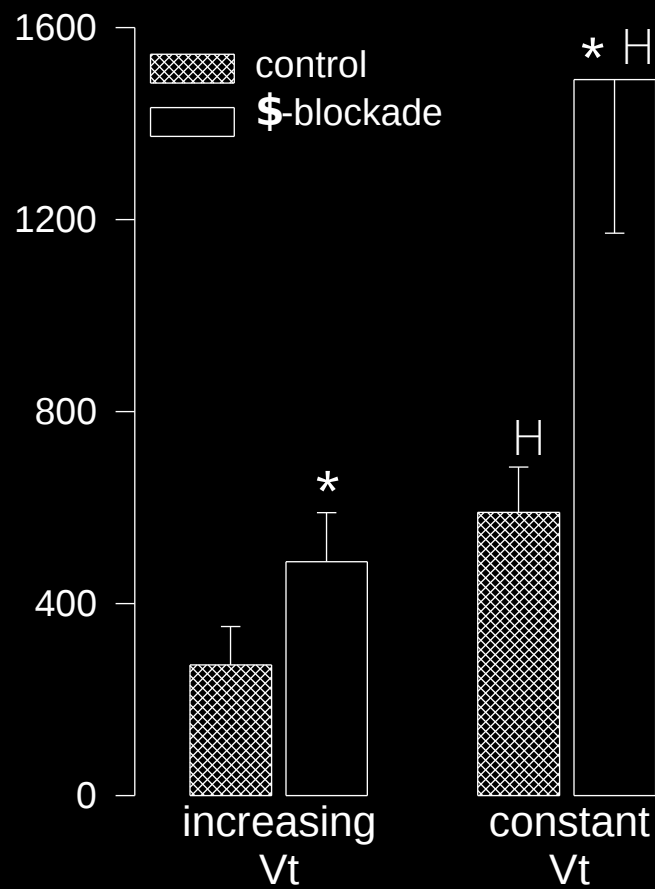


EFFECT OF DAMPING
(Forcing at 100)

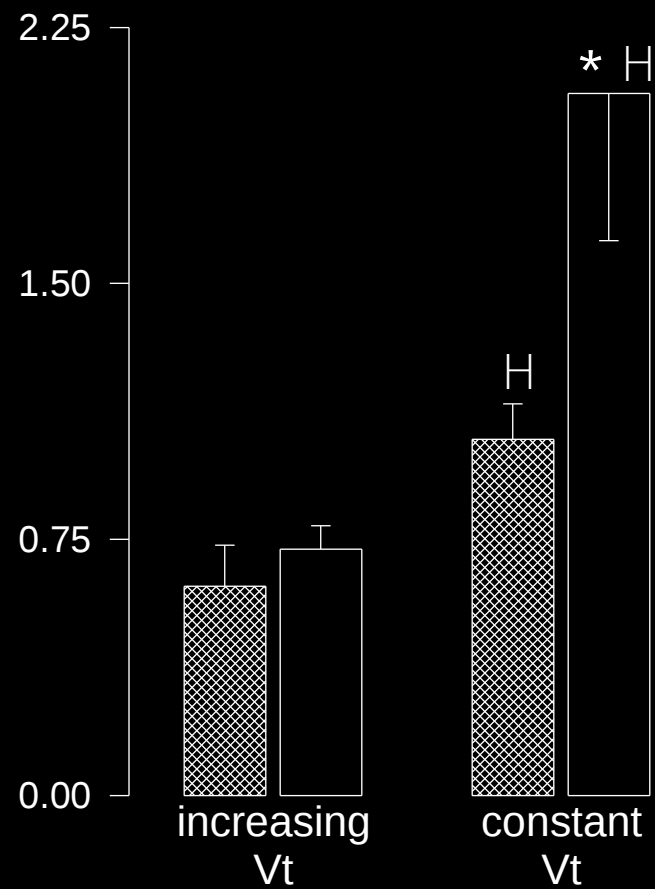




driving force



damping influence



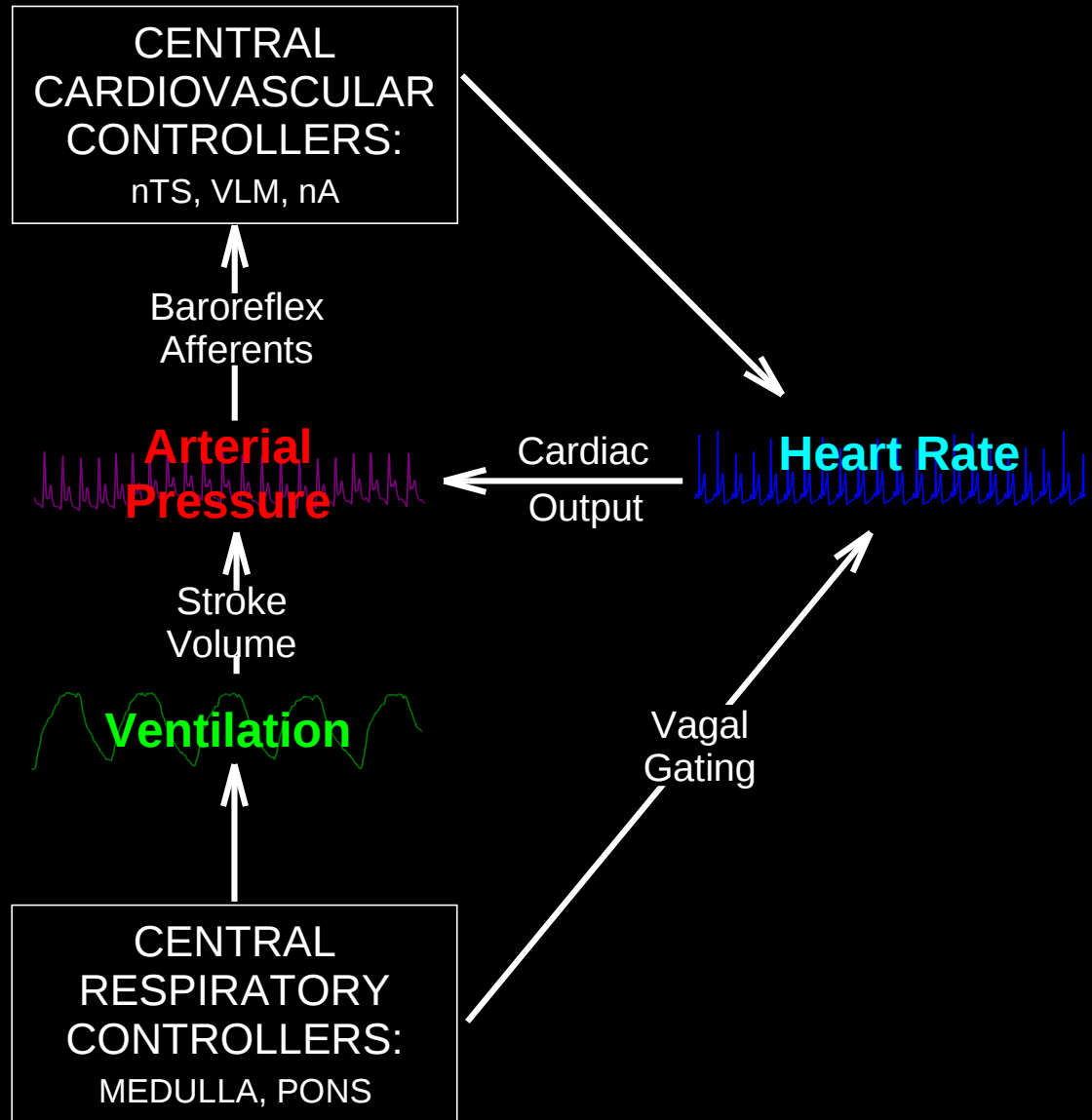
Testing the Link Between Pressure and Heart Rate Oscillations

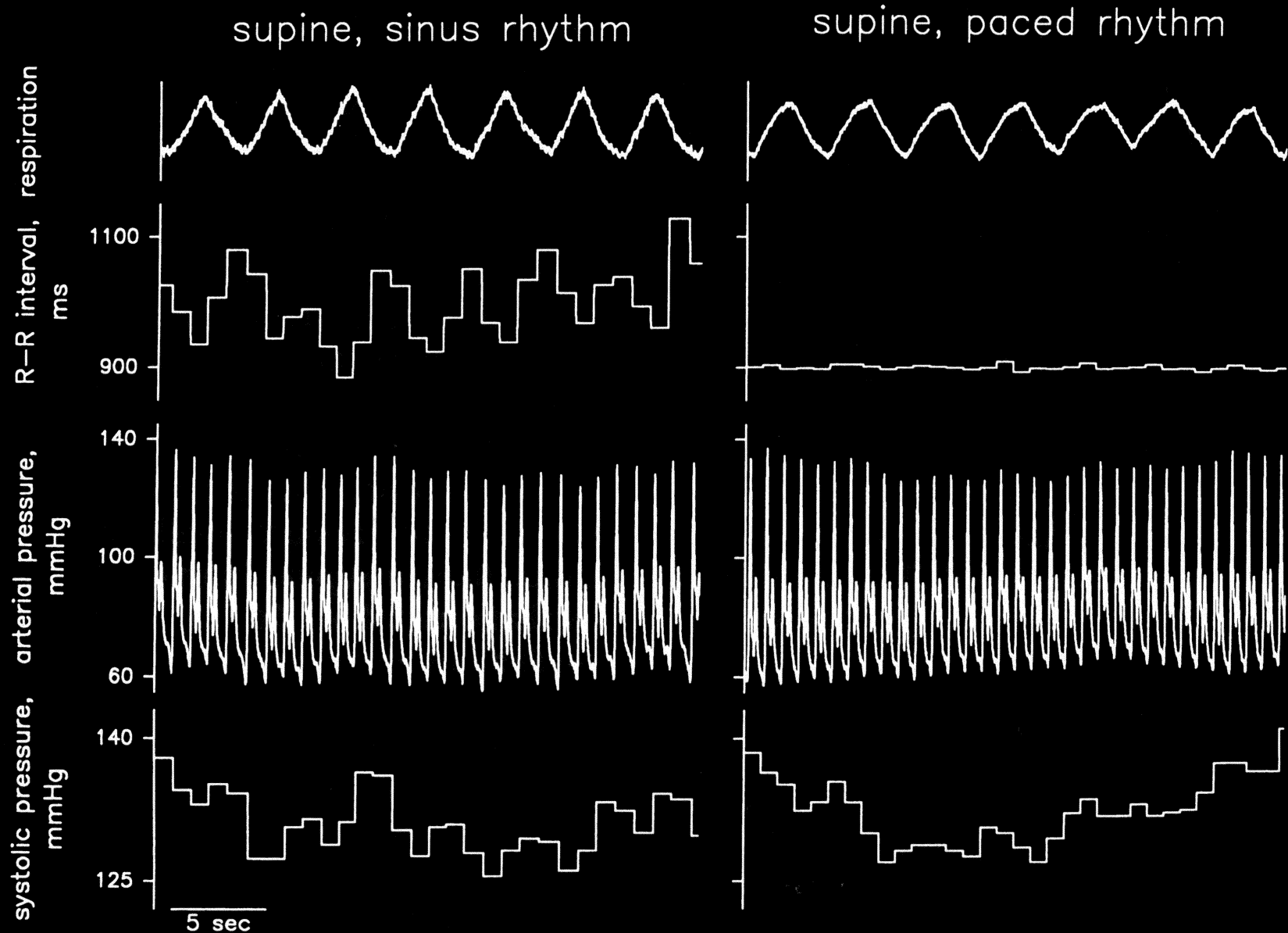
The role of the heart in buffering blood pressure fluctuations

Taylor, Eckberg.
Circulation, 1996

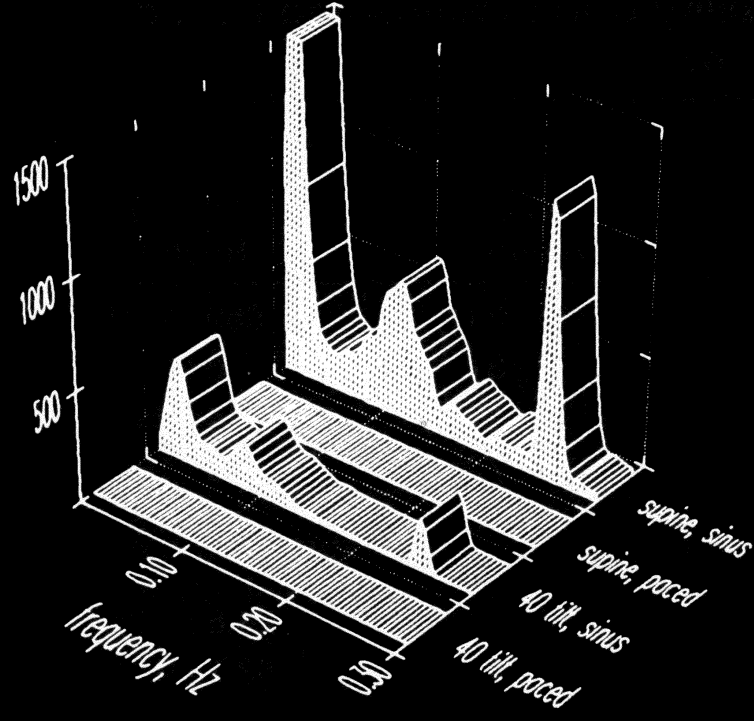
Tan, Taylor.
American Journal of Physiology, 2010

Hamner, Morin, Rudolph, Taylor.
Journal of Applied Physiology, 2001

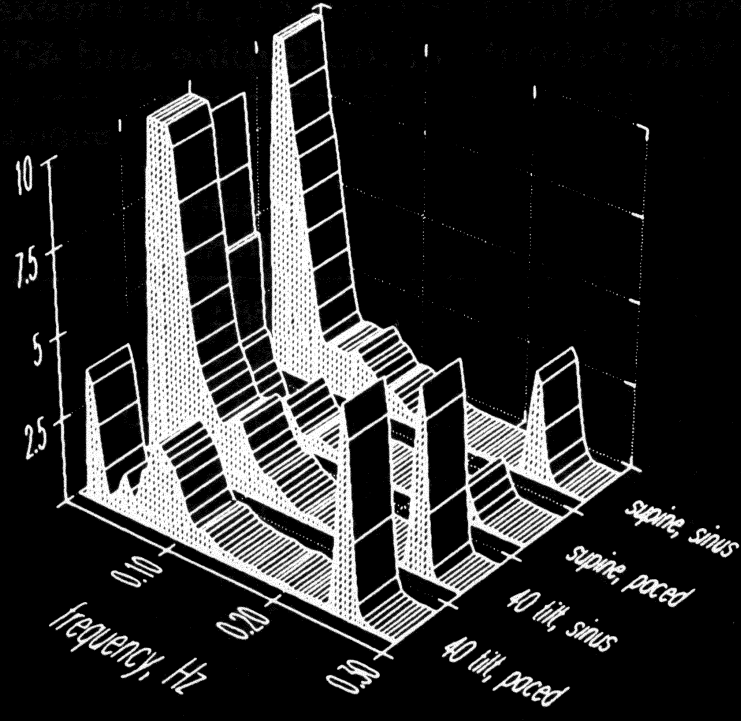




R-R interval power,
 msec^2/Hz



systolic pressure power,
 mmHg^2/Hz

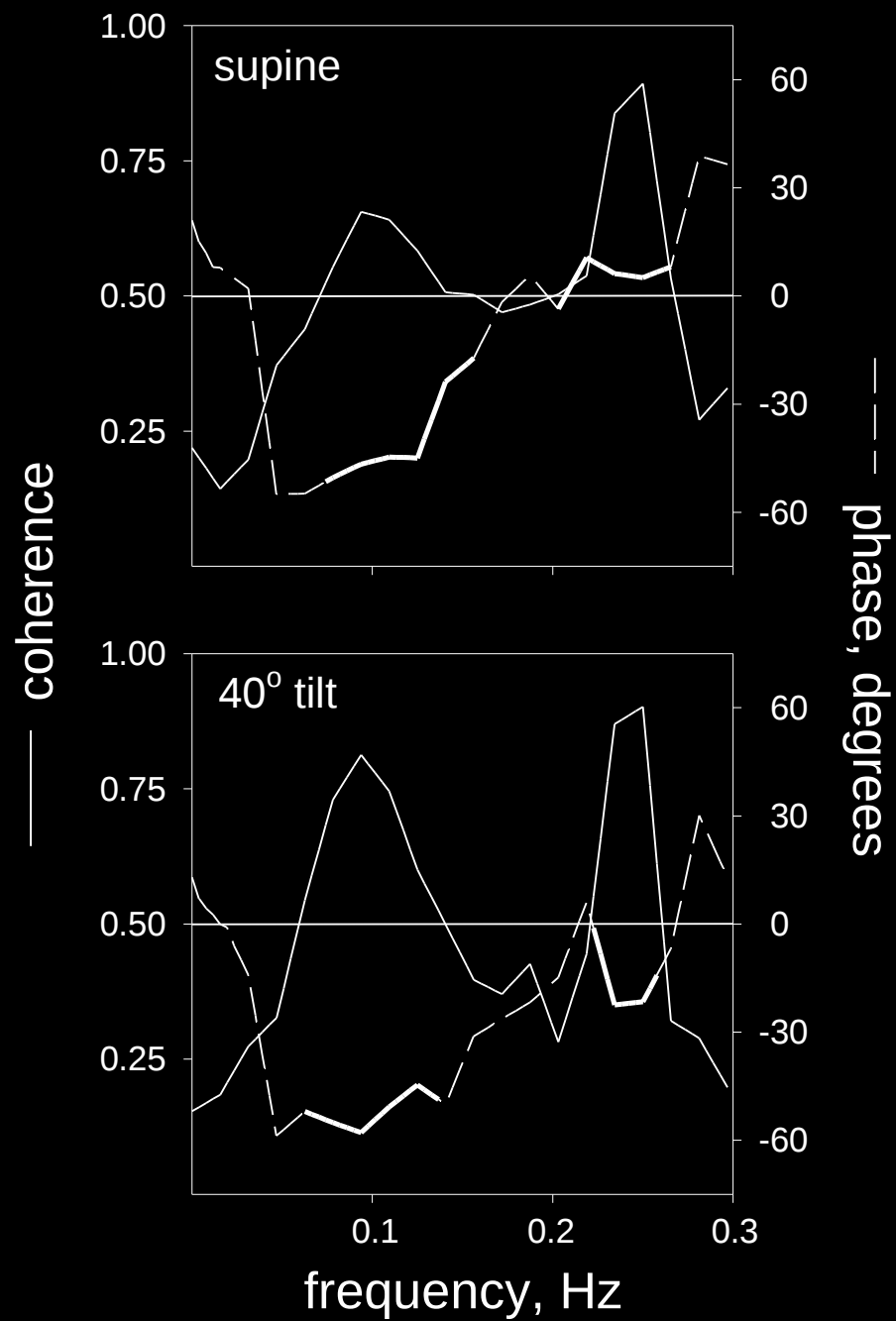


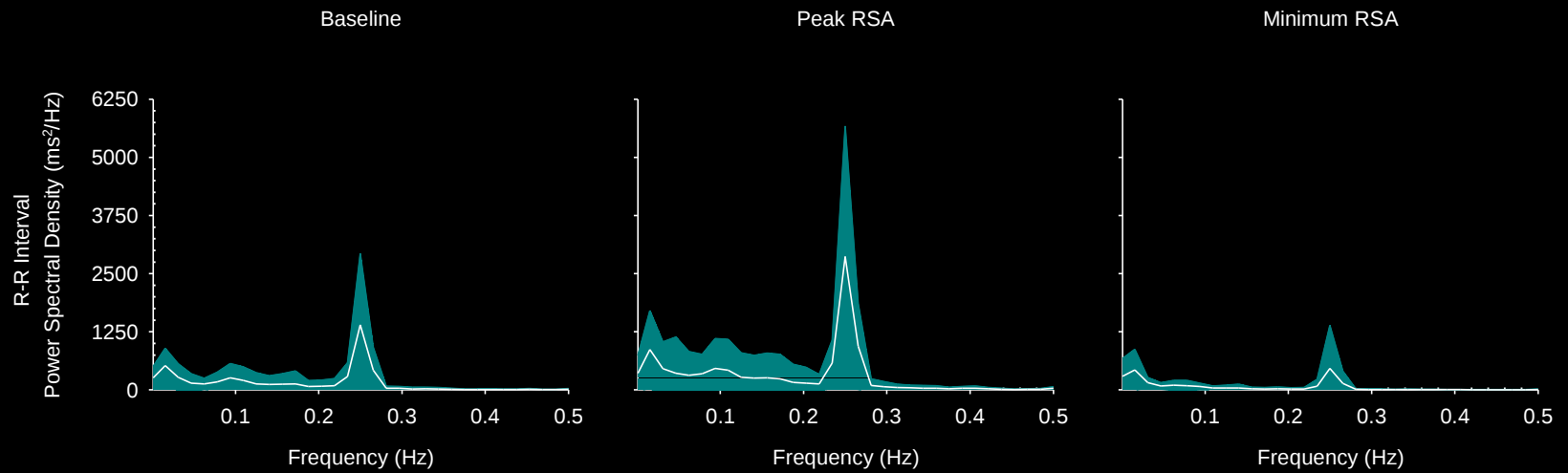
Average RR Intervals, Arterial Pressures, and Indexes of Variability During Sinus and Paced Cardiac Rhythm With Patients in the Supine and 40° Tilt Positions

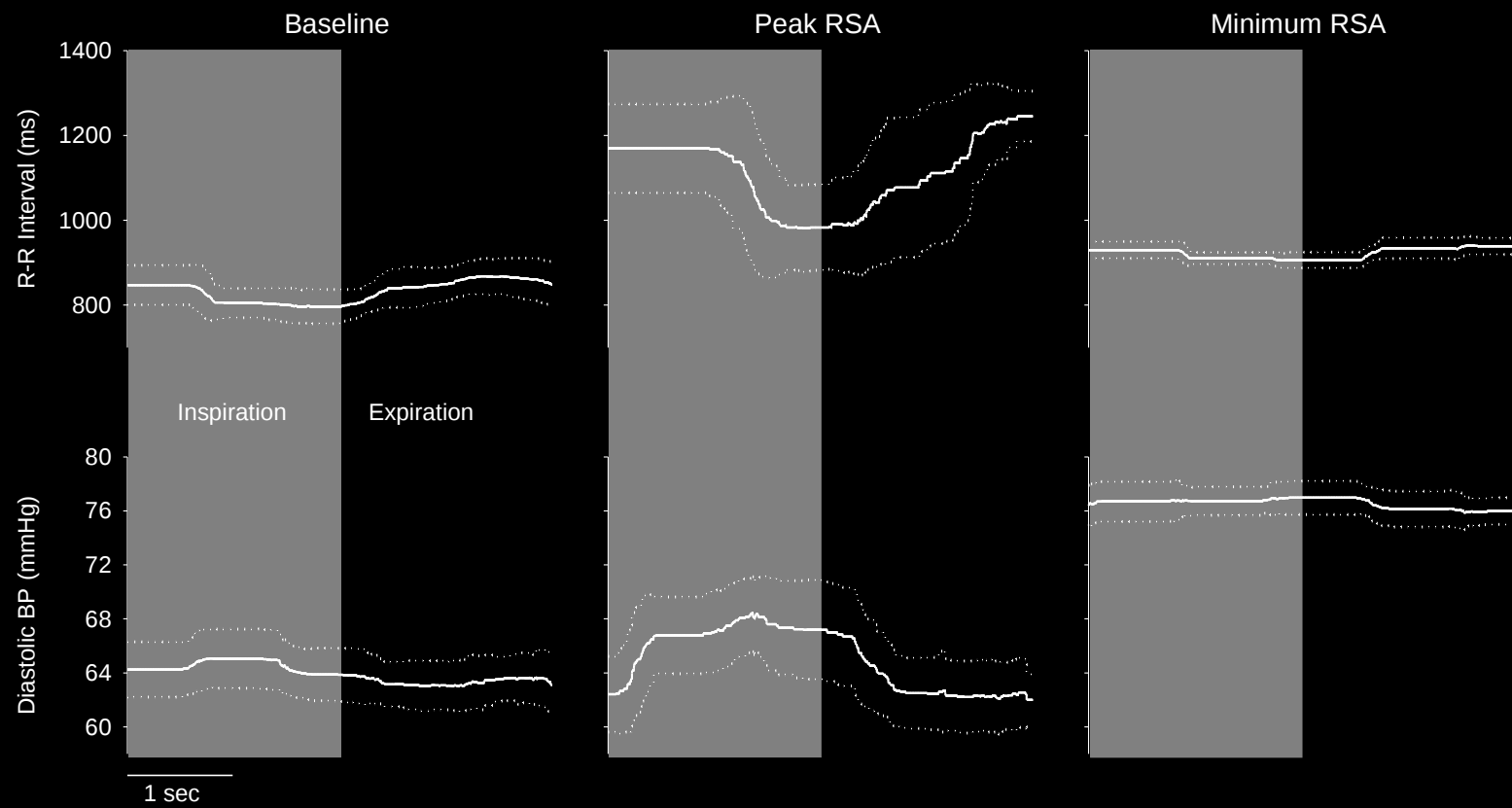
	Supine		40° Tilt	
	Sinus Rhythm	Paced Rhythm	Sinus Rhythm	Paced Rhythm
RR interval, ms	988±42	772±34*	813±34†	659±22*†
SD, ms	67±5	4±1*	39±3†	6±2*
Low-frequency power, ms ²	3853±1210	8±2*	1190±157†	44±26*
Respiratory-frequency power, ms ²	2995±726	10±2*	422±72†	30±18*
Arterial pressure, mm Hg	139/66	139/68	127/68	131/73
Low-frequency power, mm Hg ²				
Systolic pressure	11.3±3.0	10.5±2.1	19.4±3.0†	24.6±5.2†
Diastolic pressure	21.0±5.2	21.6±4.2	29.9±4.3†	58.7±9.1*†
Respiratory-frequency power, mm Hg ²				
Systolic pressure	6.8±1.8	2.9±0.6*	8.0±1.8	10.8±2.6*†
Diastolic pressure	3.0±0.4	2.3±0.4*	3.9±1.0	8.0±1.8*†

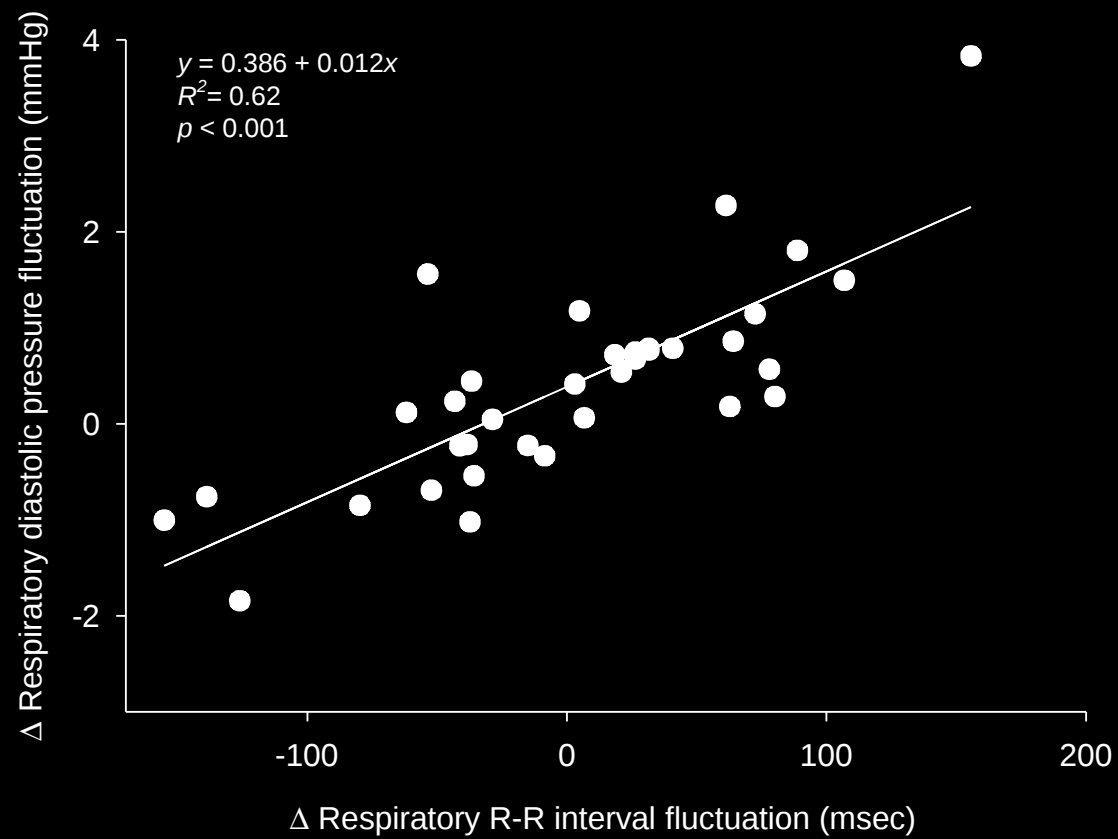
* $P < .05$ vs sinus rhythm.

† $P < .05$ vs supine position.









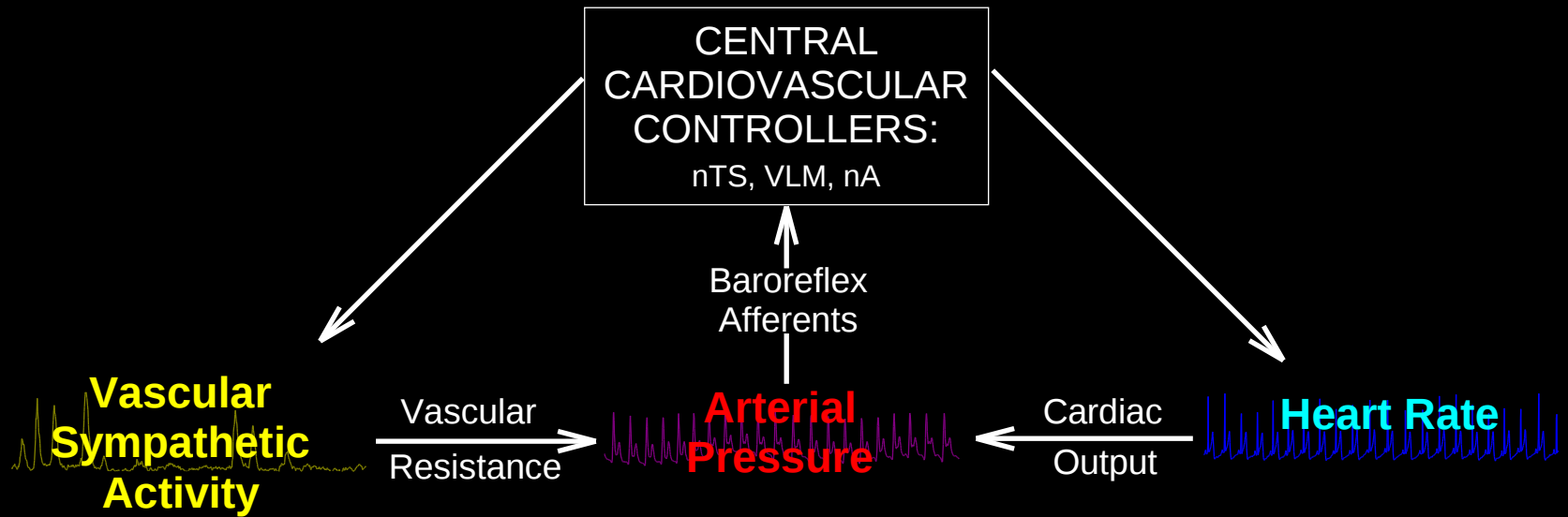
Hamner, Morin, Rudolph, Taylor. Journal of Applied Physiology 2001

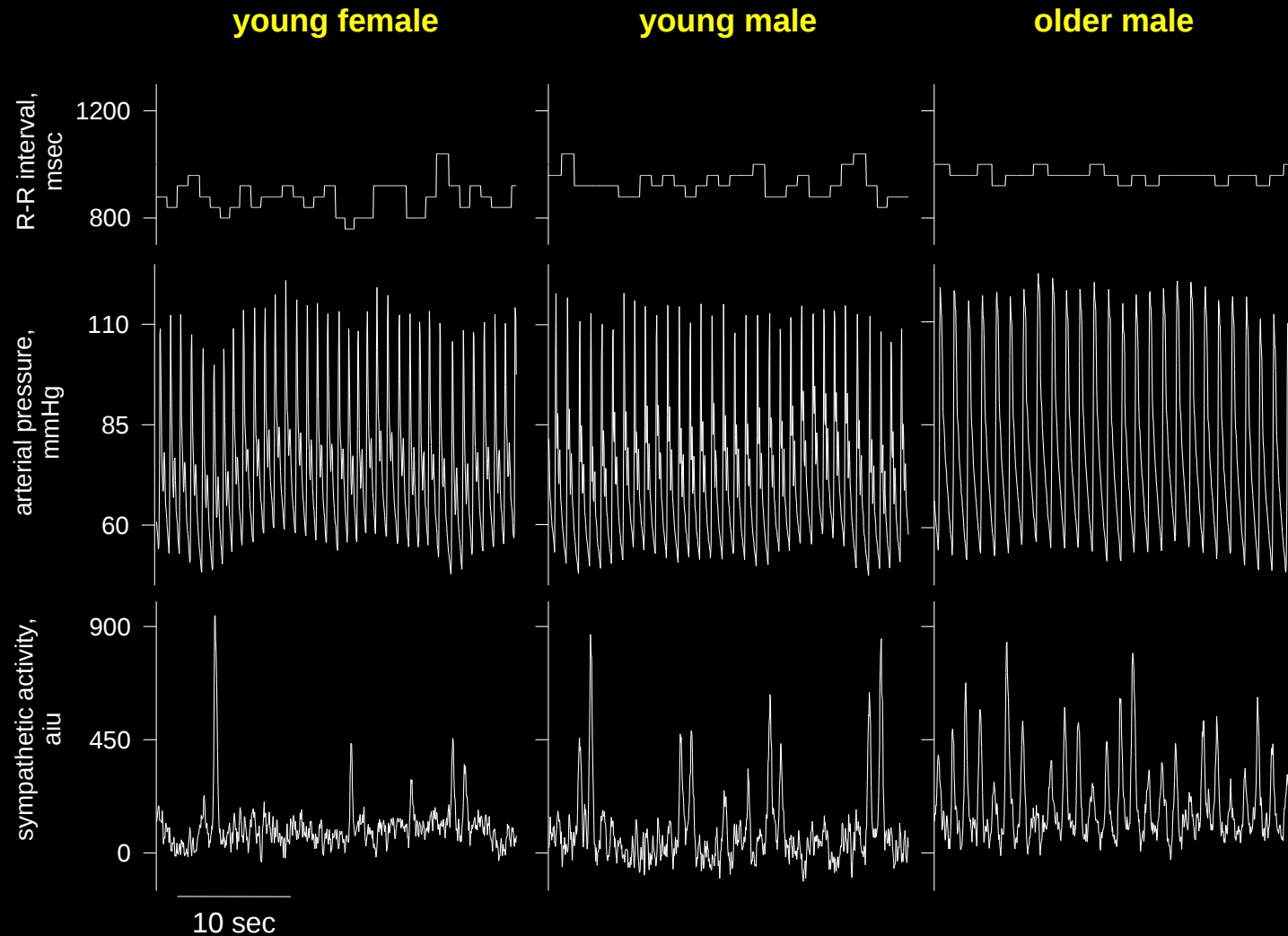
Empiric Assessment & Theoretic Modeling of Arterial Pressure Mayer Waves

Relations between sympathetic outflow and
low frequency blood pressure fluctuations

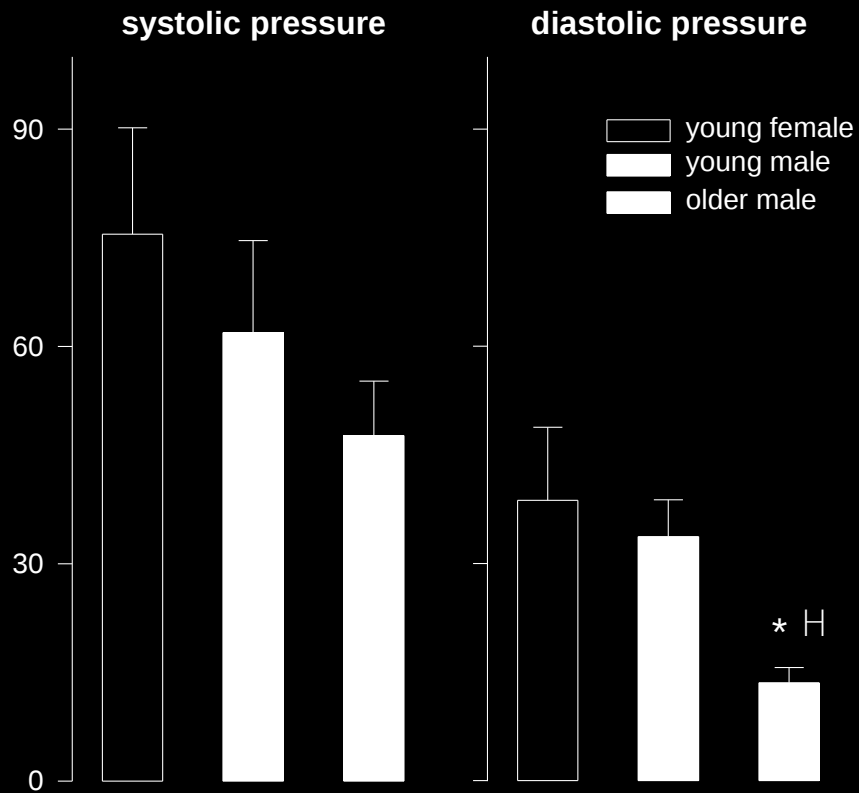
Taylor, Williams, Seals, Davy.
American Journal of Physiology 1998

Myers, Cohen, Eckberg, Taylor.
Journal of the Autonomic Nervous System 2001

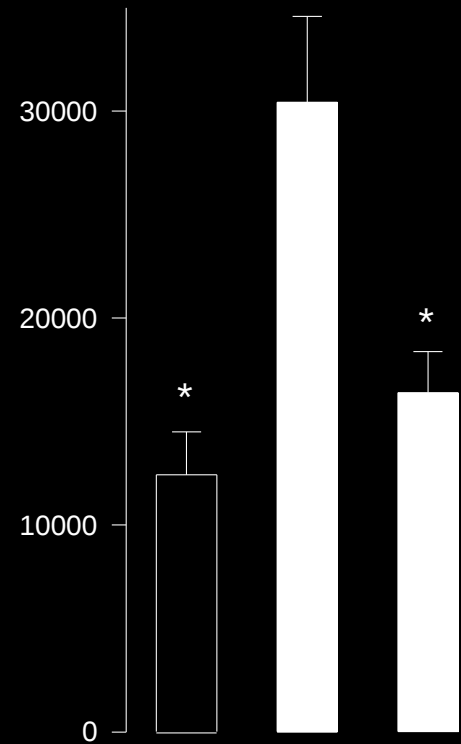




Mayer wave amplitude, mmHg²



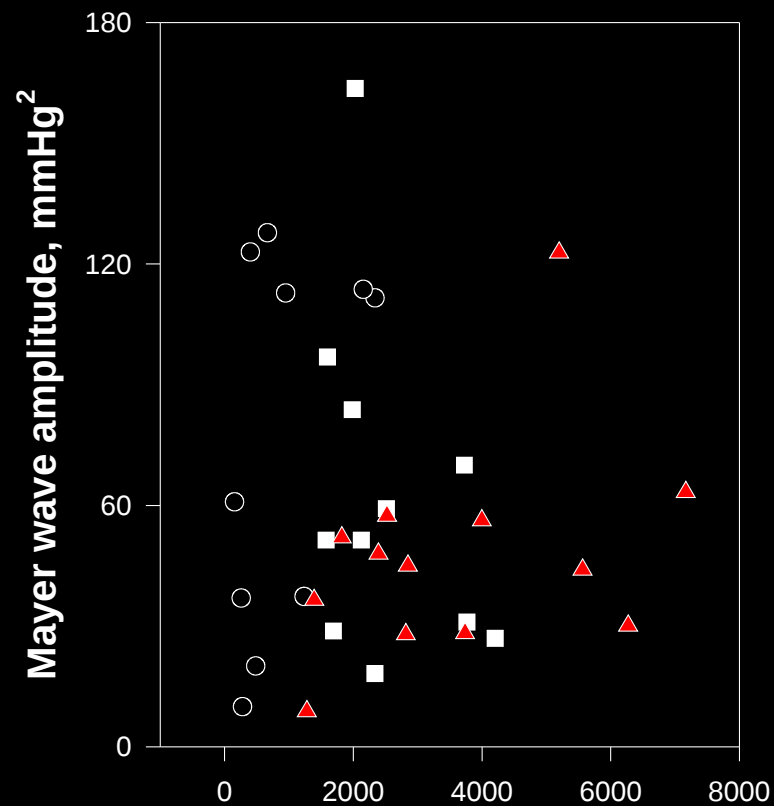
low frequency sympathetic variability, aiu²



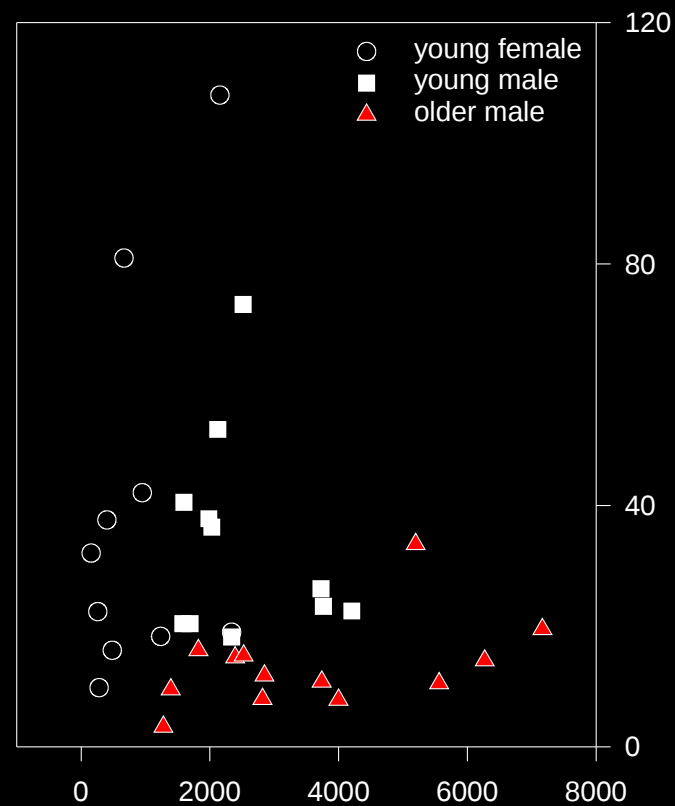
* P < 0.05 vs. young male

H P < 0.05 vs. young female

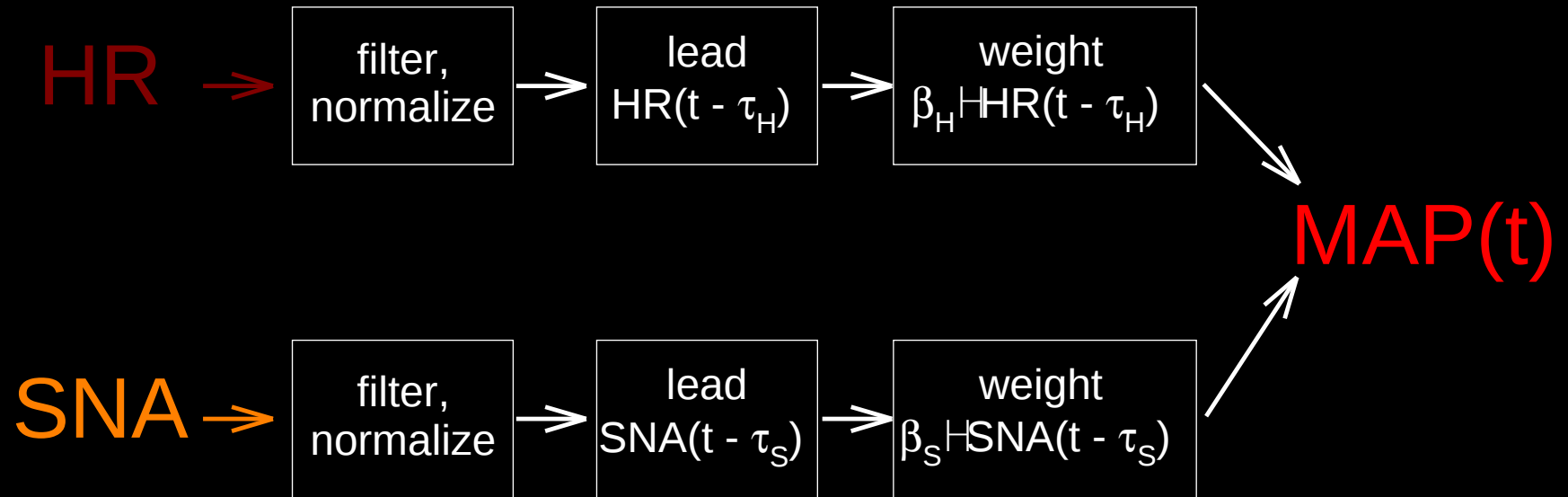
systolic pressure



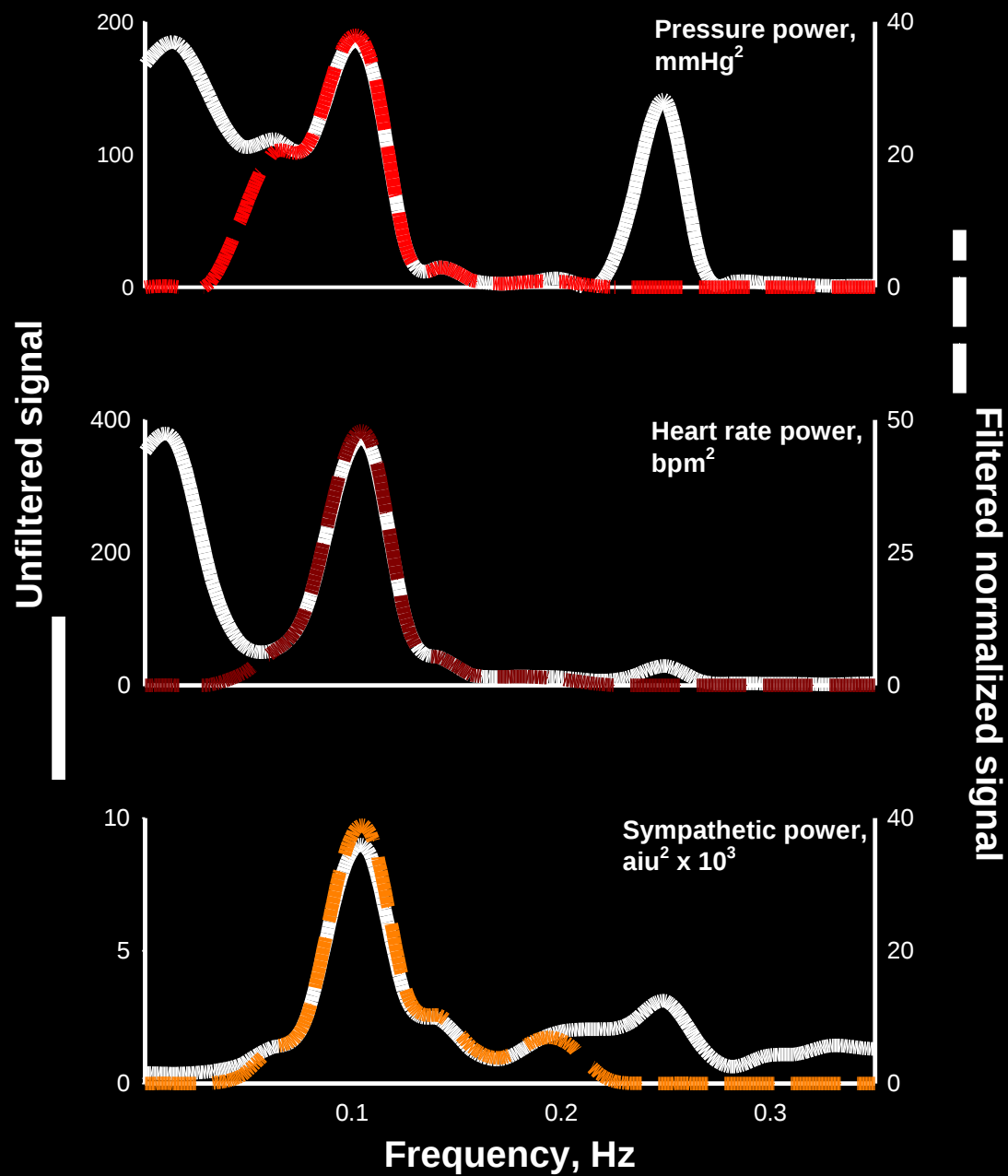
diastolic pressure

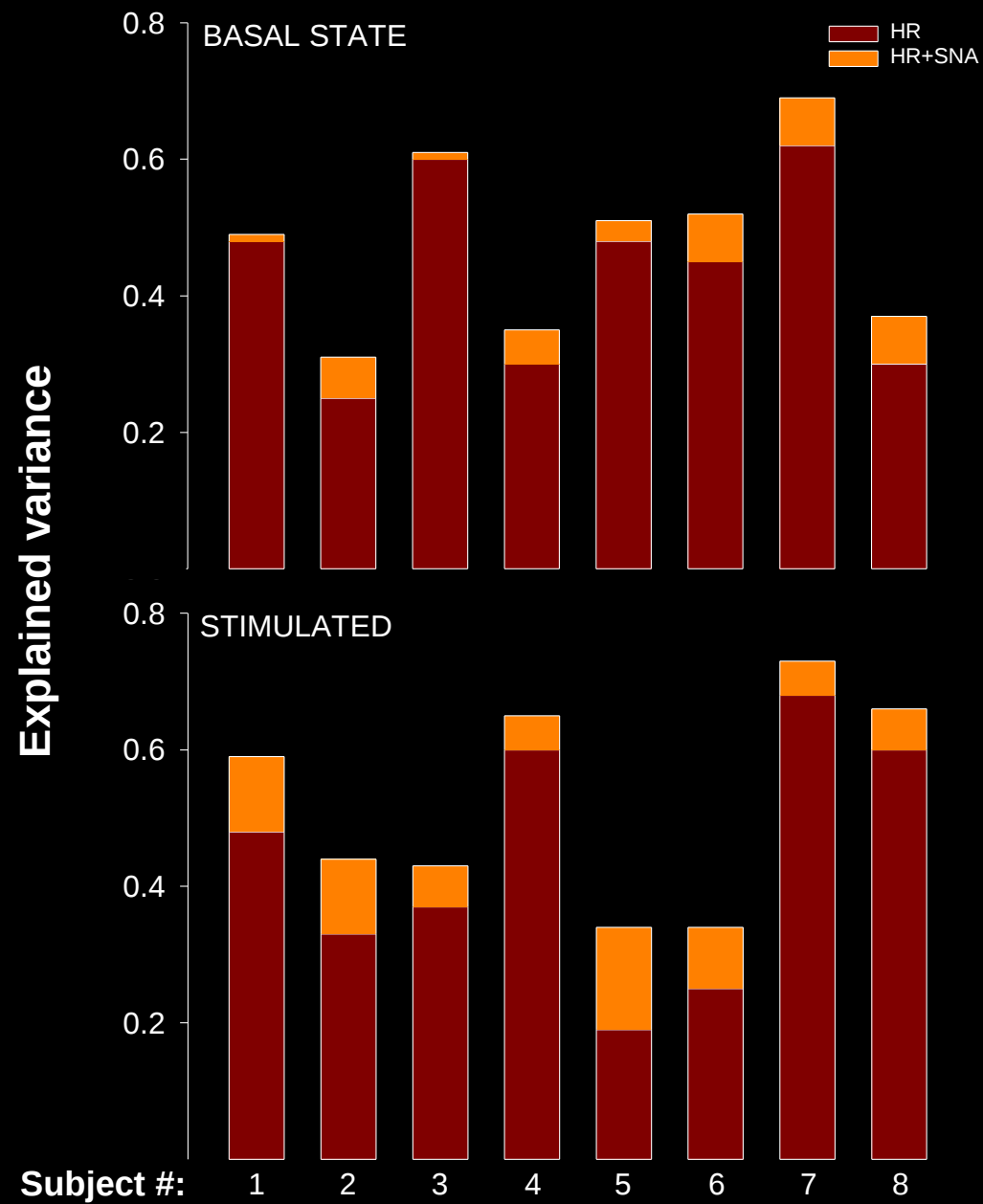


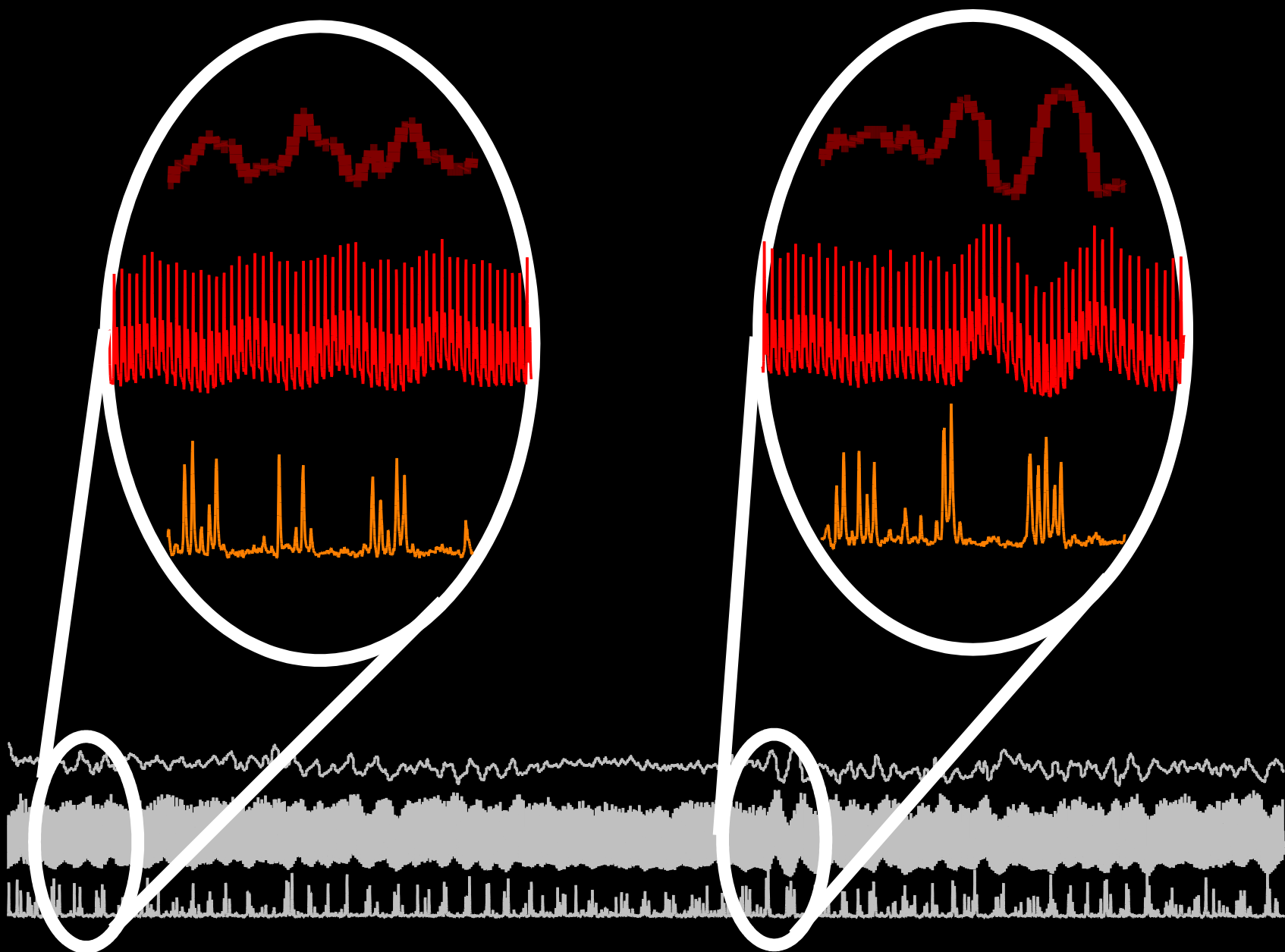
total sympathetic nerve activity, aiu



Myers, Cohen, Eckberg, Taylor. Journal of the Autonomic Nervous System 2001







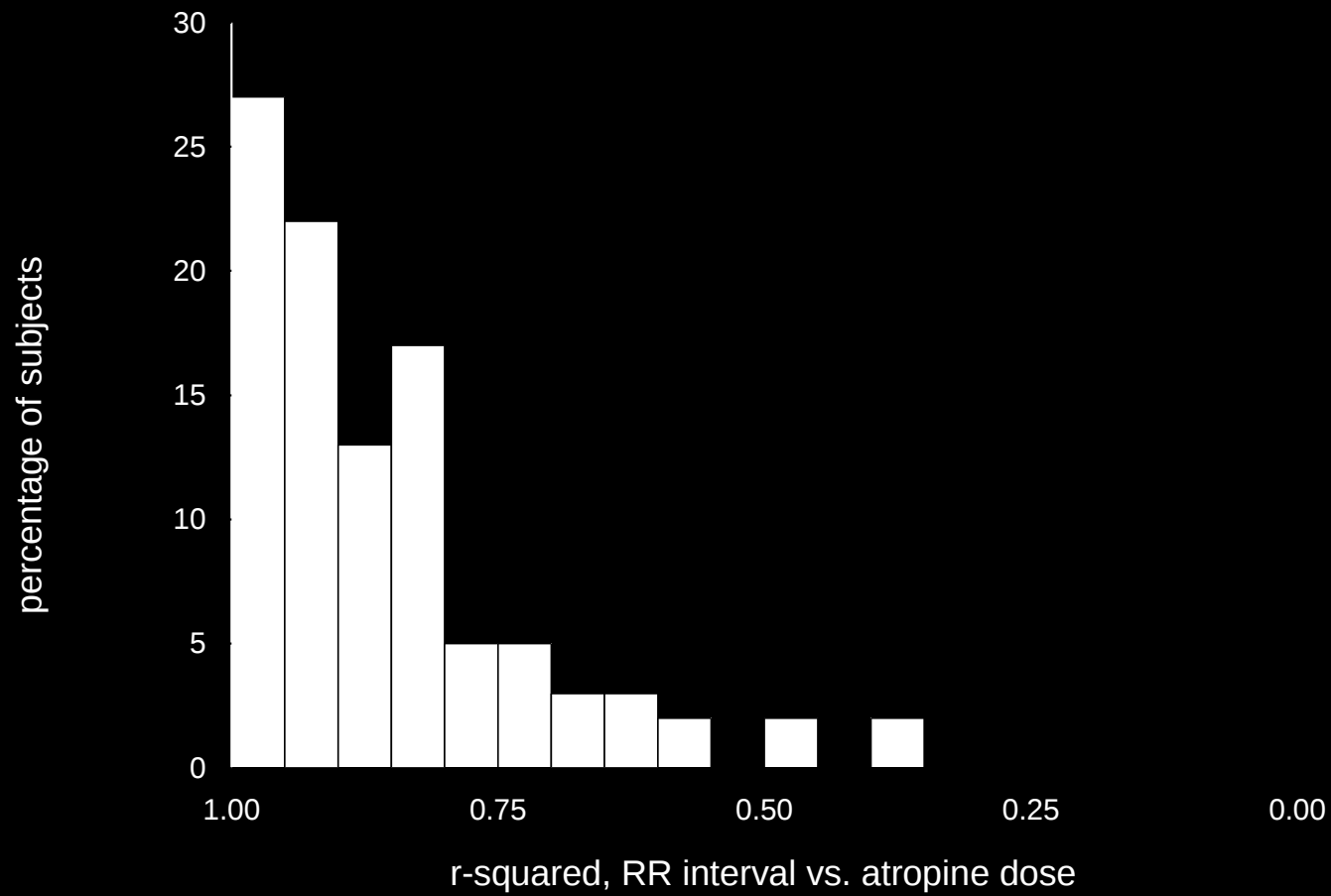
Variabilities as Estimates of Autonomic Outflow and Control

Adequacy of measures for vagal 'tone,'
baroreflex control, and fractal structure

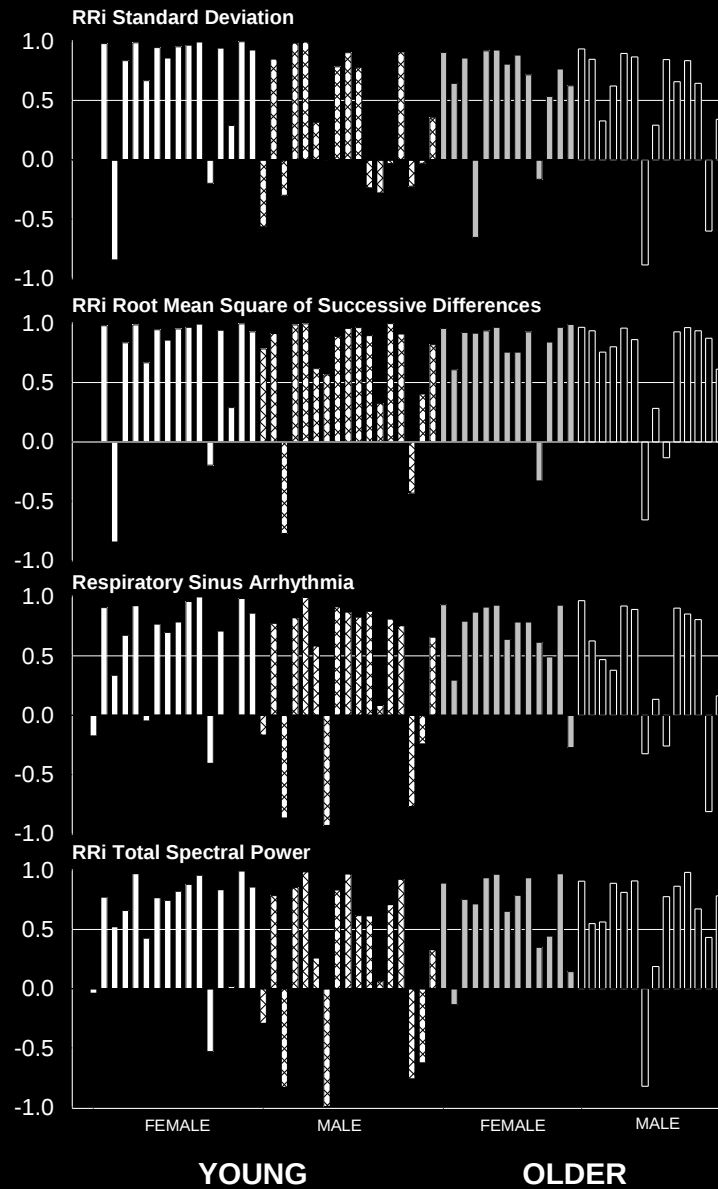
Picard, Tan, Zafonte, Taylor.
PM&R 2009

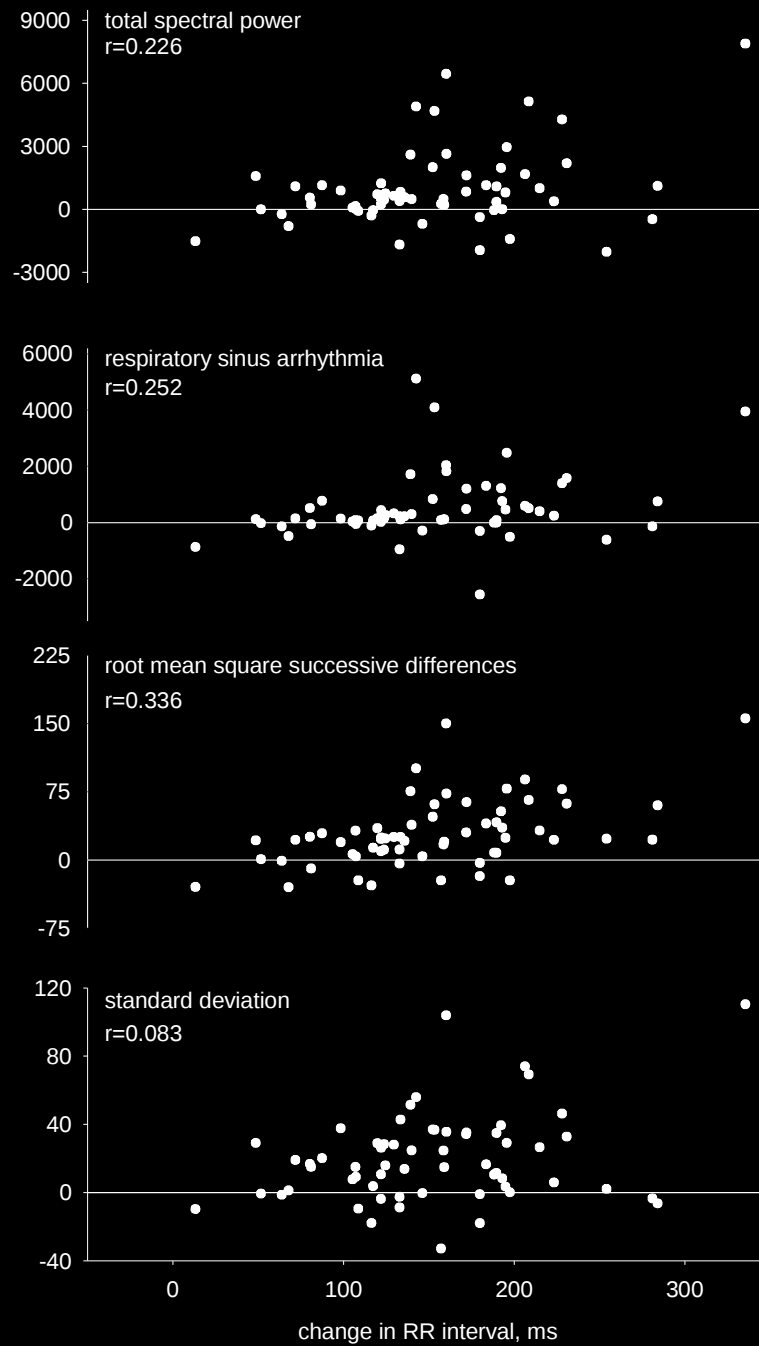
Lipman, Salisbury, Taylor.
Hypertension 2003

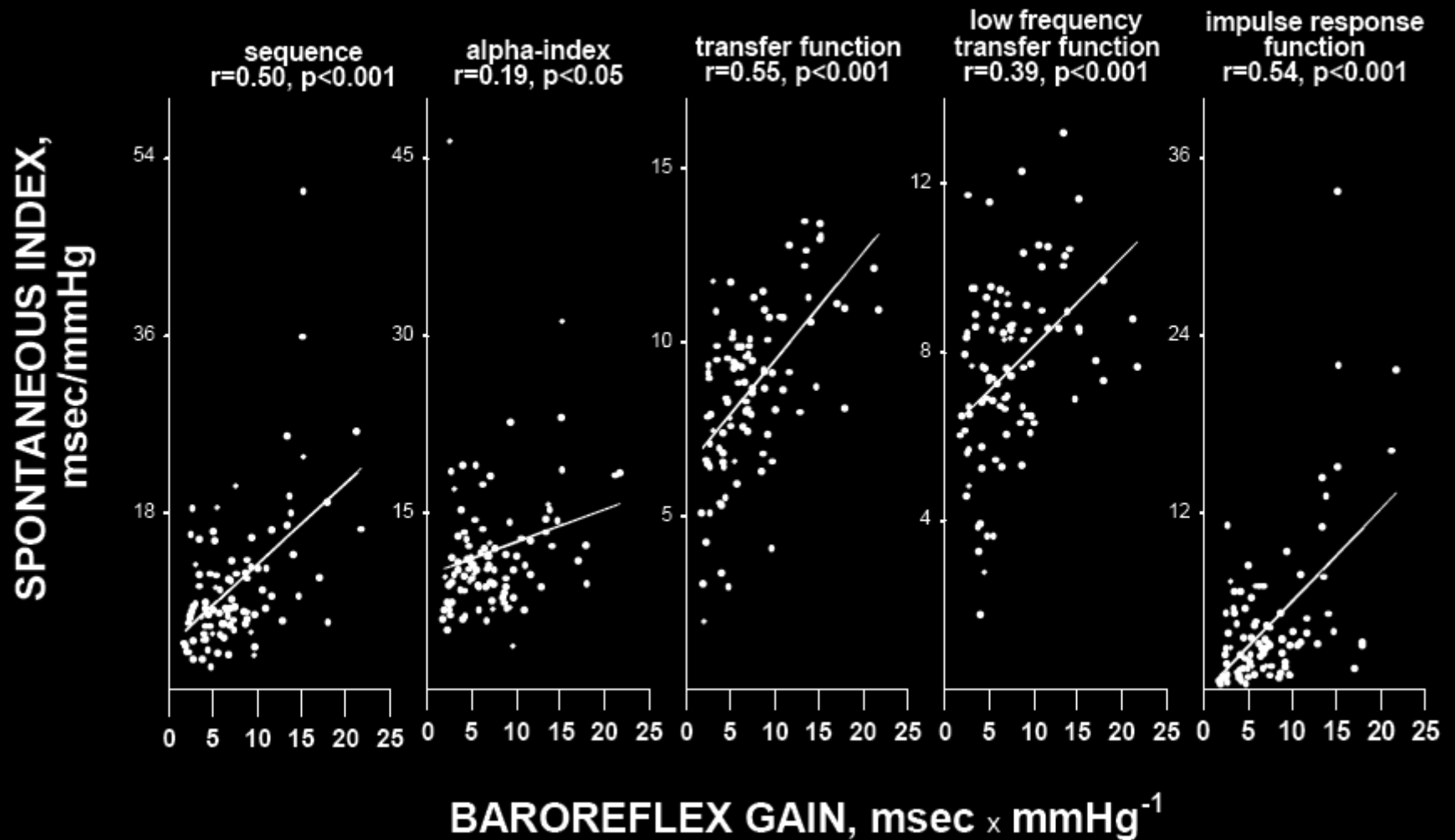
Tan, Cohen, Eckberg, Taylor.
Journal of Physiology 2009.

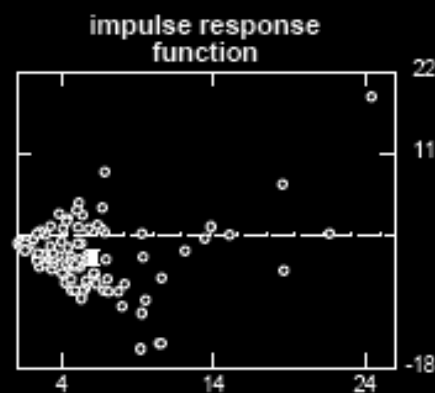
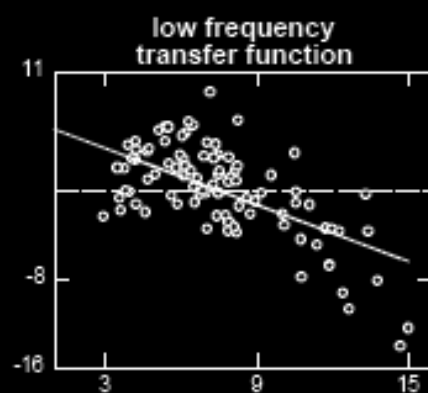
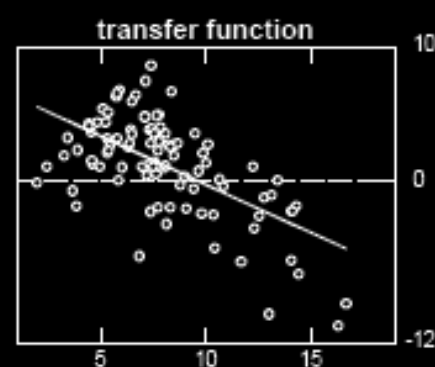
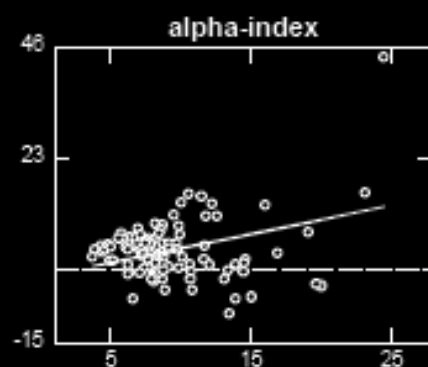
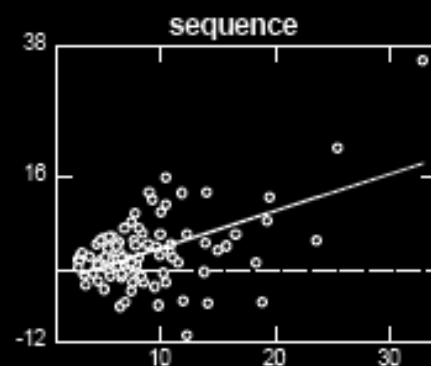


within subject correlations to RR interval, r



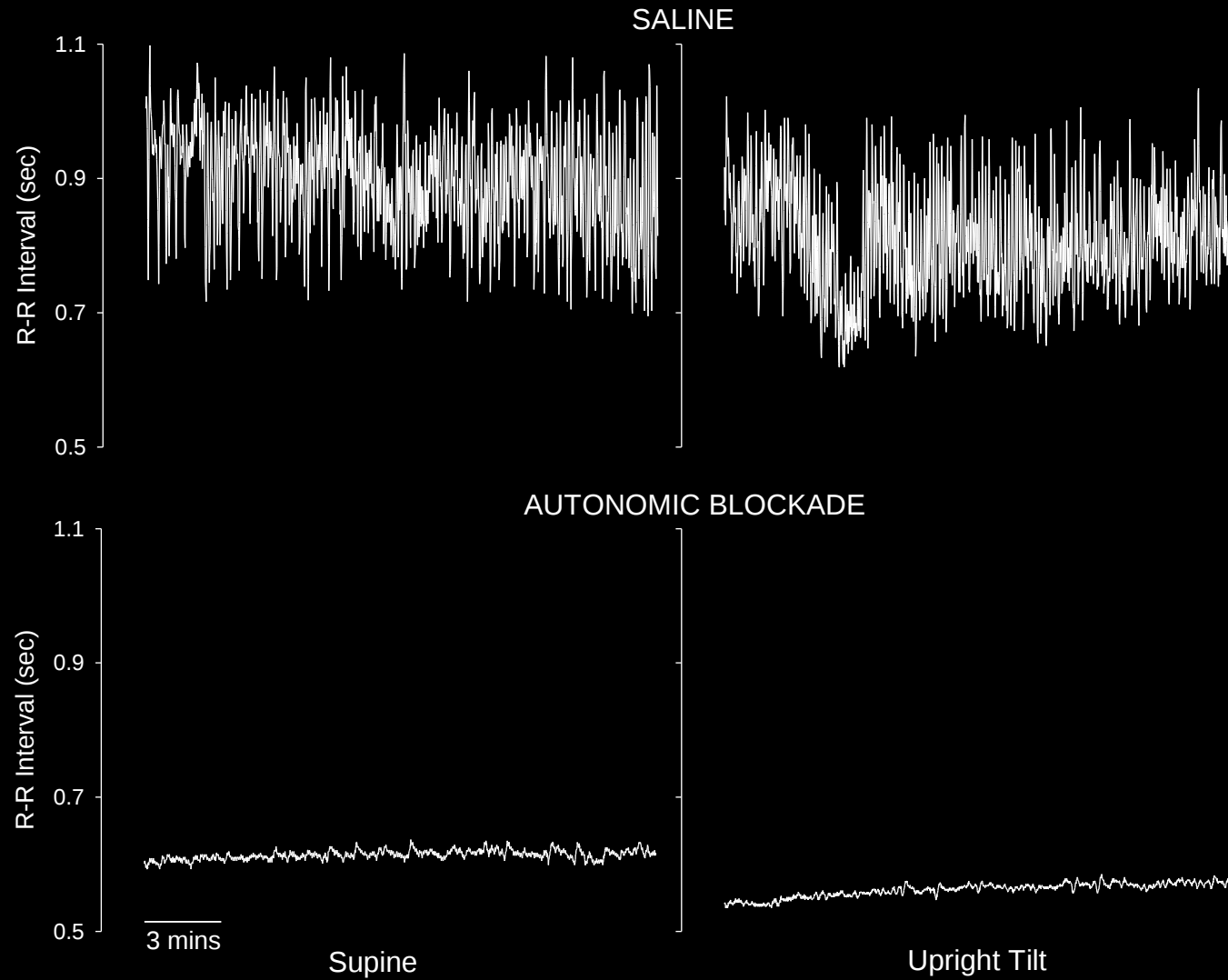


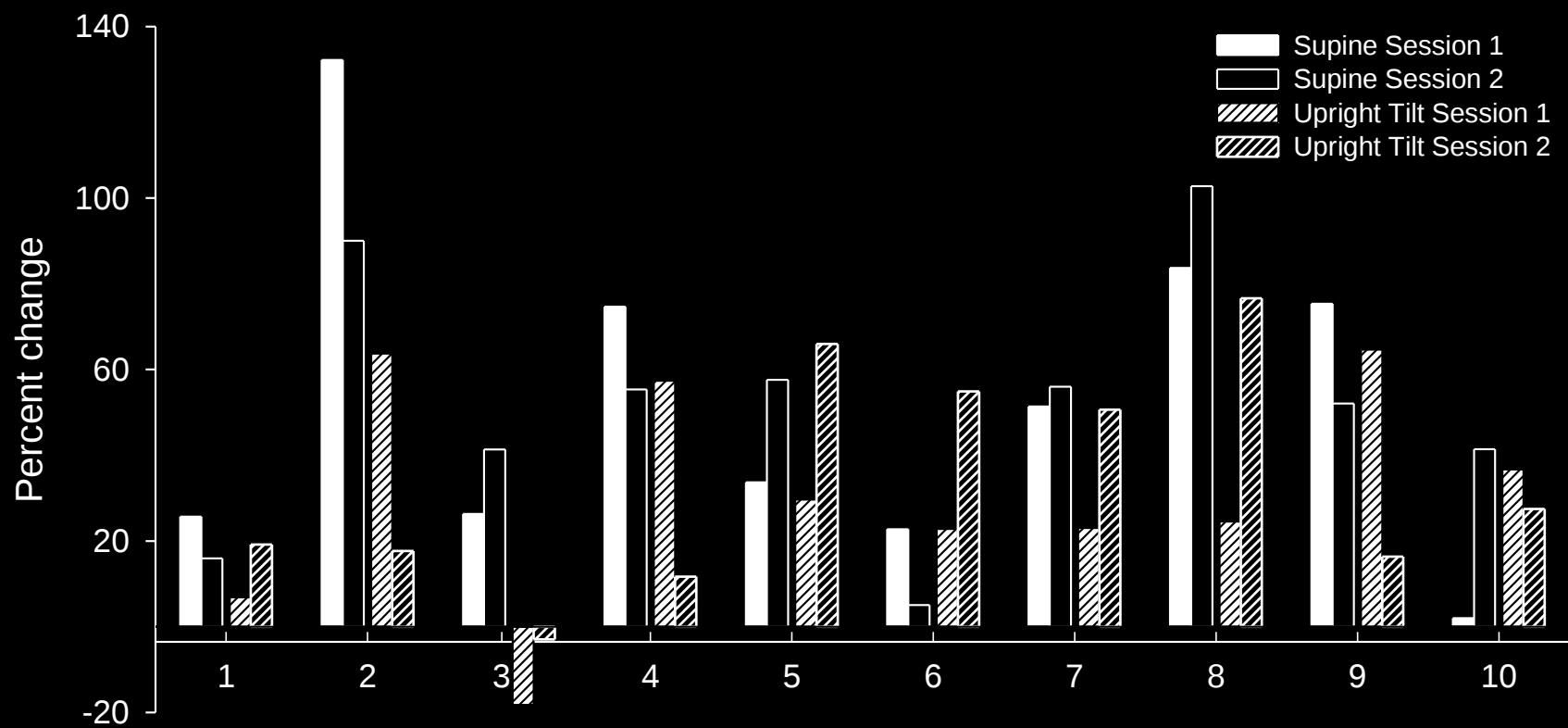




Forward stepwise linear regression
 $= \text{constant} + (x \text{ RSA}) + (y \text{ DIST})$

	β -weight (x) for respiratory sinus arrhythmia (RSA):	β -weight (y) for carotid distensibility (DIST):
Sequence	0.82	Not Significant
Impulse response function	0.80	Not Significant
Alpha-index	0.67	Not Significant
Transfer function	0.45	Not Significant
Low frequency transfer function	0.27	Not Significant
Modified Oxford baroreflex gain	0.29	0.29



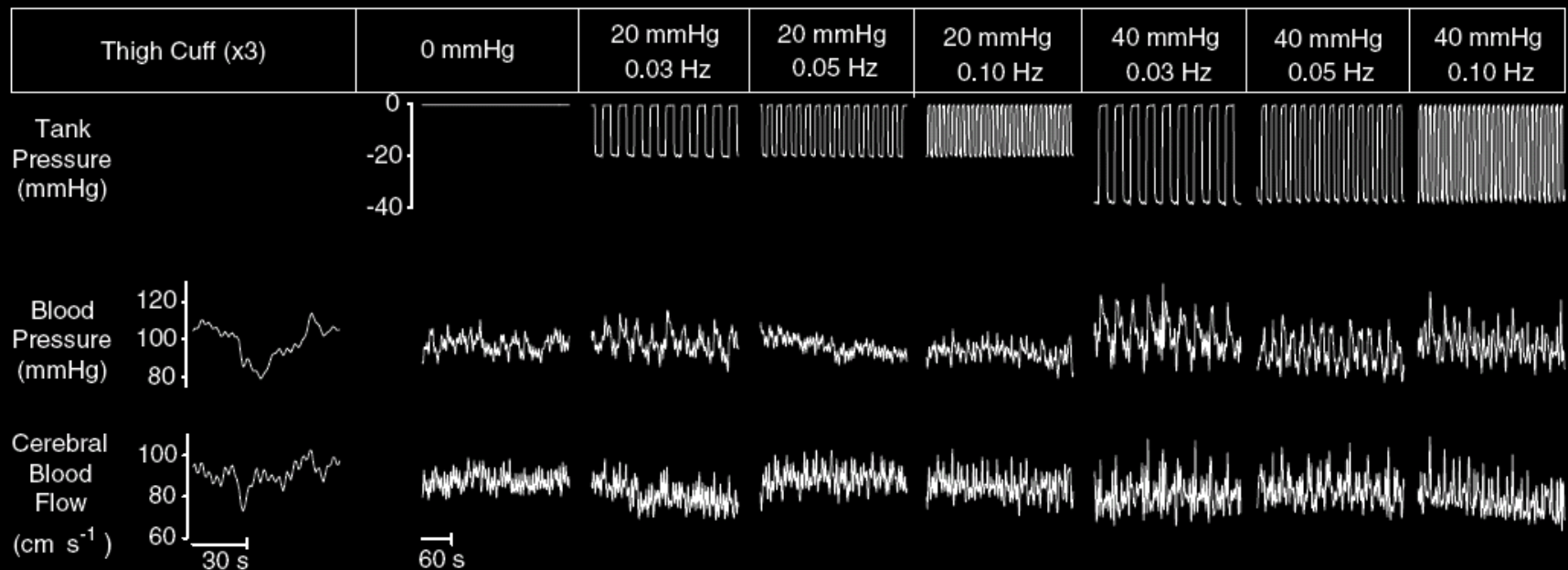


Variability to Assess Cerebrovascular Control

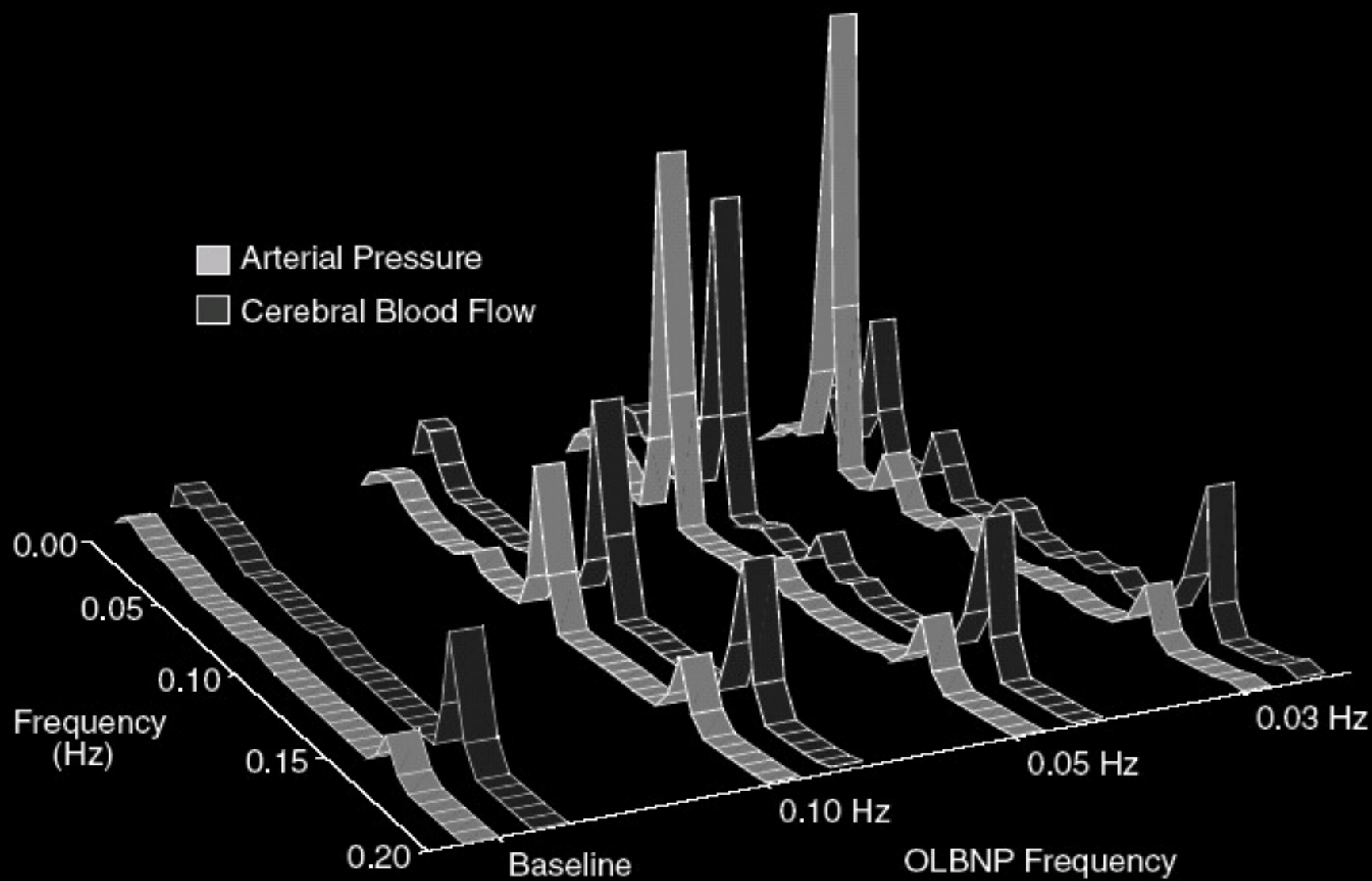
Responses to augmented fluctuations and effect
of sympathetic blockade

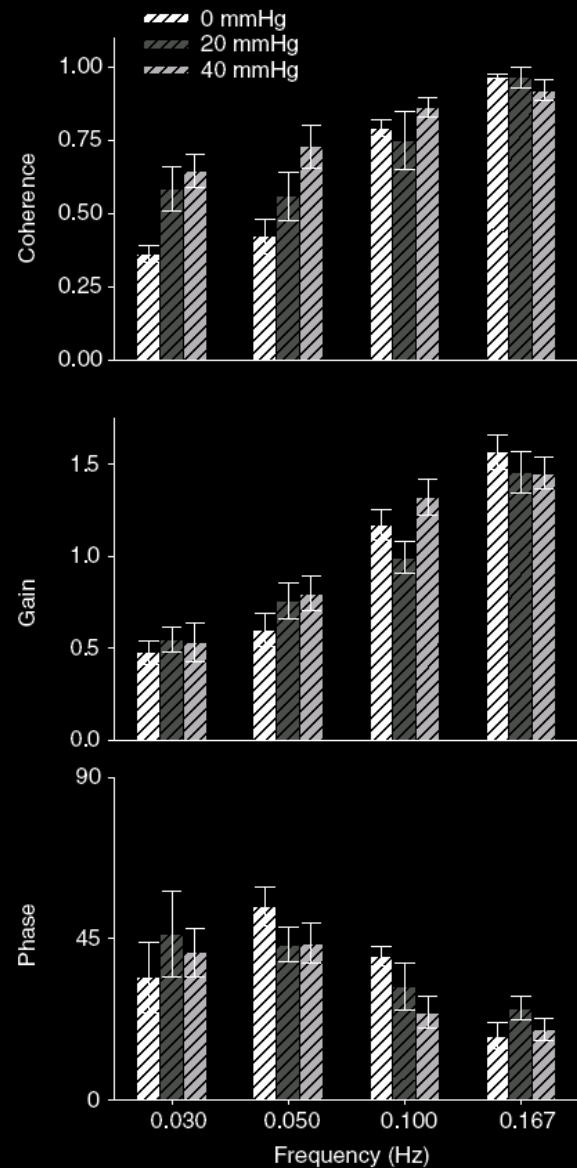
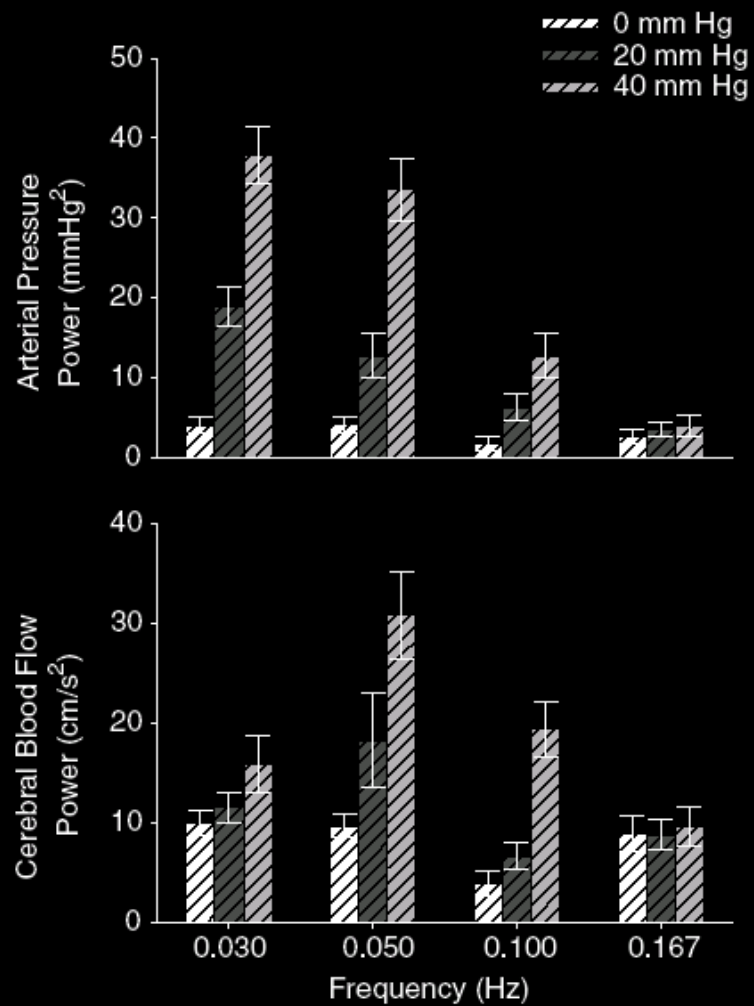
Hamner, Cohen, Mukai, Lipsitz, Taylor.
Journal of Physiology 2004

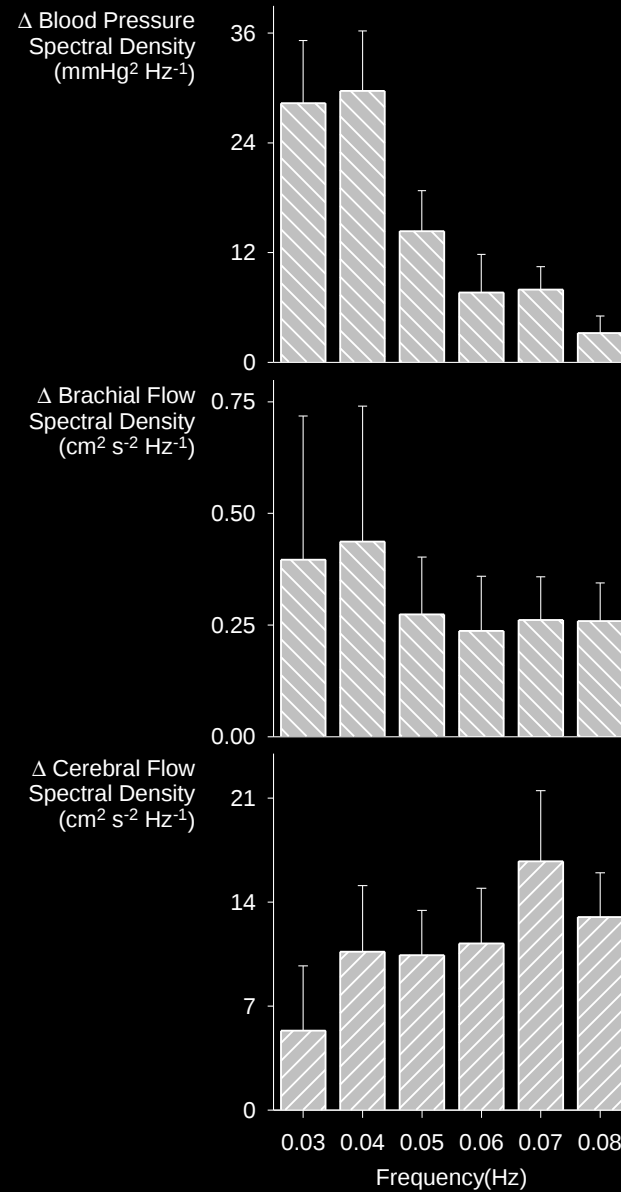
Hamner, Tan, Lee, Cohen, Taylor.
Stroke 2010

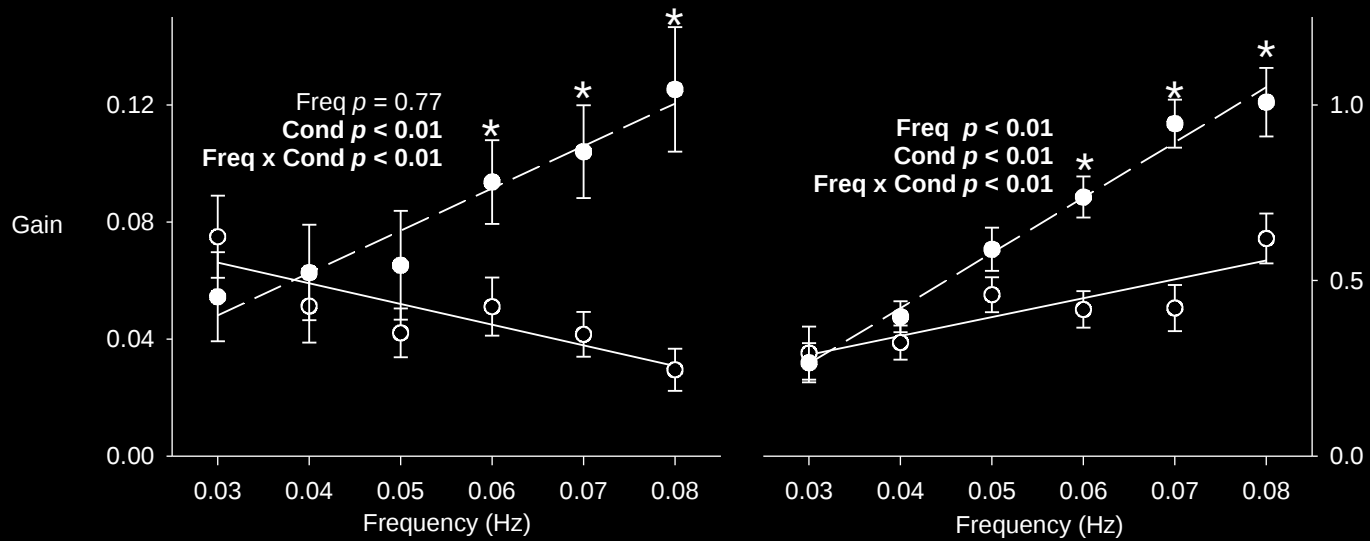
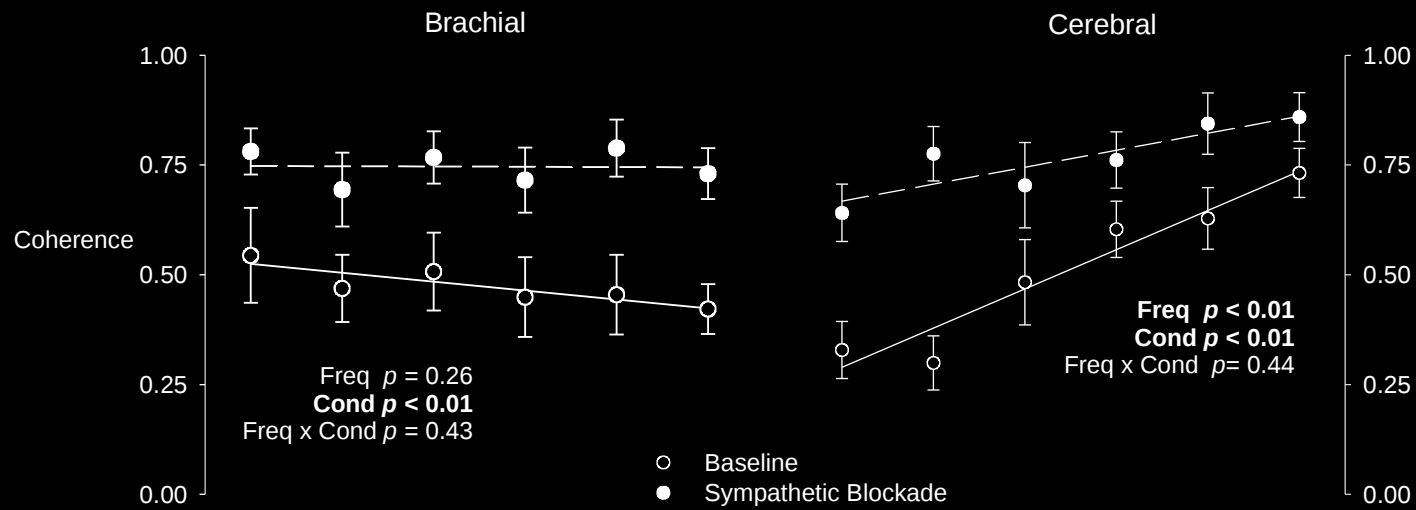


Hamner, Cohen, Mukai, Lipsitz, Taylor. Journal of Physiology 2004









Observation and Estimation of Human Cardiovascular Autonomic Control: When Does the Physiology Coincide?

Although oscillations, fluctuations, variability in the human cardiovascular/autonomic system do represent the integrated physiology, assumptions that they directly reflect precise and immutable aspects of the physiology must be rigorously tested.

Thus, in sum, when does the physiology coincide -- ***SOMETIMES!***

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