Taking Sleep to Heart

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Outline

- Methodology & Rationale – Sympathetic Nervous System and Blood Pressure
- Sleep, Sleep Deprivation, and Cardiovascular Disease
- Why Sex Matters
- Sleep Deprivation and Neural Cardiovascular Control
  - Carter et al., Am J Physiol – Heart Circ Physiol, 2012
  - Yang et al., J Appl Physiol, 2012
- What Can You Do?

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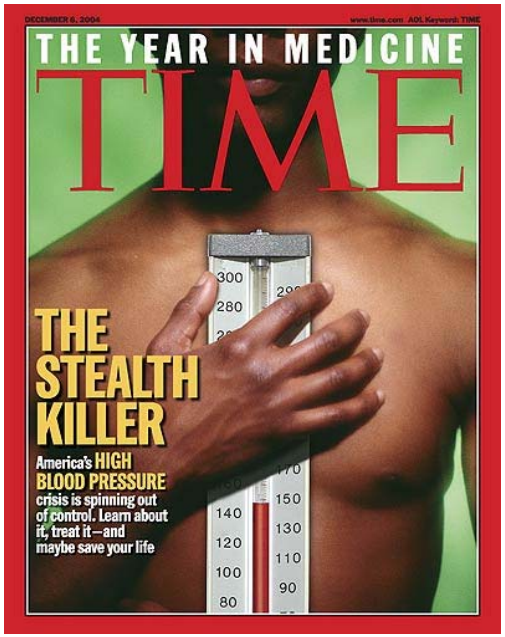
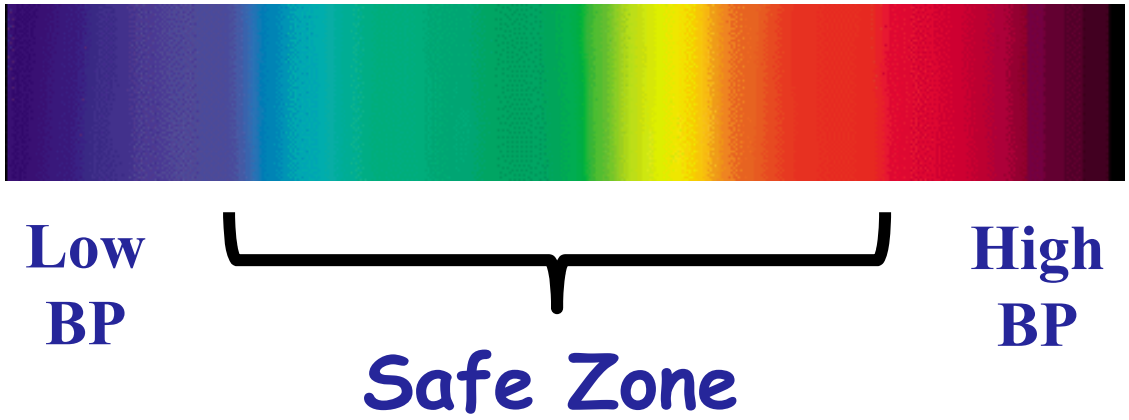
- Future Directions

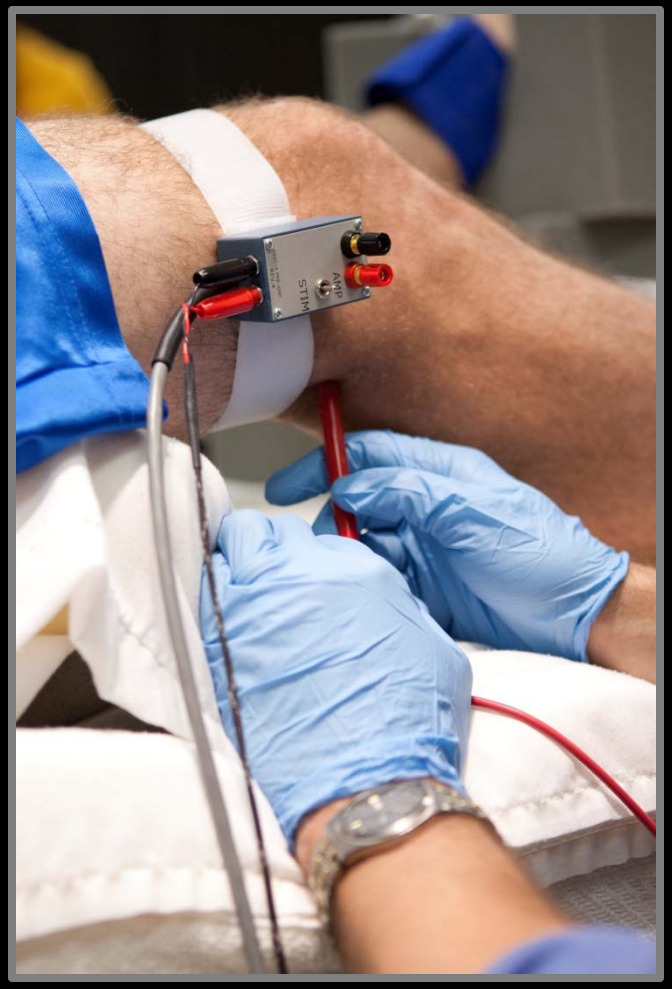
Arterial Blood Pressure

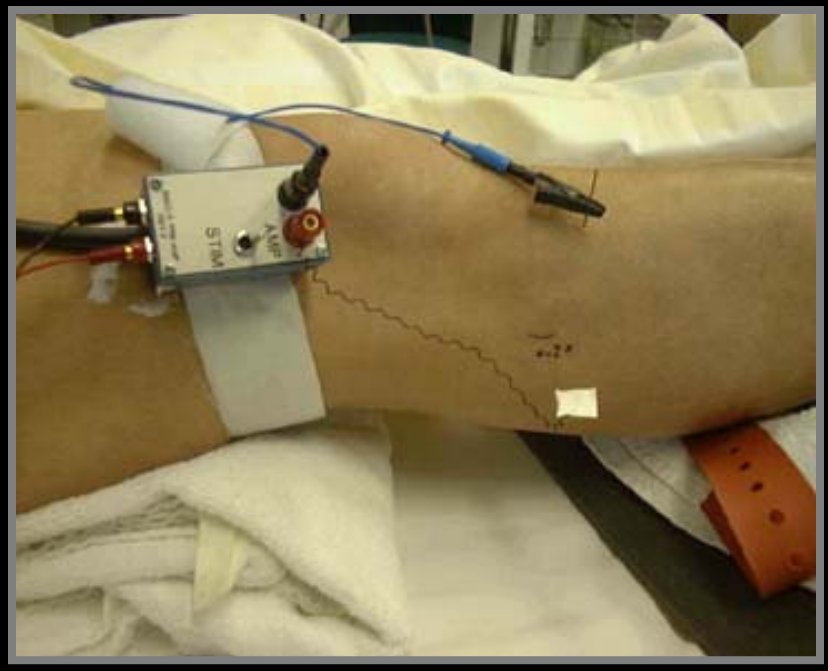


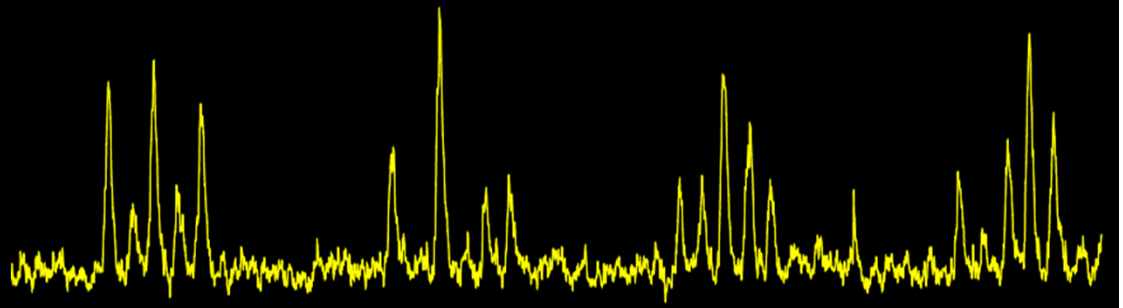


Category	Systolic (mmHg)	Diastolic (mmHg)
Hypotensive	< 90	< 60
Normal	90 – 120	60 – 80
Prehypertensive	120 – 139	80 – 89
Hypertensive	140 – 159	90 – 99
Extreme hypertension	≥ 160	≥ 100

Muscle Sympathetic Nerve Activity (MSNA)







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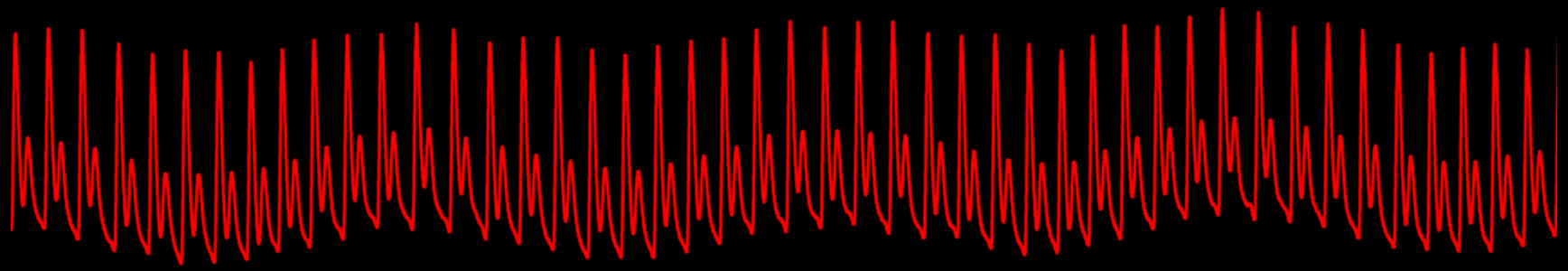

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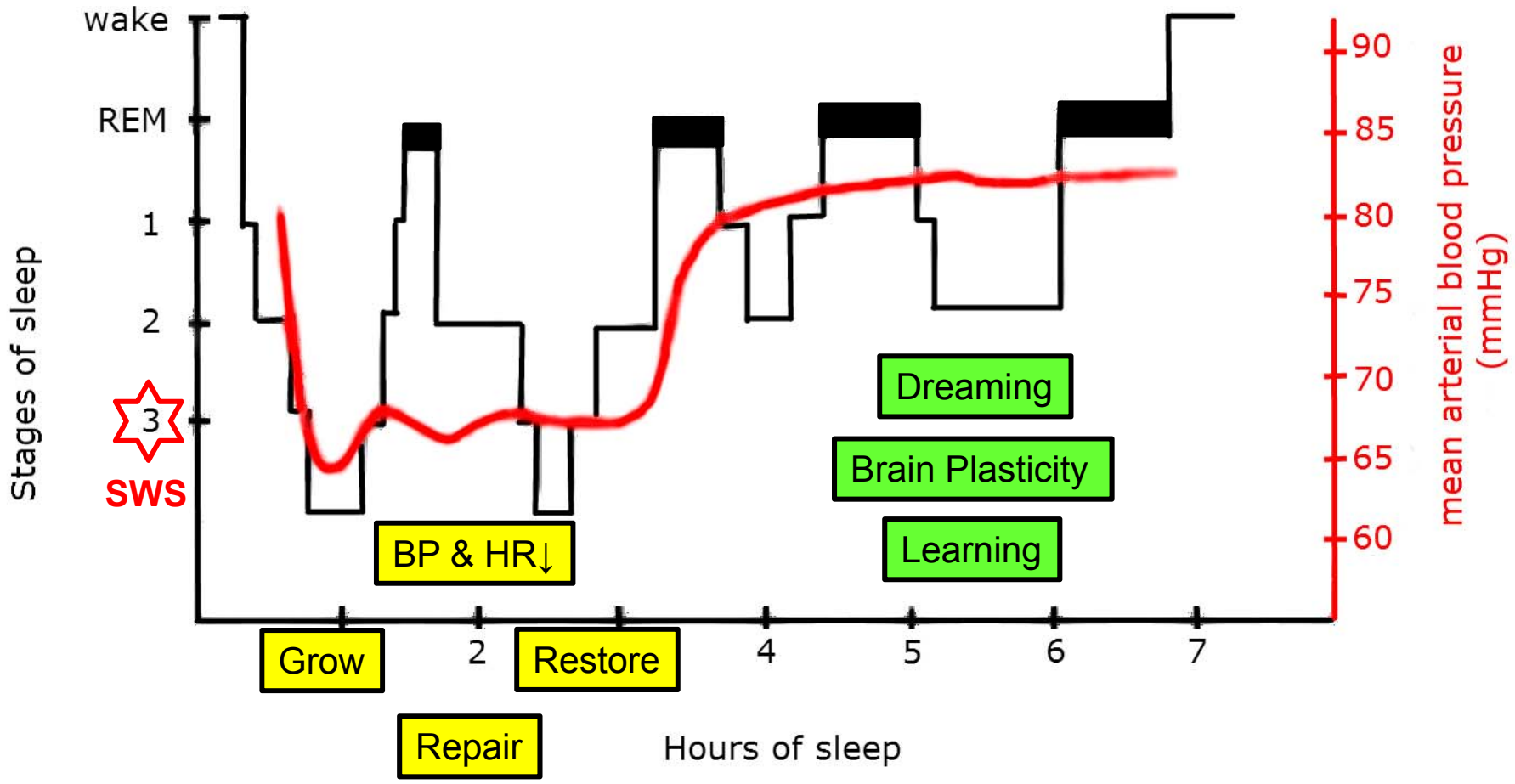
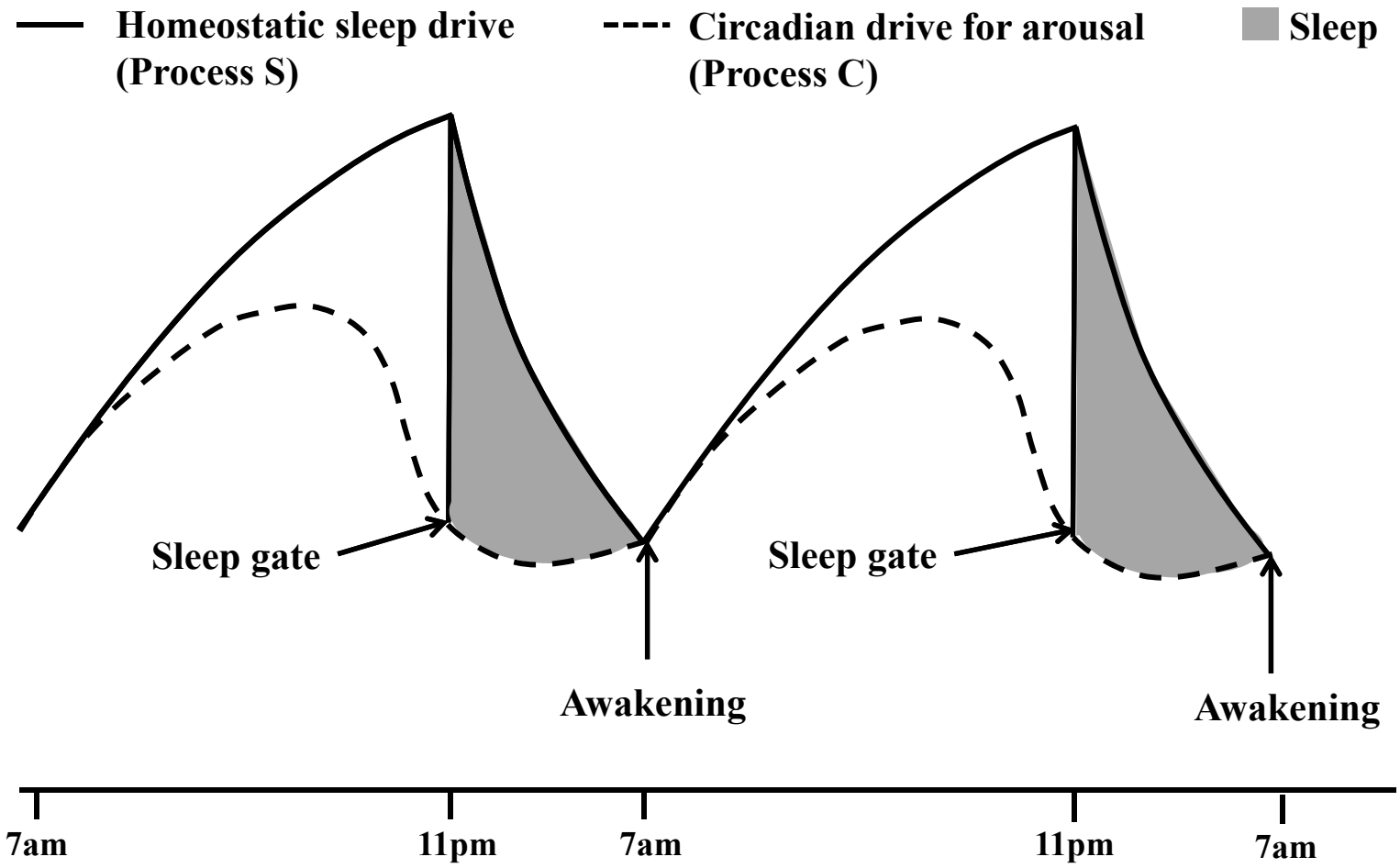
Sleep Stages

Non-REM vs.REM



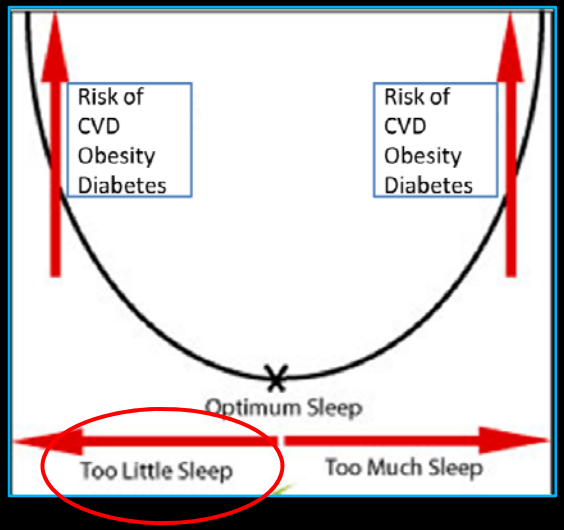
Javaheri and Redline, *Curr Hypertens Rep* 14:422-488 2012

Regulation of Sleep



(Modified from Achermann et al. Aviat Space Environ Med 75:A37-43,2004)

Consequences of Sleep Deprivation



Normal Sleep

Adults: 7-8 hours

37.1% of U.S. adults reported regularly sleeping <7hrs/night
Source: 2005-2008 NHANES

Motor Vehicle Accidents

Memory Loss

Depression

Hypertension

Metabolism

Diabetes

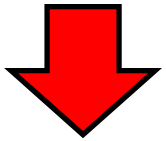
Obesity

Sleep Deprivation and Hypertension

Short Sleep Duration as a Risk Factor for Hypertension
Analyses of the First National Health and Nutrition Examination Survey

James E. Gangwisch, Steven B. Heymsfield, Bernadette Boden-Albala, Ruud M. Buijs, Felix Kreier, Thomas G. Pickering, Andrew G. Rundle, Gary K. Zammit, Dolores Malaspina

Gangwisch et al., Hypertension, 2006



Gender-Specific Associations of Short Sleep Duration With Prevalent and Incident Hypertension
The Whitehall II Study

Francesco P. Cappuccio, Saverio Stranges, Ngianga-Bakwin Kandala, Michelle A. Miller, Frances M. Taggart, Meena Kumari, Jane E. Ferrie, Martin J. Shipley, Eric J. Brunner, Michael G. Marmot

Cappuccio et al., Hypertension, 2007

Short duration of sleep (≤5hrs vs. 7 hrs) was associated with higher risk of hypertension in <u>women</u>, but not men (n=5766).

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Sex vs. Gender

J Appl Physiol 99: 785–787, 2005;
doi:10.1152/japplphysiol.00376.2005.

Editorial

Sex and gender: what is the difference?

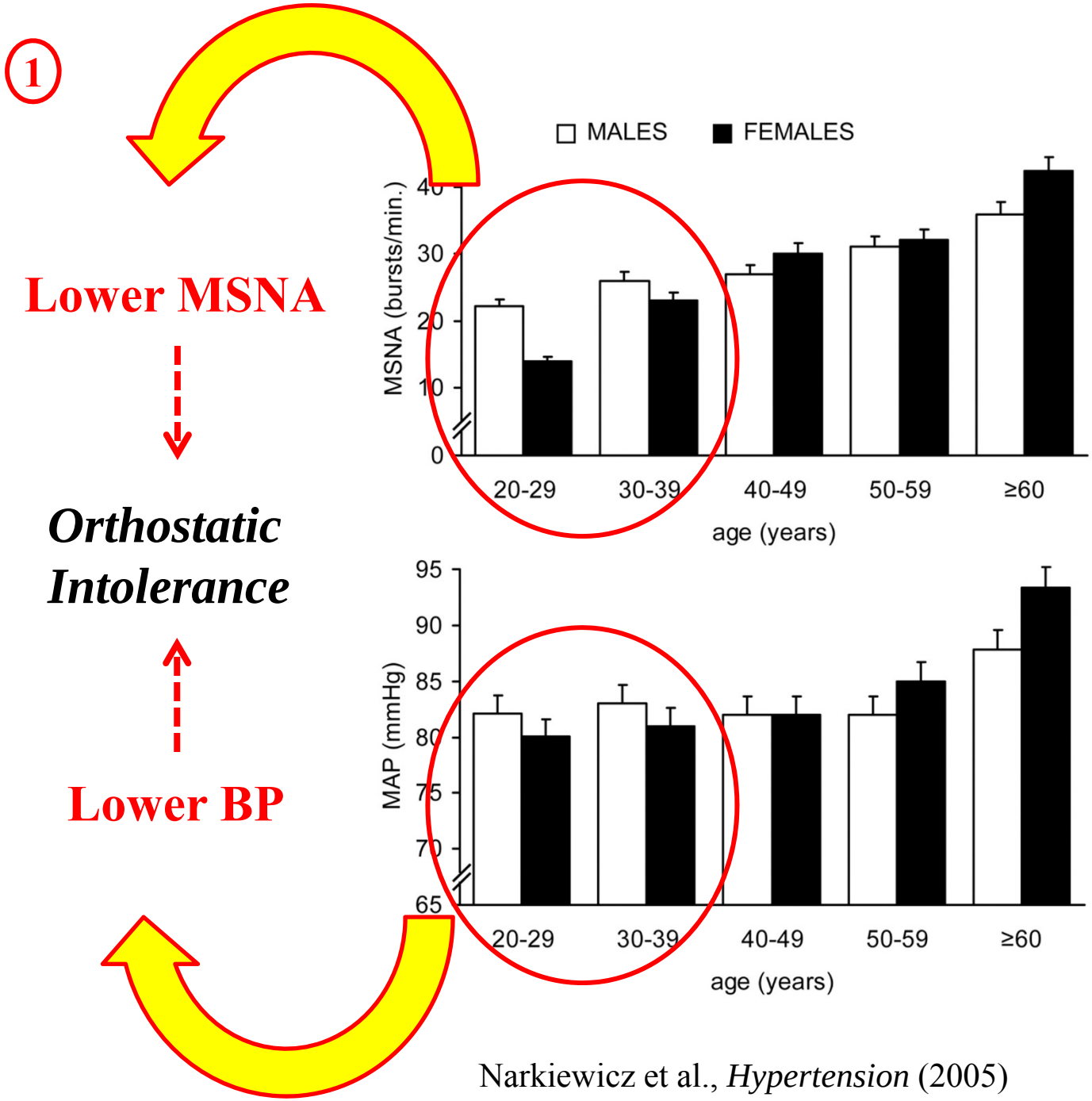
IT IS CLEAR THAT SEX IS A key biological variable that should be considered in all basic physiological and biological research. However, despite a long history of interest in sex-based investigations, this topic has historically not been well studied. The current importance of sex research is obvious by the recent rise in articles reporting on sex-based biology across scientific journals, including the *Journal of Applied Physiology*. There are two terms being used in this contemporary dialogue to Health policies demanding the inclusion of women in federally funded clinical trials and ensuring that women and minorities are included in all human subjects research (7).

The American Physiological Society (APS) has been a leader in integrating sex-based research into its journals and has devoted issues of the *Journal of Applied Physiology* to sex-based differences, including the Highlighted Topics series on "Genome and Hormones: Gender Differences in Physiol-

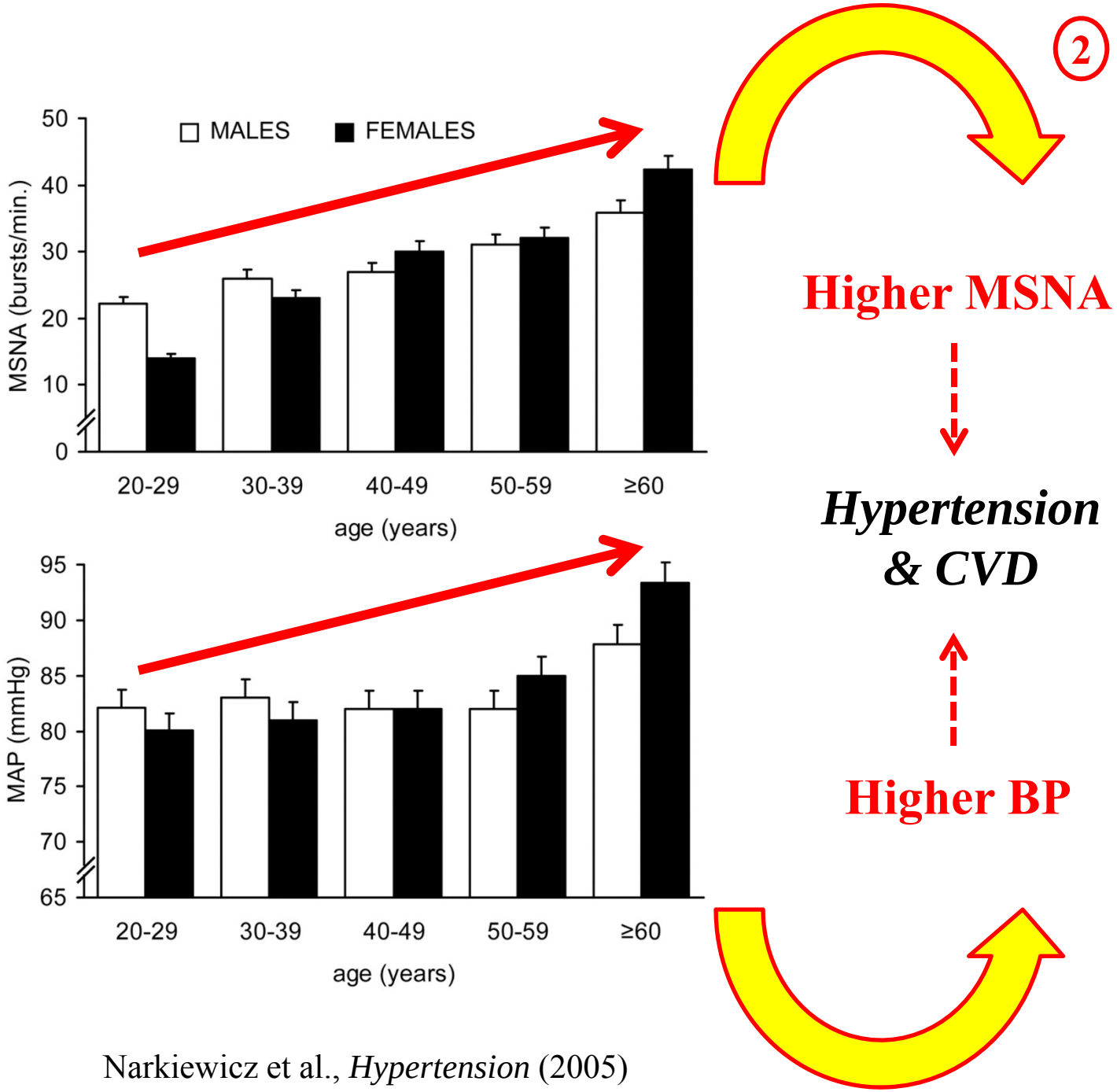
Institute of Medicine Recommendations:

Sex: "*classification according to the reproductive organs and functions that derive from chromosomal compliment*"

Gender: "*person's self-representation as male or female*"



Narkiewicz et al., *Hypertension* (2005)



Narkiewicz et al., *Hypertension* (2005)

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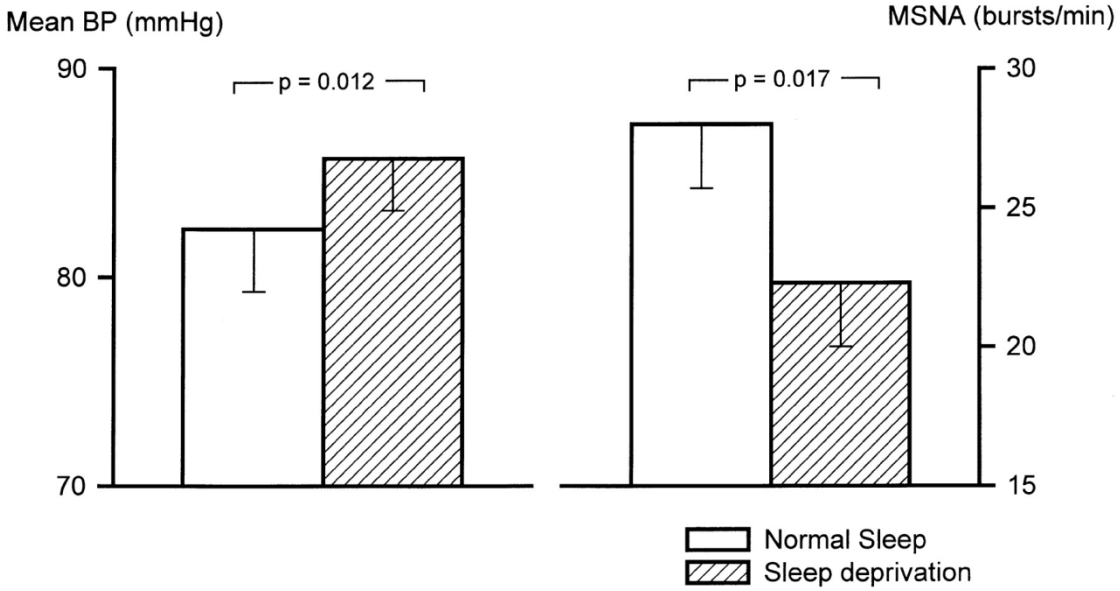
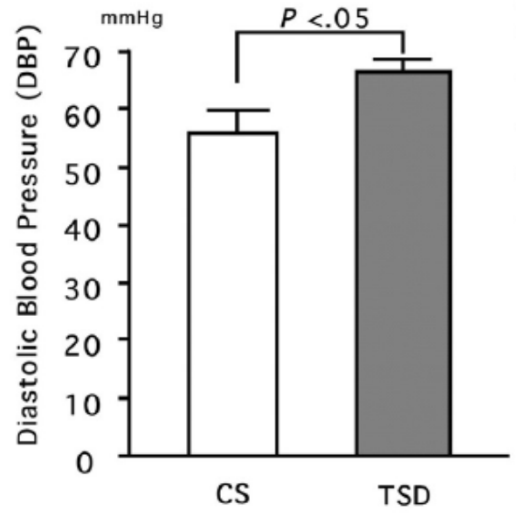
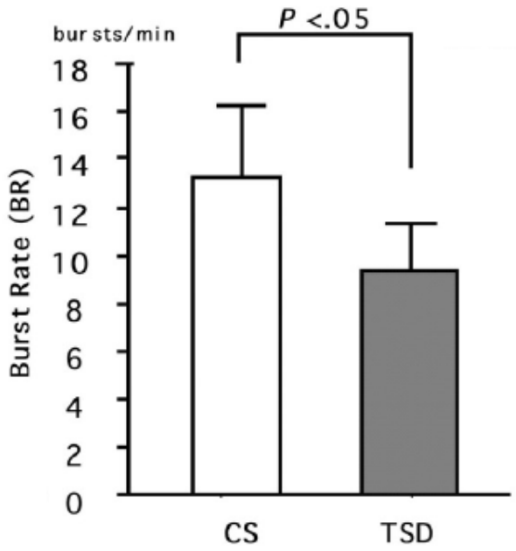
Sleep Deprivation and MSNA



Kato et al., *Hypertension* (2000)

Kato et al.: n=8
Ogawa et al.: n=6
} **12 men, 2 women**





Ogawa et al., *Sleep* (2003)

Experimental Design

Subjects:

Healthy young (age, 22±1 yrs)

~~15 men vs. 15 women~~

14 men vs. 14 women

Protocol:

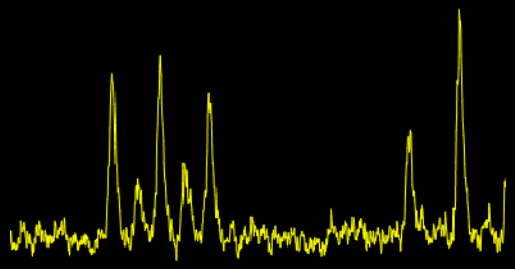
- Randomized, crossover design (sleep dep vs. normal sleep)
  - *One month apart to control for menstrual cycle (EF phase only)*
- Screen for obstructive sleep apnea (OSA) using the at-home ApneaLink
- Wrist actigraphy (Actiwatch-64) for the 3 days prior to each trial

Experimental Design

Protocol:

On each testing day:

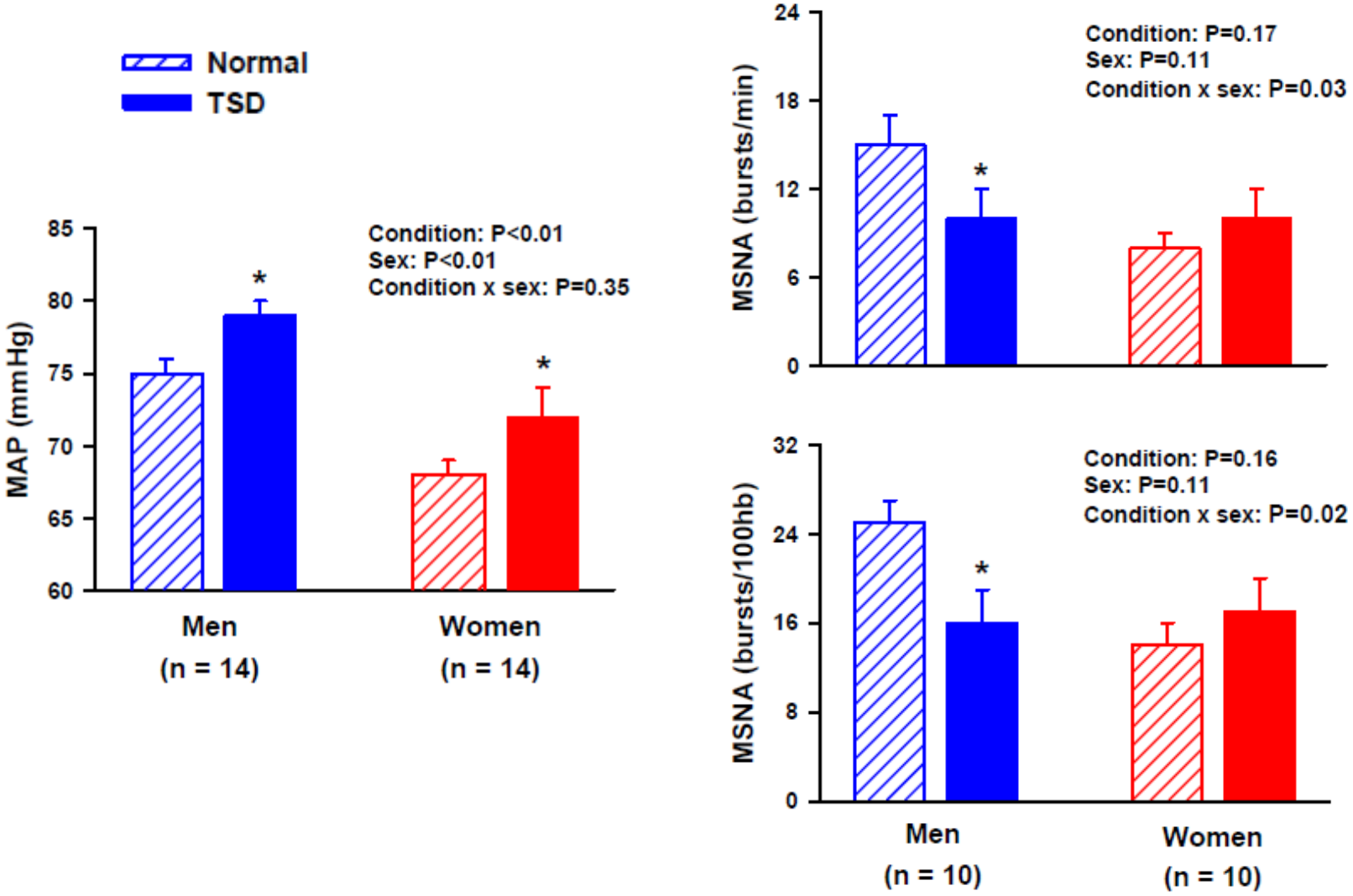
- 3 seated resting BP recording
- Venous blood sample (sex steroid levels)
- Standard breakfast
- Autonomic and hemodynamic instrumentation
- 10 min supine baseline
- Mental stress trial (5 min BL, 5 min MS, 5 min Rec)
- Cold pressor test trial (3 min BL, 2 min CPT, 3 min Rec)



***Measurements*:**

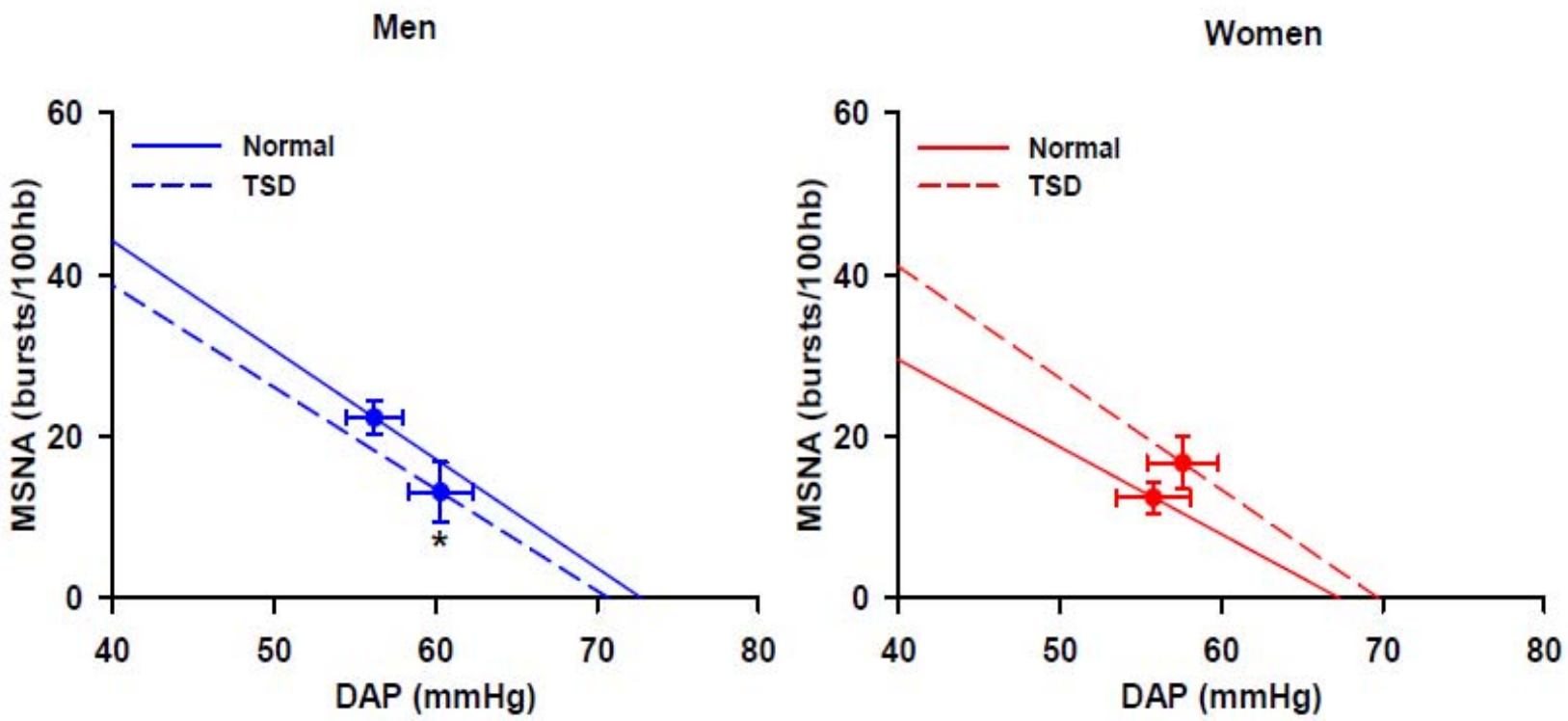
- MSNA (microneurography)
- Resting BP (automated sphyg)
- Beat-to-beat BP (finger pleth.)
- Heart rate (ECG)
- Limb Blood flow (VOP)

Sleep Deprivation and MSNA



Carter et al., *Am J Physiol Heart Circ* (2012)

Baroreflex Operating Point



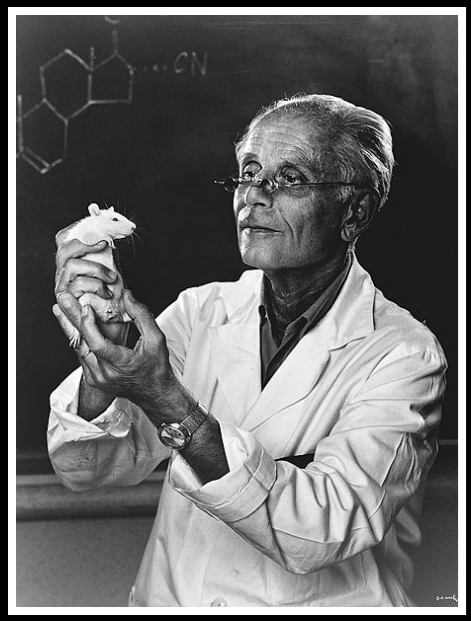
Carter et al., *Am J Physiol Heart Circ* (2012)

Stress and Disease

Walter Cannon

Mental Stress

Neuroendocrine Response



Hans Selye

Adrenal Medulla

- ↑ Epinephrine
- ↑ Norepinephrine

Nervous System

- ↑ Sympathetic N.S.
- ↓ Parasympathetic N.S.

Adrenal Cortex

- ↑ Cortisol

CVR Hypothesis

Exaggerated cardiovascular reactivity:

(1) is a marker of elevated disease risk

(2) plays a causal role

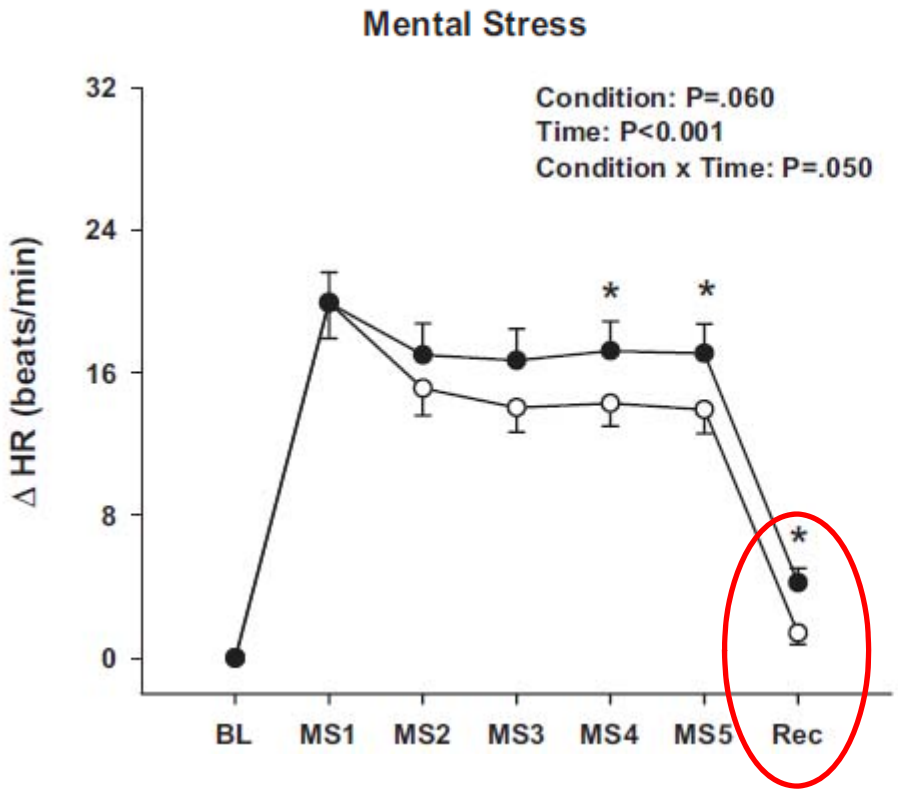
Laboratory stressor -- controlled, short-term physical, cognitive, and/or emotional challenges.

- Cold pressor test
- Mental stress

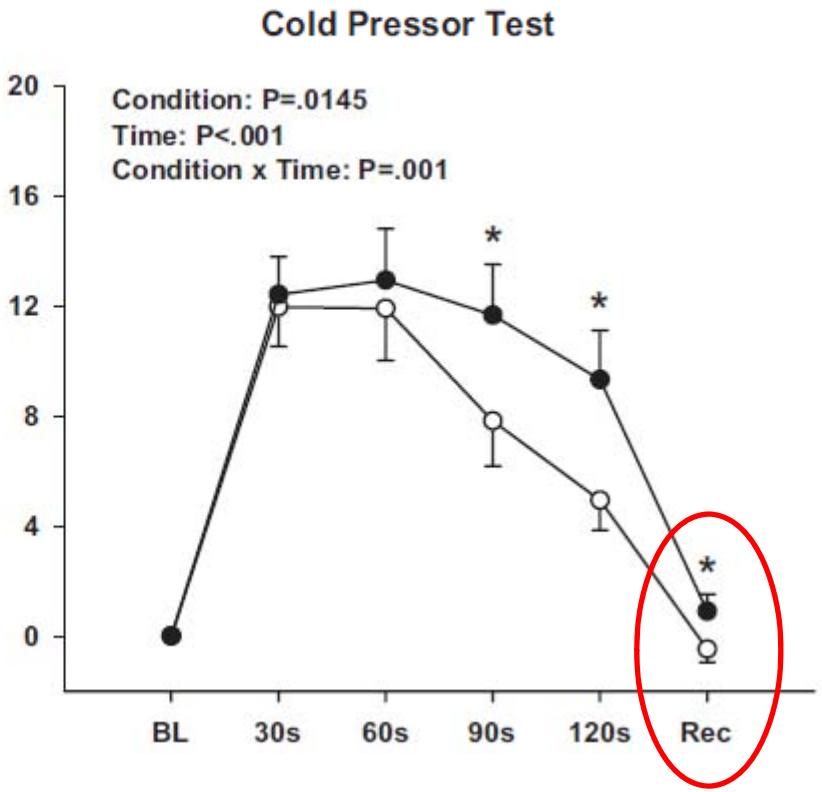
Recent research suggests:

- Aggregation across tasks improves 'generalizability'
- Recovery responses may be a useful predictor

Sleep Deprivation and HR Reactivity



(n = 28)



(n = 28)

Huan et al., *J Appl Physiol* (2012)

Summary

- Sex differences exist regarding sympathetic neural responsiveness to sleep deprivation.
  - Total sleep deprivation elicits acute hypertension in both sexes, but only men demonstrate concurrent reductions in resting MSNA
  - Possible baroreflex dysfunction and/or testosterone influence

- Sleep deprivation augmented HR reactivity to acute laboratory stress. Importantly, this augmented HR reactivity persisted:
  - Across both MS and CPT stressors (Aggregation Theory)
  - During both MS and CPT recovery (Recovery Theory)

- These findings provide new insight regarding emerging links between sleep deprivation and CVD.

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Sleep Tips

- **Acknowledge that sleep is a major pillar of health**

- **7-8 hours of *regular* sleep**
  - Avoid being a weekend warrior
  - Let your body be your guide; don't force yourself to sleep in

- **Practice good 'sleep hygiene'**
  - Create a bedtime ritual*
  - Set a regular bed time; consider an earlier bed time
  - Comfortable bed/pillow and room cool (~65°F)

- **Maximize Light during Day, Melatonin at Night**
  - Let there be light… and remove your sunglasses sometimes
  - Avoid TV, computer, and backlit reading devices in late evening
  - Make sure your room is dark (i.e., summer)

- **Eat right and get regular exercise**
  - Avoid alcohol, caffeine, nicotine (discuss alcohol myth)
  - Avoid late evening snacks and fluid drinking

Sleep Tips

Possible Sleep Routine

- ❑ Take a warm bath or shower
- ❑ Read a book or magazine by soft light
- ❑ Stretching, yoga, other relaxation/mindfulness routines
- ❑ Simple preparations for the next day (i.e., iron)
- ❑ Reserve the bed for 'sleep and sex'
- ❑ Listen to soft music

Falling Back Asleep

- ❑ Stay out of your own head
- ❑ Postpone worrying and brainstorming
- ❑ Make relaxation, not sleep, your goal
- ❑ Focus on your own breathing pattern
- ❑ If your up for more than 15 min, consider non-stimulating activity
- ❑ Keep light off or low for bathroom breaks (i.e., flashlight)

Focus on Cognitive Behavioral Approaches

- ❑ Avoid sleeping pills
- ❑ Avoid melatonin pills

Be Your Own Advocate

- ❑ **Make sleep something you discuss with your primary care physician**
- ❑ **Know when to get a new physician or see a sleep physician**

<u>Consider seeing a sleep physician if you have</u>:

- ❑ **Loud snoring and pauses in breathing**
- ❑ **Chronic difficulty falling or staying asleep**
- ❑ **Frequent morning headaches**
- ❑ **Restless sensations in your legs or arms at night**
- ❑ **Inability to move while falling asleep or waking up**
- ❑ **Physically acting out your dreams**
- ❑ **Falling asleep at inappropriate times**
- ❑ **Chronic daytime sleepiness or fatigue**

Acknowledgments

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- Chris Schwartz, Huan Yang, Robert Larson, Sarah Stream, Jennifer Witting

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  Eve Van Cauter (U Chicago)