THE UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL

Endocrine Stress Reactivity Associated with Extreme Sports

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1st International Extreme Sports Medicine Congress






Stress




Eustress ⟷ Distress

"Positive" *"Negative"*

Stress Hormone Reactivity

Focus on athletes in “traditional Olympic sports and military personnel

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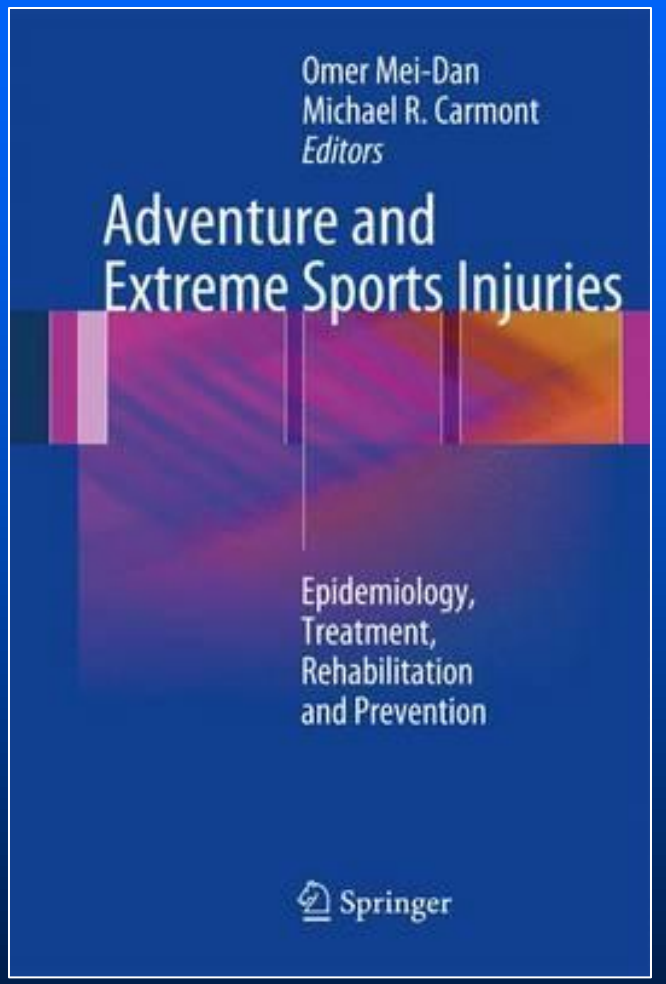
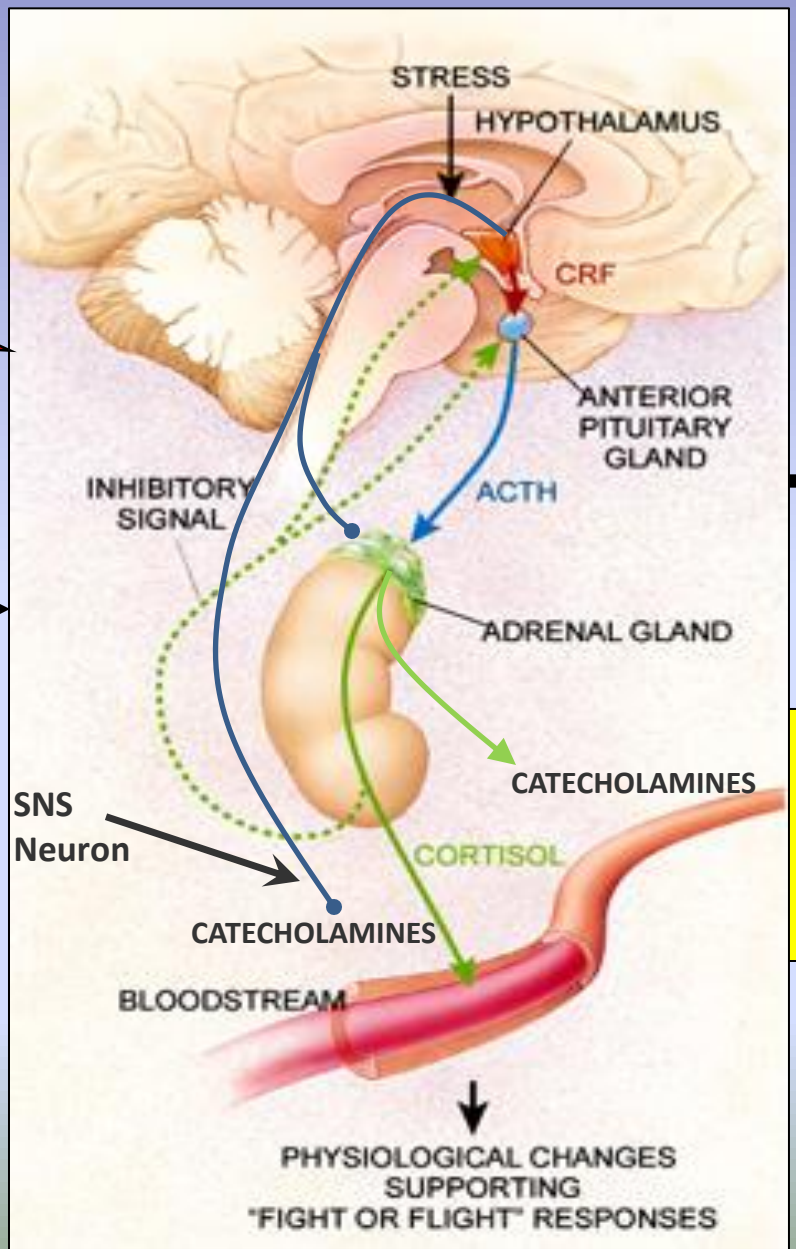


Ultra

Stress



Physiological Adjustment Allowing Exercise

- Physical activity stress
- Environmental stress

Endocrine disruption – dysfunction associated with excess stress

Overtraining Syndrome
Underperformance Syndrome
“Burnout”
Hypogonadism
PTSD

Purpose

To provide an overview of the hormonal stress responses to a variety of extreme sports, and examine whether there are implications for health relates issues due to these responses.

"Cherry picked"

Purpose

- Systematic and controlled research studies
- Avoided case studies, anecdotal reports, "junk science"

- Ultra-endurance events
- Extreme mental stress events

Limited research – number an scope

Ultra-Endurance Events

Two Oceans Ultra-marathon

- Hew-Butler et al. 2008
  - ↑↑ cortisol
  - ↑↑ aldosterone
  - ↑↑ BNP
  - ↑↑ IL-6
  - ↓↓ AVP

Before and after completing race (56 km) and in comparison to 60 min laboratory run

Hawaiian Ironman

- Ginsburg et al. 2001
  - Men
    - – ↑ cortisol
    - – ↑ estradiol
    - – ↓ testosterone
    - – ↓ lipid peroxidation (free radical formation)
  - Females no Δ hormones, peroxidation (*n*)

Before vs. after completing race

160 km Ultra-marathon

- Kraemer et al. 2008
- Hackney et al. 2009
  - ↑ IL-6
  - ↑ TNF-α
  - ↑ growth hormone
  - ↑ cortisol
  - ↓ testosterone
  - ↓ innate immune function (days in recovery)

Before vs. after completing race

UMSTEAD 100 MILLE
Trail Run

Greenland Artic Trek

- Bishop et al. 2001
  - ↓↓ testosterone:cortisol ratio
    - » ∝ length of trek
  - ↑ psychological stress
    - » ∝ length of trek
    - » e.g., anxiety, fatigue, depression
    - » ↑ cortisol (∝ association)

Measured immediately before and throughout trek

Military War Games

- Aakvaag & Opstad 1978, 81
- Hackney et al. 1994, 95, 96
  - ↓ testosterone
  - ↑ cortisol
  - ↓ T_3
  - ↑ prolactin

Measured before and throughout maneuvers (4-6 day, continuous, minimal sleep)

Mountaineering

- Benso et al. 2007
- Hackney et al. 1993, 95
  - ↑ growth hormone
  - ↑ IGF
  - ↑ catecholamines
  - ↑ rT_3 , ↓ T_3
    - » “Low T3 Syndrome” (Euthyroid sick syndrome)

Measured before and throughout ascent-descent (3 weeks to 2 months)

Extreme Mental Stress Events

Bungee Jumping

- Henning et al. 1994
- Van Westerloo et al. 2011
  - ↑ cortisol
  - ↑ β-endorphins
  - ↑ leukocytes
  - ↑ catecholamines

Measured day before, at time of jump and ↓ rapidly after jump

Potholing

- Stenner et al. 2007
  - ↑cortisol
  - ↑growth hormone
  - ↑free T_4

Measured day before and as preparing to descent, upon ascent back to normal

Rock Climbing

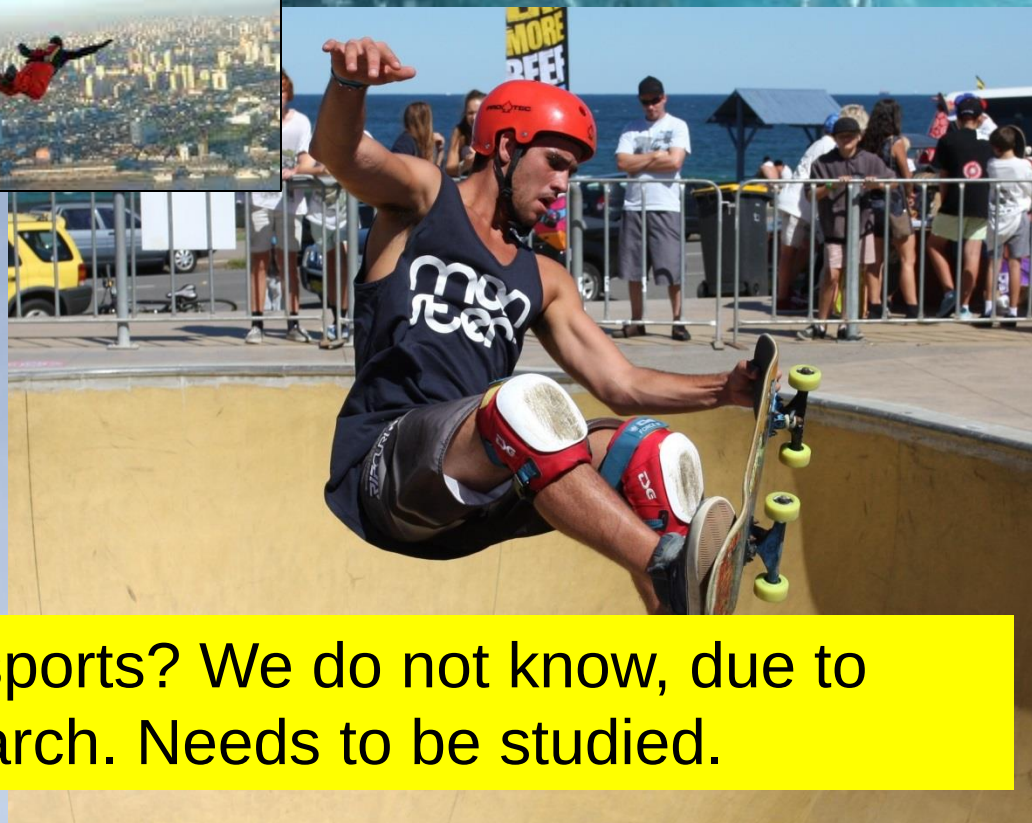
- Hodgson et al. 2009
- Sherk et al. 2011
  - ↑, no Δ cortisol
  - ↑ growth hormone
  - ↑ testosterone
  - ↑ anxiety ∝ difficulty climb

Measured before and after climb

Skydiving - Paragliding

- Chatterton et al. 1997
- Thatcher et al. 2003
  - ↓ testosterone
  - ↑ cortisol
  - ↑ catecholamines
  - ↑ prolactin
  - ↑ growth hormone
  - ↑ anxiety (peaked immediately before jump)

Measured day before vs. immediately before jump, returned to normal rapidly after jump



What about these sports? We do not know, due to a lack of research. Needs to be studied.

Summary

- Ultra-endurance events
  - Hormonal response $\propto$ metabolic load
  - $\uparrow$ heat, cold, hypoxia, hypocaloric
  - $\uparrow$ Anxiety, fear, apprehension (smaller degree)
  - Changes persist into recovery – hours, days
- Extreme mental stress events
  - $\uparrow$ Anxiety, fear, apprehension (greater degree)
  - Changes transient, abate early in recovery
  - Hormonal response $\propto$ metabolic load (smaller degree)

Conclusions

- Limited research on this topic – need more
- Extreme sports provoke
  - Stress hormone reactivity
    - » ↑ cortisol, GH, PRL, catecholamines
      - ∝ metabolic demands (select sports)
      - ∝ anxiety encountered (select sports)
- Medical implications
  - » Stress hormone reactivity could exacerbate select medical conditions (e.g., hypertension)
  - » Caution may be advised for some sports activities and a good level of physical fitness is recommended prior to participation for all

Future Directions

"Adrenaline Junkie"

"Fear is an incredibly strong emotion. If something scares us, the body immediately releases endorphins, dopamine and norepinephrine. Endorphins mitigate pain, dopamine and norepinephrine are performance enhancers. There haven't been direct studies on so-called action sports, but the general scientific thinking is that the more fearful a certain sport makes you, the greater the release of these chemicals. The greater the release of these chemicals, the greater the addiction-like symptoms."

Michael Davis, Ph.D.
Neuropharmacology
Emory University
Psychology Today

Acknowledgements

Exercise Endocrine Research Group

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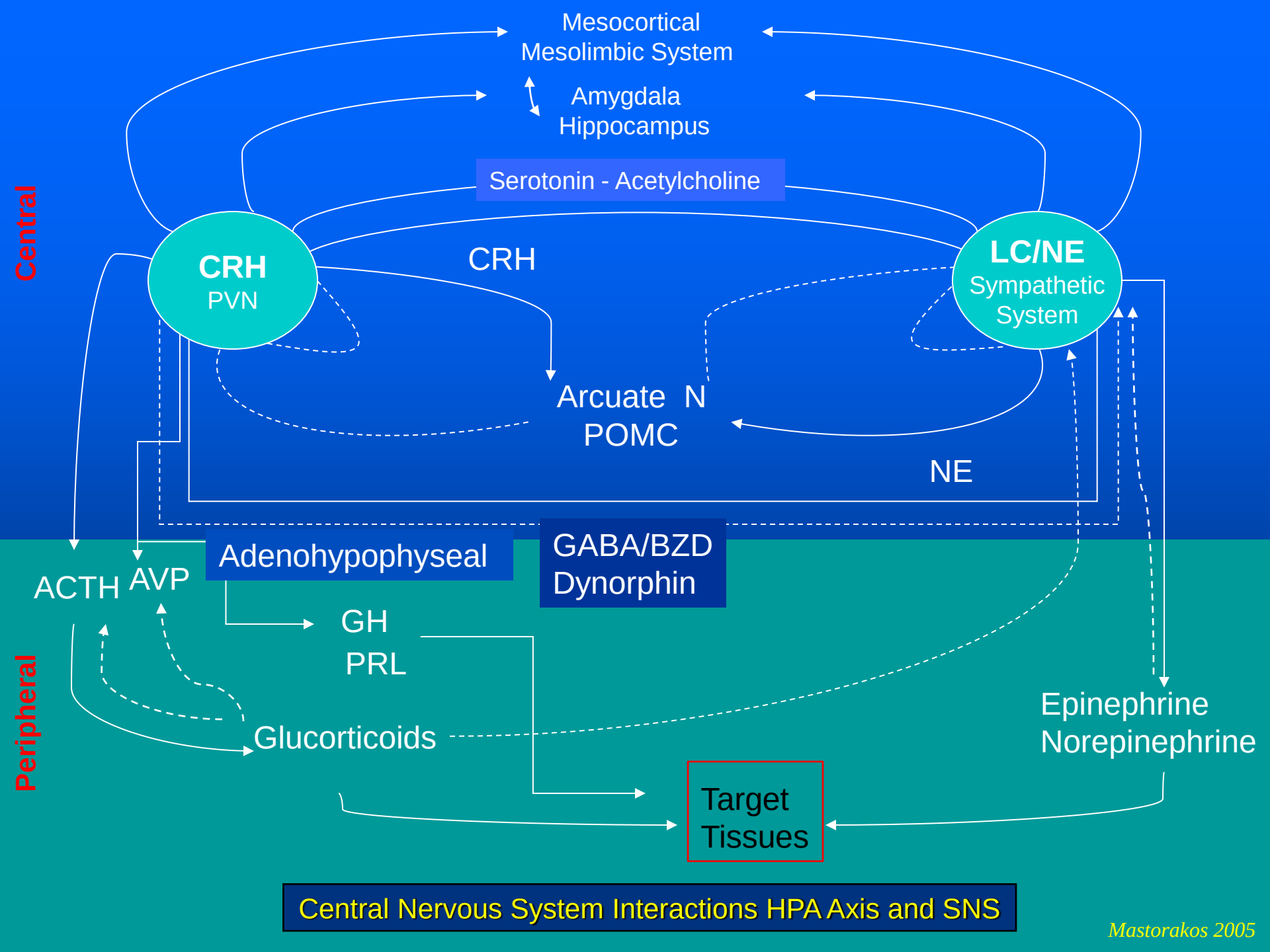
Amy R. Lane


Mesocortical
Mesolimbic System
Amygdala
Hippocampus
Serotonin - Acetylcholine
Central
CRH
PVN
CRH
LC/NE
Sympathetic
System
Arcuate N
POMC
NE
Adenohypophyseal
GABA/BZD
Dynorphin
ACTH
AVP
GH
PRL
Peripheral
Glucorticoids
Epinephrine
Norepinephrine
Target
Tissues
Central Nervous System Interactions HPA Axis and SNS
Mastorakos 2005

Stress Hormones – Exercise Response

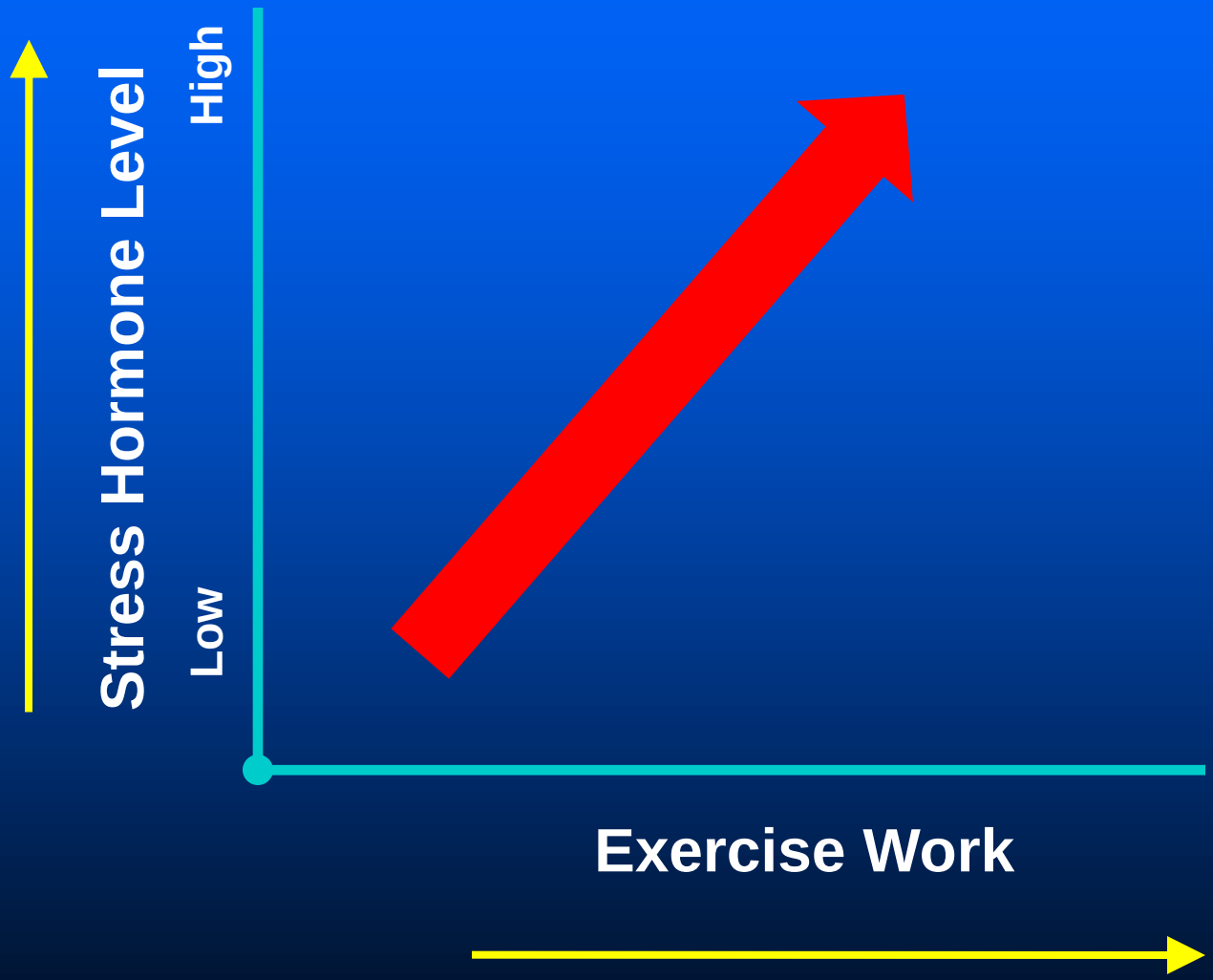
Increase from basal levels

- Norepinephrine (NE) >1000%
- Epinephrine (E) >2000%
- Adrenocorticotrophic Hormone (ACTH) > 500%
- Cortisol > 400%
- Prolactin >1000%
- Growth Hormone >1000%

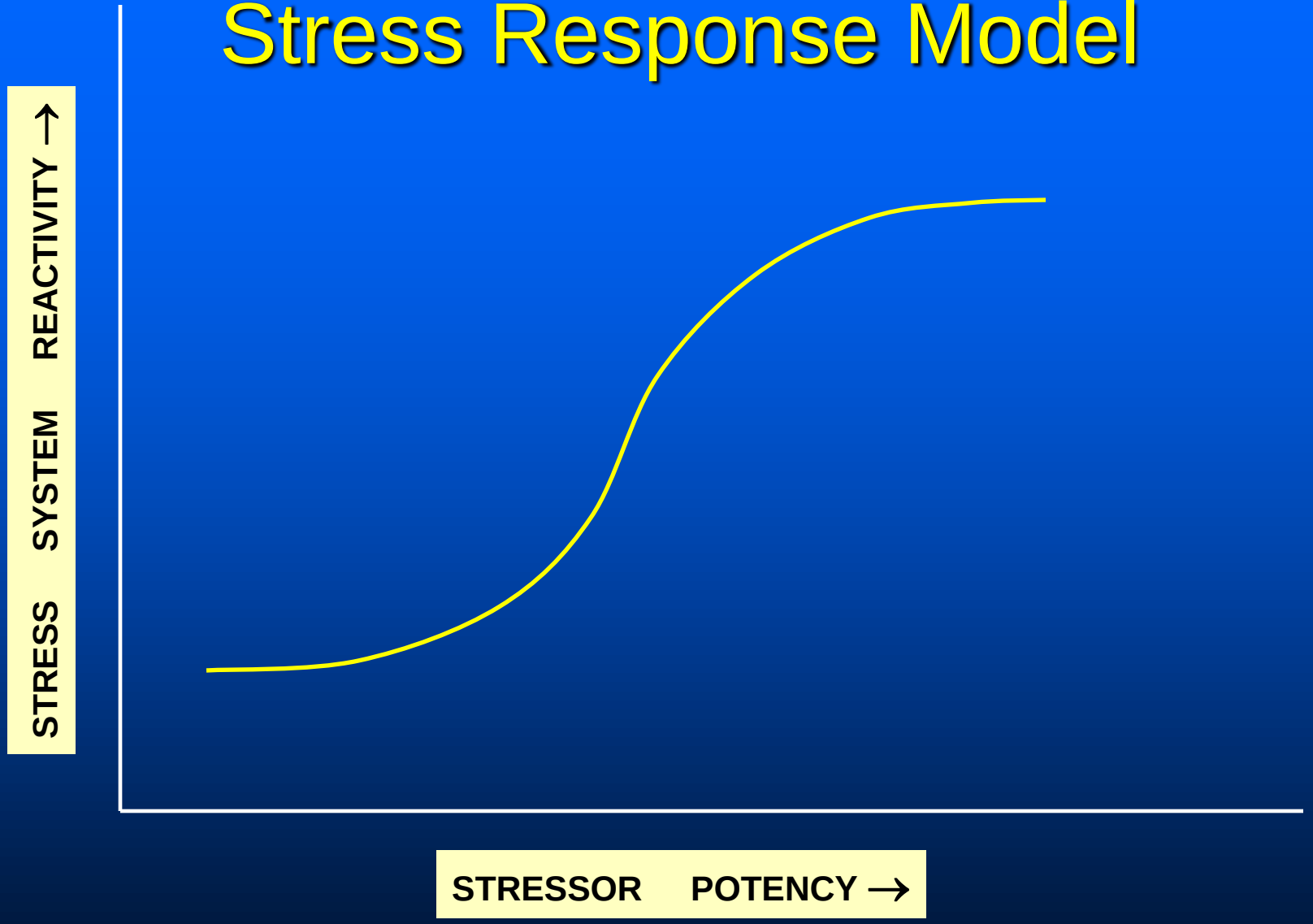
Stress Hormones – Exercise Response

- Norepinephrine (NE)
- Epinephrine (E)
- Adrenocorticotrophic Hormone (ACTH)
- Cortisol
- Prolactin
- Growth Hormone

Exercise Effects



Stress Response Model



Tsigos, Kyrou & Chrousos, 2002

- ↑ paratelic state (“thrill - excitment seeking”)