THE INFLUENCE OF EARLY EXPERIENCE ON STRESS PHYSIOLOGY: LIFE COURSE IMPLICATIONS

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Why yes, I am a bit stressed.
Why do you ask?

PREFACE


Stress can lead to depressio
Your Mental Health
Linda Hamilton
Cognitive behavioural therapist
FAMILY-BASED EDUCATIONAL INTERVENTIONS CAN IMPROVE CONDITIONS OF CHILDREN WITH CHRONIC ILLNESS, SPECIFICALLY ASTHMA AND DIABETES
EASING THE STRESS IN SICK KIDS
Morning India
Patna, Saturday December 25, 2021
Young Professionals and Stress—What's the Solution?
GUEST COLUMN
Cohen, Mitchell to probe Togus V stress 'treatment
By GERRY BOYLE
Sentinel Staff
AUGUSTA — Charging that there has been "a complete lack of progress" in treatment of Maine veterans suffering from post-traumatic stress disorder (PTSD) at the Togus Veterans Administration hospital, Sen. William S. Cohen has joined with Sen. George J. Mitchell in calling for a public airing of the issue.
GOOD HEALTH
I took the new STRESS TESTS
They claim to show whether you're truly wound up – and why. But do they really work? JENNIE AGG put the pressure on
46% of people say they eat badly due to stress
ASK DR GOOGLE
You've got mail ... and anxiety: How to reduce stress from an overflowing inbox
Six ways to manage
Stop worrying and start living: here are some practical tips on
RADHIKA PANJWANI
SPECIAL TO THE GLOBE AND MAIL
PUBLISHED MARCH 24, 2024
Cost of living
Job losses add to inflation woes
Consumer group warns of crisis
Dogs can sniff out stress
Topical Tuesdays!
Science News
Stress can ... studying for exams
Studying for exams at the last minute might be the best way to learn, according to new research that has revealed that stress helps the brain form stronger memories.
We have a problem with work stress, but it isn't what you think
SCOTT SCHIEMAN AND PAUL GLAVIN
SPECIAL TO THE GLOBE AND MAIL
PUBLISHED JUNE 24, 2024

BEAUTY

5 Signs Your Cortisol Levels Are Too High

BY GEORGIA DAY AT BRITISH VOGUE

April 25, 2024

iiievgeniy

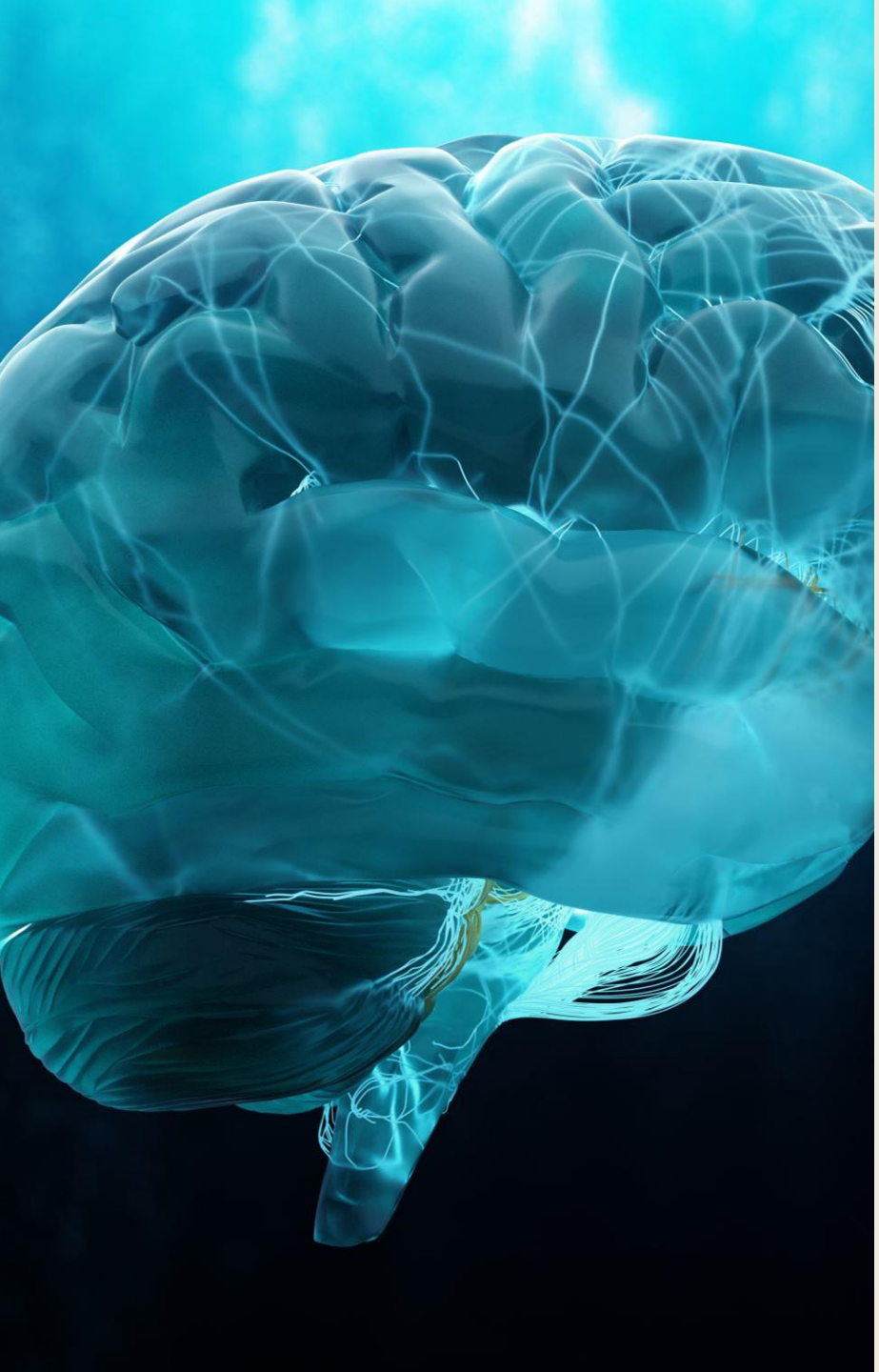
The New York Times

The Truth About the Internet's Favorite Stress Hormone

Cortisol gets a bad rap, but it's not so clear-cut.

Share full article 186

"Internet searches for cortisol were spiking last week, with Google reporting that 'how to reduce cortisol' was the fourth most popular search in the last 90 days"



Why study stress physiology?

1. Stress is not just a subjective experience; it is also a physiological process.
2. Cortisol is key regulator in the face of challenge
   - *upregulates systems involved in fight or flight*
   - *downregulates systems of no immediate use*
3. Cortisol is one of two hormones we cannot live without.
4. Under conditions of repeated or chronic stress, cortisol damages the brain.
5. Cortisol is linked to almost every human disease process, physical and psychological.
6. Early stress experiences can have a lifelong impact, partly through endocrinological systems.

Cortisol is linked to most disease processes

Diabetes

Hypertension

Immune system malfunction

Abdominal Obesity

Impaired growth

Osteoporosis

Ischemic heart disease

Cancer

Alzheimer’s

Cushing syndrome

Anxiety

PTSD

Major Depression

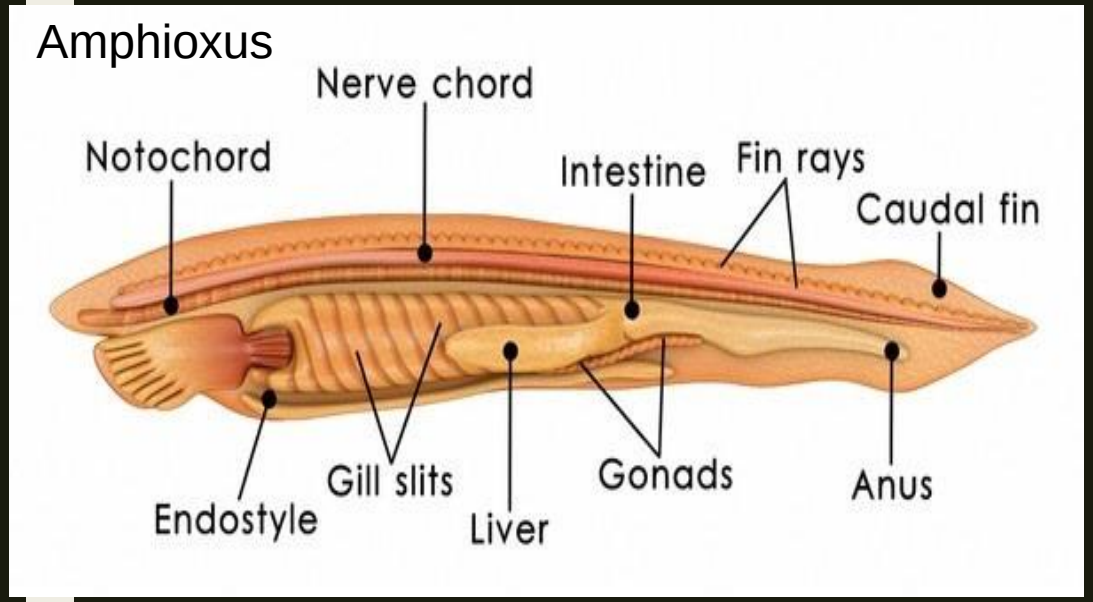
Suicide

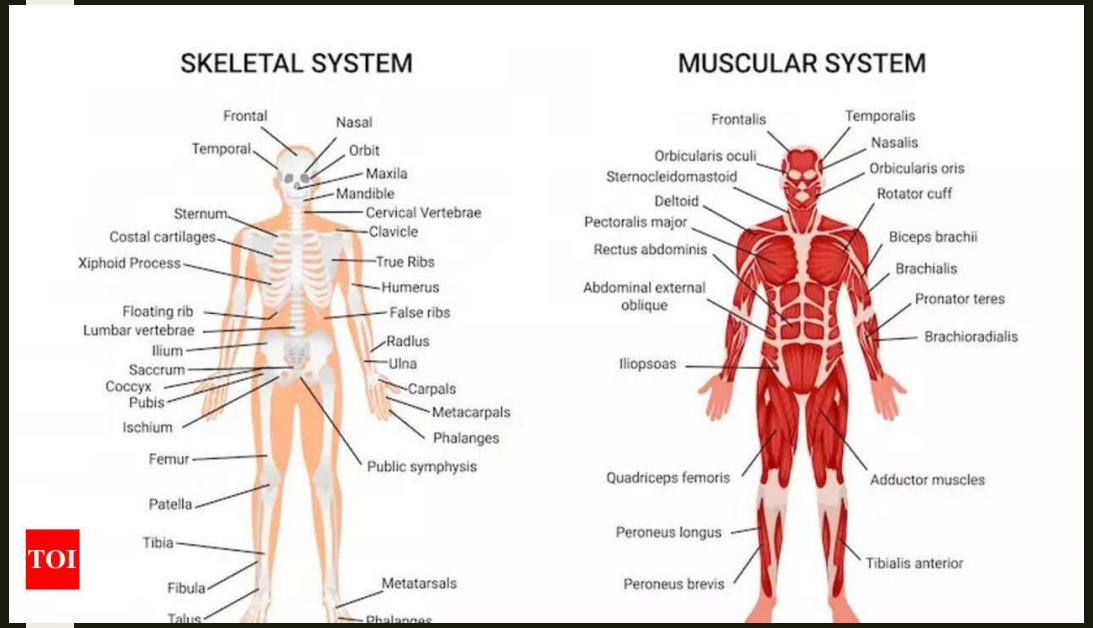
Aggression

ADHD

Impaired cognitive function


ALLOSTASIS





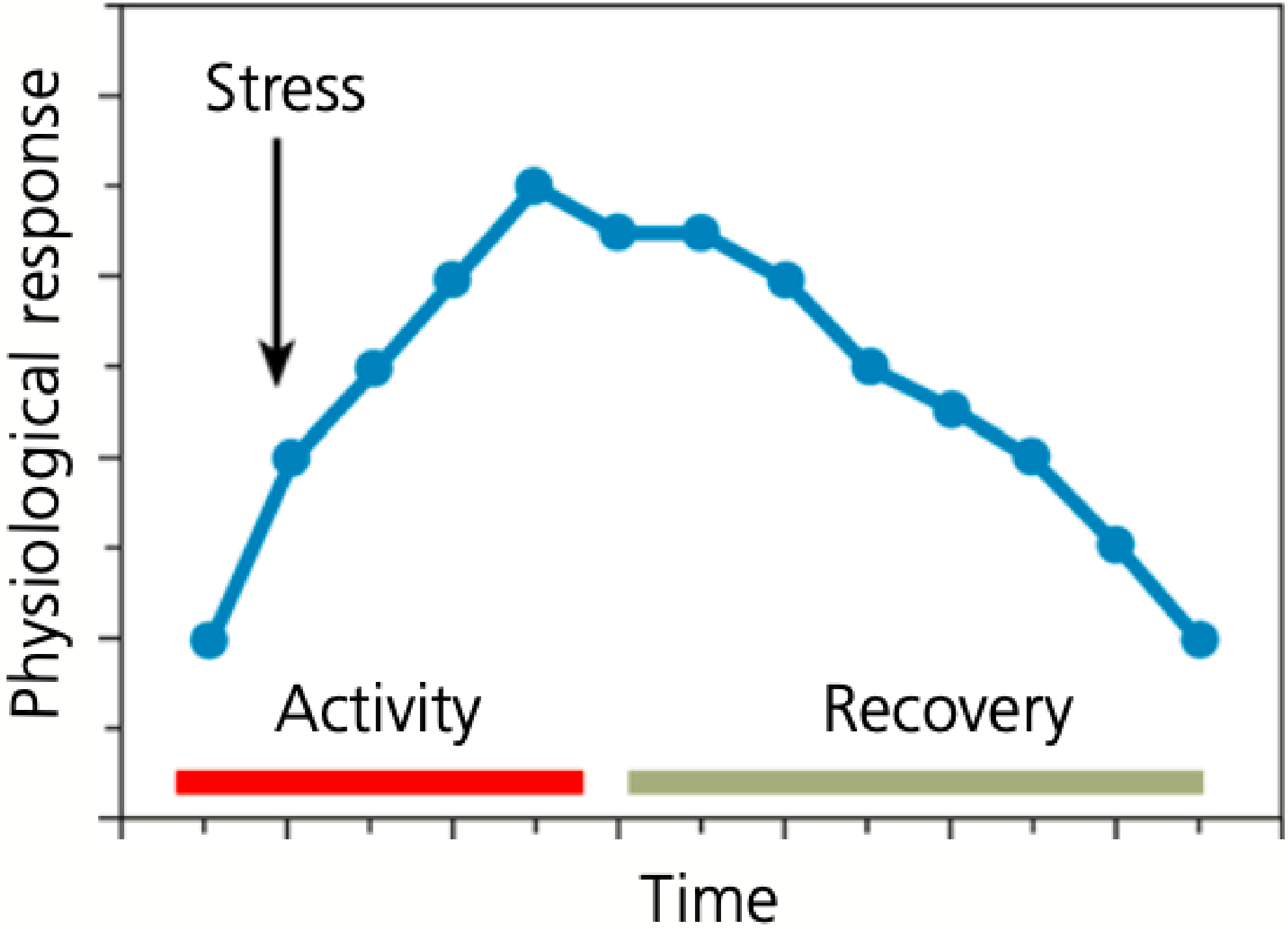
Allostasis is *core* function of the brain

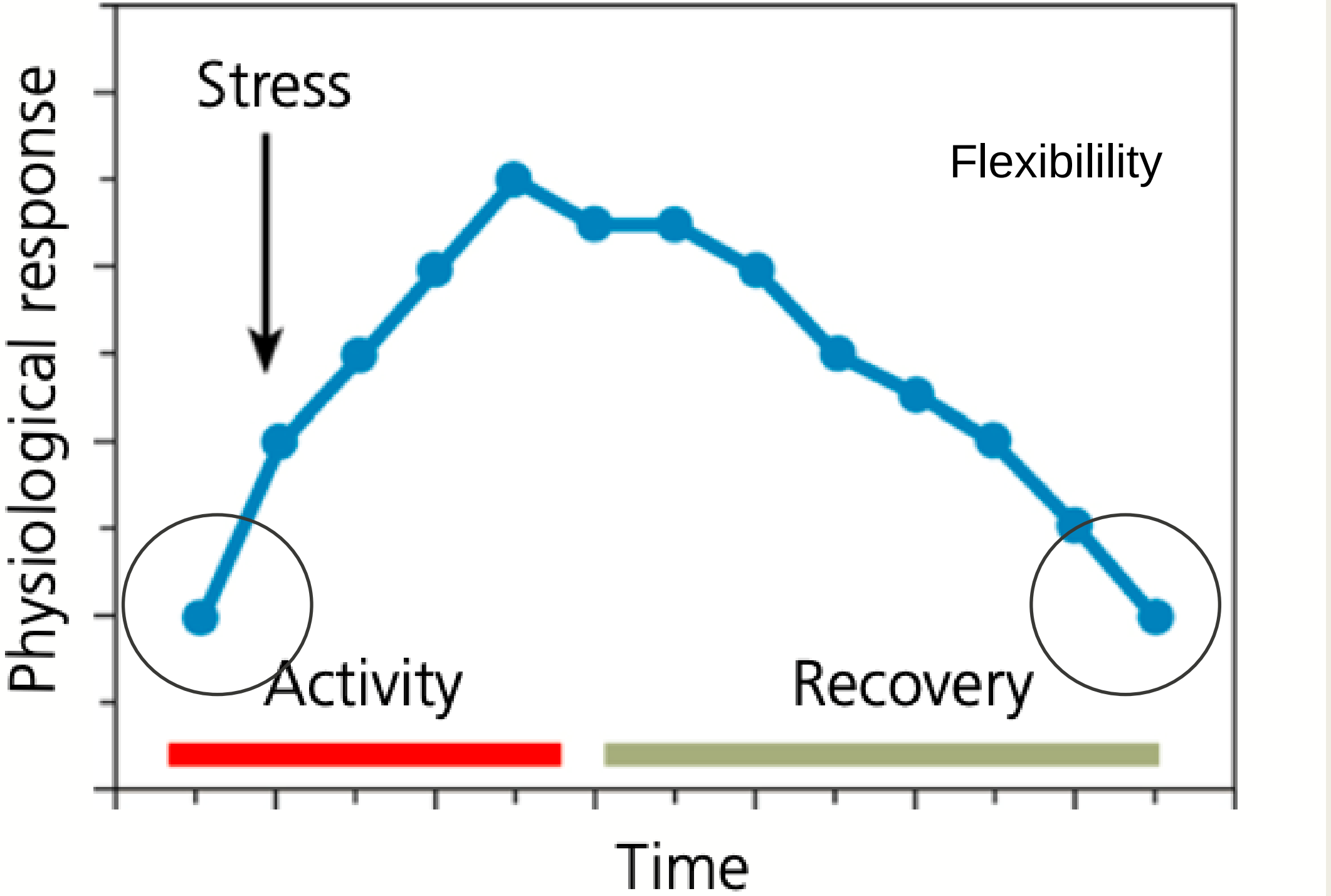
Allostasis involves

- ***coordinating*** *the body's multiple, complex systems*
- ***budgeting*** *resources; using resources efficiently*
- ***anticipating*** *bodily needs and* ***preparing*** *to meet them, rather than reacting to them*
- *all key to survival at the most basic level*

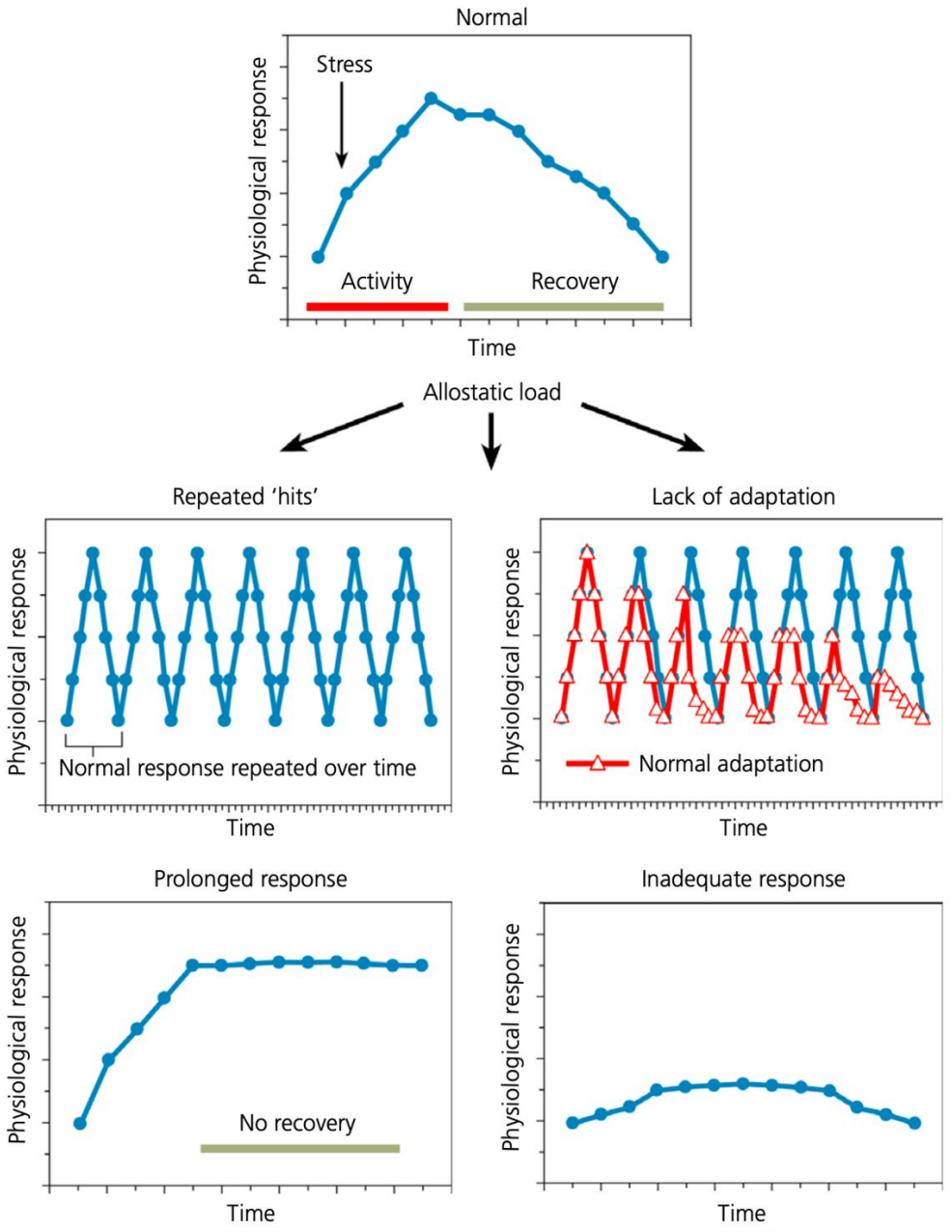
Allostasis is not the same as homeostasis

- Homeostasis is designed to prevent systems from varying too much
  - *Reactive*
  - *Reactionary*
  - *Corrective*
- Allostasis is designed to maintain stability through change


Stress
Physiological response
Activity
Recovery
Time


Stress
Flexibilility
Physiological response
Activity
Recovery
Time

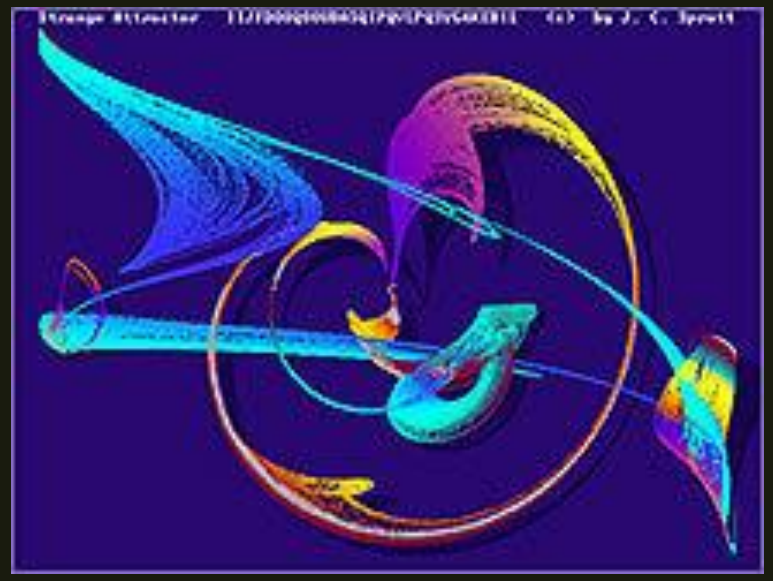

ALLOSTATIC LOAD



From McEwen, 1998; Reproduced with permission

Allostatic Load

- **Long-term wear and tear under repeated or chronic stress** (McEwen, 1998)
- Inevitable aspect of aging but rate of change over time is importantly dependent on experience of stress, past and present
  - *Pace of aging*



Allostasis as Flexibility, Attunement, Coordination

ALLOSTATIC FUNCTION AS *FLEXIBILITY*

Flexibility – ability to titrate response according to level of threat

How do we provoke stress experimentally?

- Mild physical challenge
  - medical examination, weighing, diaper change
- Brief separation from caregiver
- Anger induction
  - deprivation of attractive toy
- Fear induction
  - exposure to toy spider, mask, robot

Challenges are variably potent in provoking a cortisol stress response

- With these data comes the potential to exploit different challenge *combinations*
- To address *flexibility*, which we operationalized as response flexibility across challenges (Atkinson et al., 2016, 2024)
- Selected maternal separation and toy frustration as challenges

TABLE 2. Categorical moderators

	k	*N*	*g*	*SE*	95% CI (*g*)
Stressor type					
Separation	18	1752	.15***	.05	.01–.24
Frustration	10	1088	.00	.04	–.08–.07
Novelty	5	340	.12	.08	–.04–.28
SF	15	915	.16	.08	–.00–.32
3-ep	7	552	.06	.09	–.12–.23
5-ep	8	363	.25*	.13	.00–.50

From Puhakka & Mikko, 2020

Challenges are differentially potent across individuals

- We assessed challenge impact across dimensions that would differentiate the children's cortisol responsivity

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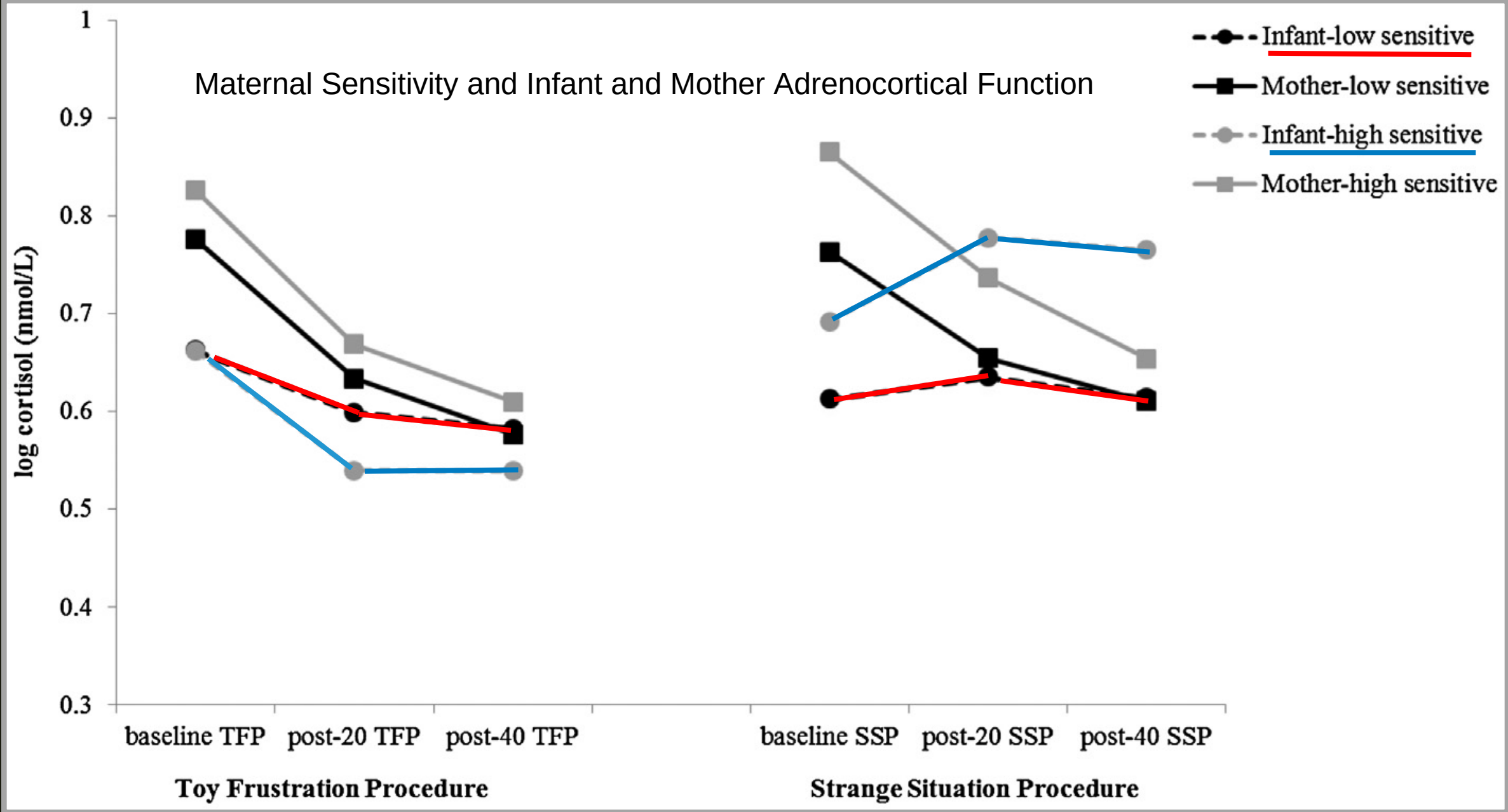


From Atkinson, Gonzalez et al., 2013

Maternal Depressive Symptoms + Infant Genes = Cortisol Inflexibility

- genotyped infants, specifically assessing two dopamine-related genes (SCL6A3, DRD2) that play a part in controlling cortisol secretion
- assessed maternal depressive symptoms via self-report

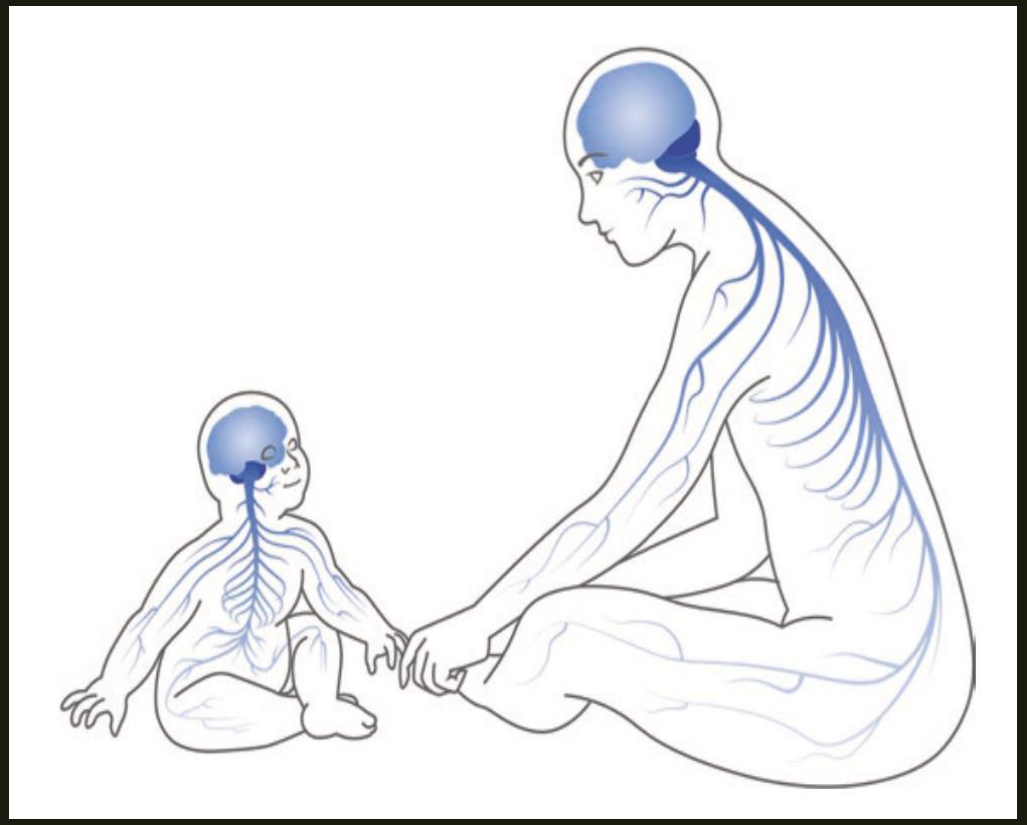
- Found that infants with **susceptibility gene variant + depressed mother** showed
  - *blunted response to both challenges*
  - *less flexibility of cortisol response across challenges*

Ludmer et al., 2015

Allostatic Function as Flexibility: Conclusion

Toddlers with vulnerabilities (both environmental and genetic) show weaker increase after maternal separation, weaker decline after toy frustration

AND they show less flexibility across challenges



Allostatic Function as Attunement

What is attunement?

core tenet of developmental psychology: caregiver(s) and children influence one another in dynamically interactive tandem over time

attunement, synchrony, mutuality, reciprocity, rhythmicity, harmonious interaction


Mutual Gaze


Joint Attention


Language

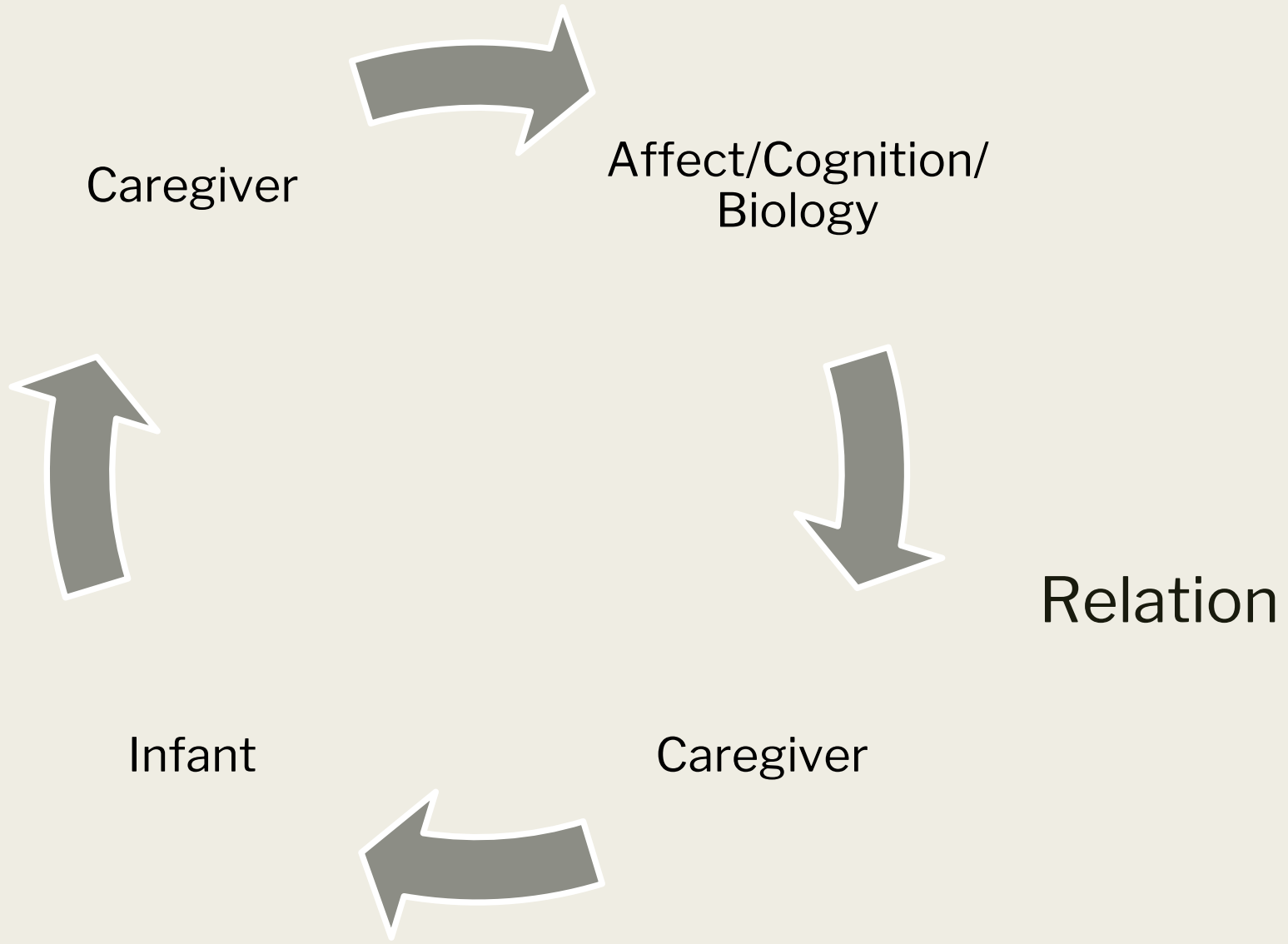
Attunement


Affective Tone

core tenet of developmental psychology: caregiver(s) and children influence one another in dynamically interactive tandem over time

attunement, synchrony, mutuality, reciprocity, rhythmicity, harmonious interaction, **biobehavioural** and **biological synchrony**

- Process of mutual regulation, with caregiver sculpting
- Relationship is outer ring, protecting infant biological systems



Attunement

- Allostasis construct founded on the insight that morbidity and mortality rates are linked to the disruption of intimate social relations amongst all primates (Sterling, 2012; Sterling & Eyer, 1988)

- Human physiology must support the species' altricial nature, itself prerequisite to evolutionary success (Atkinson, 2019).

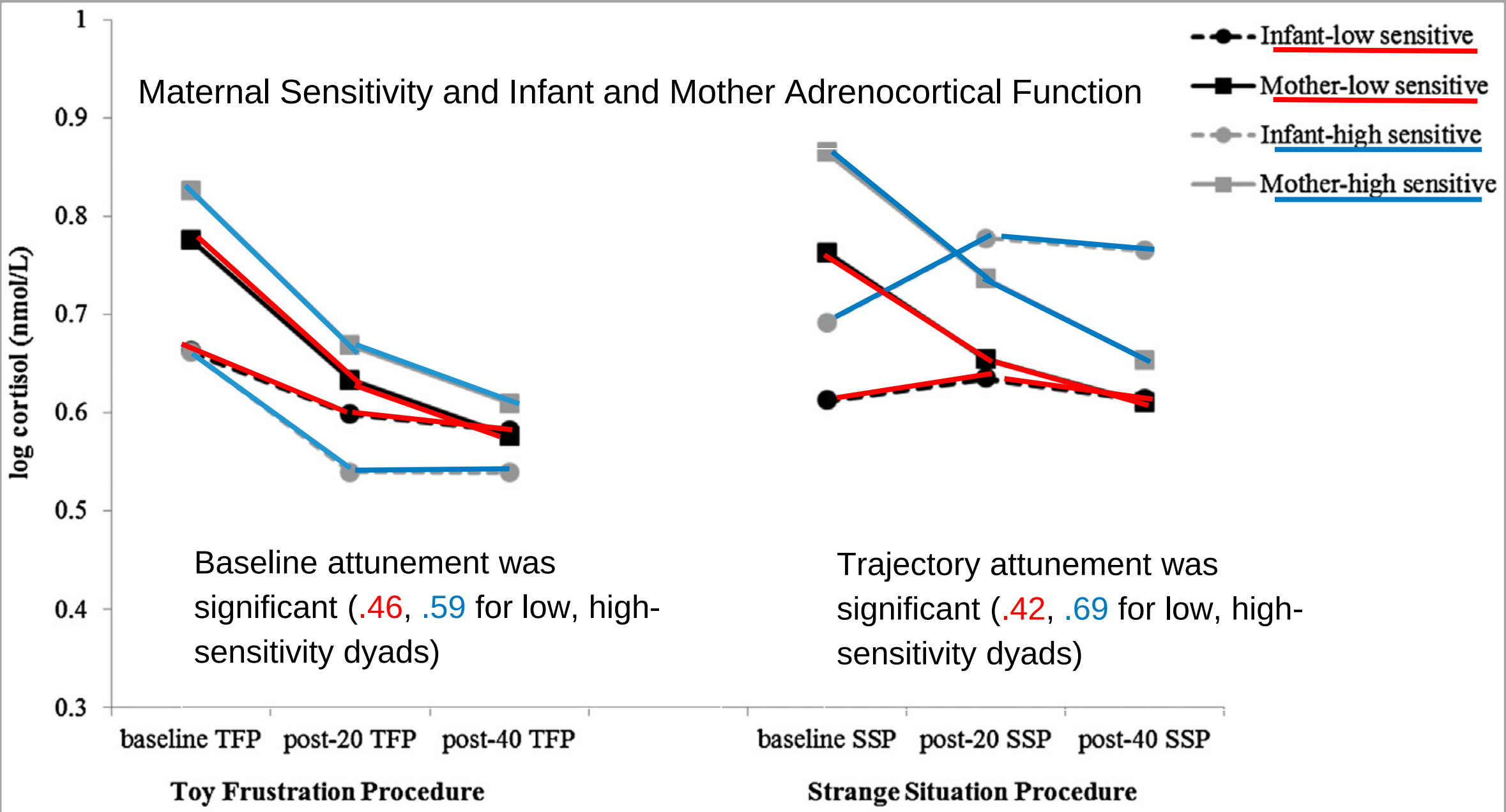
Attunement

- Attunement likely
  - *supports neurobehavioral maturation*
  - *shapes the ability to handle stress*
  - *organizes the child's lifetime capacity for social affiliation*
  - *aids provision of adequate parenting in the next generation (Feldman, 2012, p. 155)*

- Where dyadic systems go amiss, so too do
  - *emotional*
  - *behavioral*
  - *cognitive*
  - *physical development* (Del Giudice et al., 2011).

- "Health happens between people" (Maunder & Hunter, 2015, p. 5).

Maternal Sensitivity and Infant and Mother Adrenocortical Function

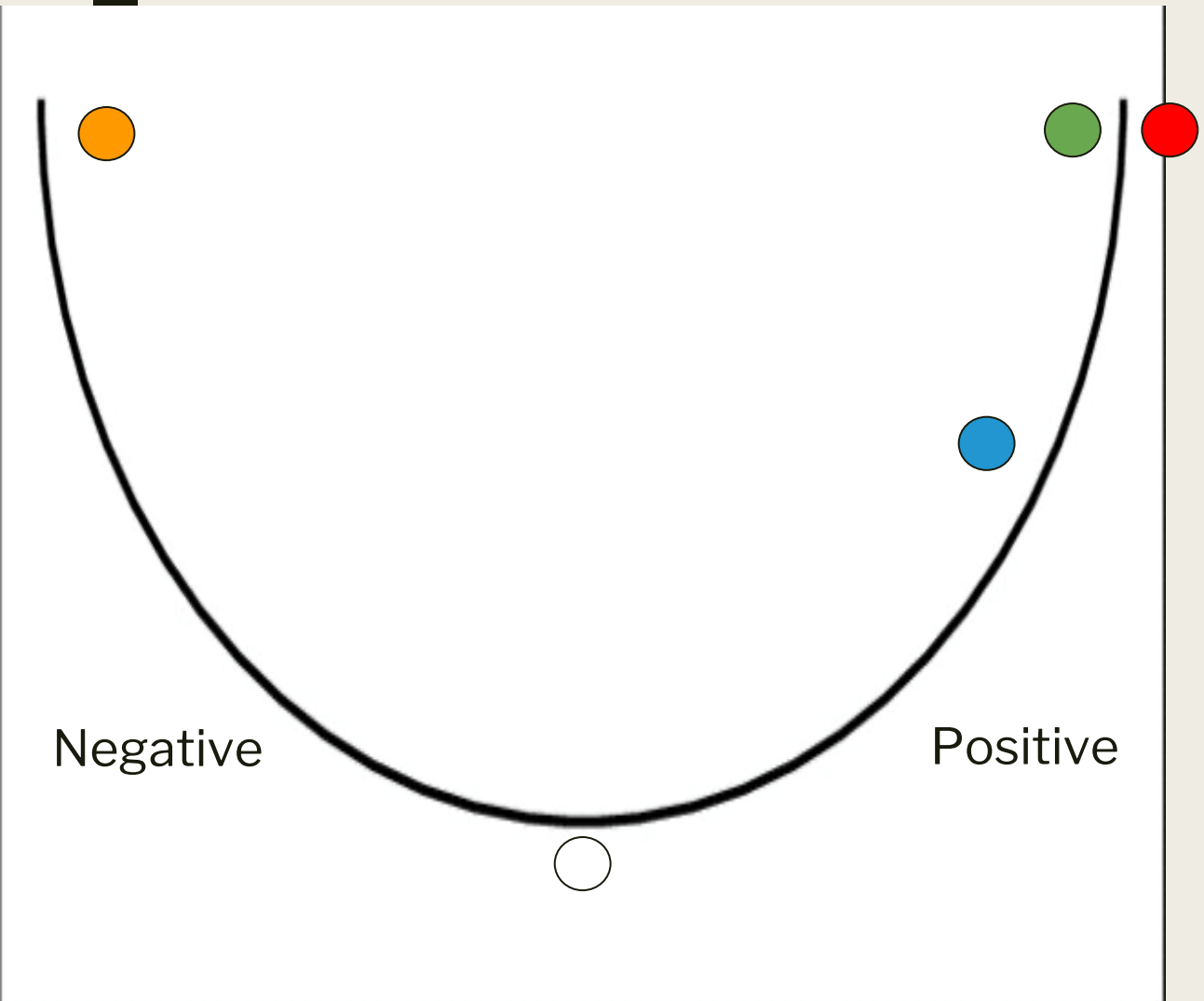


Baseline attunement was significant (.46, .59 for low, high-sensitivity dyads)

Trajectory attunement was significant (.42, .69 for low, high-sensitivity dyads)

From Atkinson, Gonzalez et al., 2013

Environment and cortisol attunement



Positive parenting

- 10 studies, preterm to 4 years
- holding, skin-to-skin, sensitivity
- low risk, low income, psychiatric

Child emotion regulation difficulties

Troubled parenting

- disrupted communication, extreme
- intrusiveness, disorganised relationship
- parent with history of maltreatment

Extreme environment challenge

- Intimate partner violence
- extreme mood change pre- to post-natal

Atkinson et al., 2024

Allostatic Function as Coordination

Allostasis involves the brain's agentic orchestration of numerous systems that are activated or suppressed to facilitate a common goal (Sterling, 2012)

HPA axis and Autonomic Nervous System

- ANS regulates involuntary physiologic processes including heart rate, blood pressure, respiration, digestion

Several factors are linked to poor coordination of HPA-axis and ANS systems

- Maternal sensitivity (Jamieson et al., 2016; Hibel et al., 2018)
- Extreme shift from lower depression during pregnancy to higher postnatal depression (Laurent et al., 2012)
- History of mother's early care (Ali & Pruessner, 2012)
- Mother's maltreatment history (Gordis et al., 2008)
- Maternal cortisol/sAA ratio (Laurent et al. 2012)

- Cortisol-ANS coordination is under social control, with stress response system coordination highest in supportive social relationships (Hibel et al., 2018)

Social engagement and allostatic load mediate between adverse childhood experiences and multimorbidity in mid to late adulthood (Canadian Longitudinal Study on Aging)

- *N* = @28,000
- 45–85 years at recruitment
- ACES retrospective:
  - physical, emotional, and sexual abuse, neglect, intimate partner violence, parental divorce/separation, parental death, living with a family member with mental health problems
- Allostatic load – 26 markers
  - endocrinological, haematological, cardiometabolic, pulmonary, etc.
- Outcomes: 21 diagnoses
  - skeletal, nervous, endocrine, cardiovascular, lymphatic, respiratory organ systems

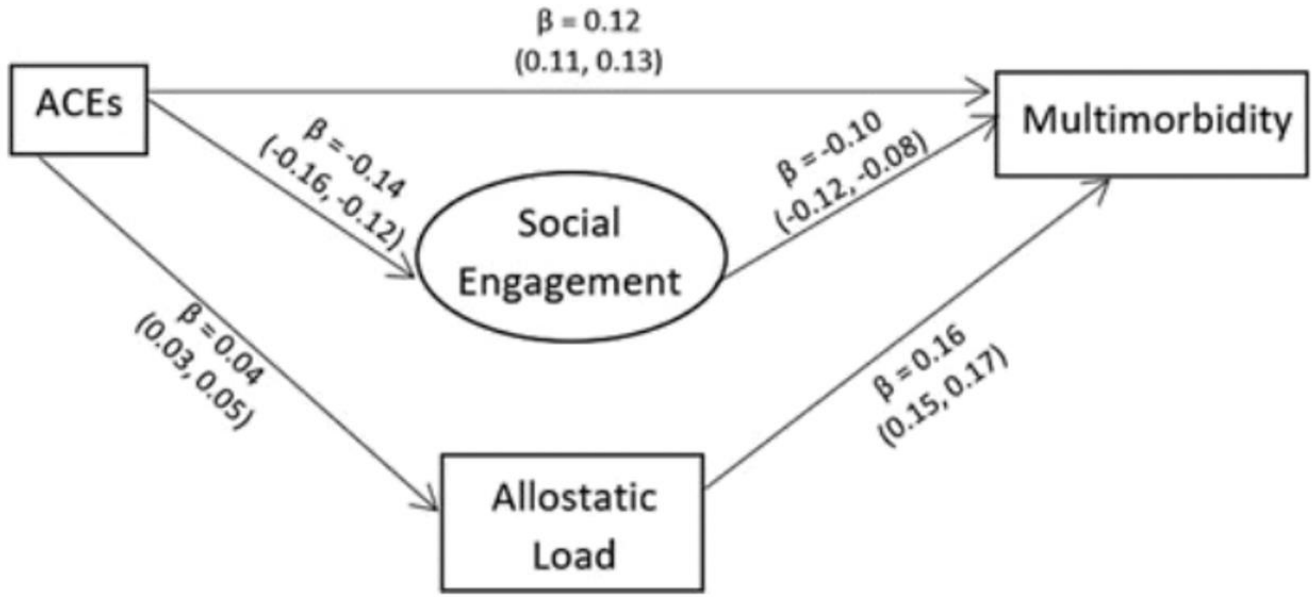
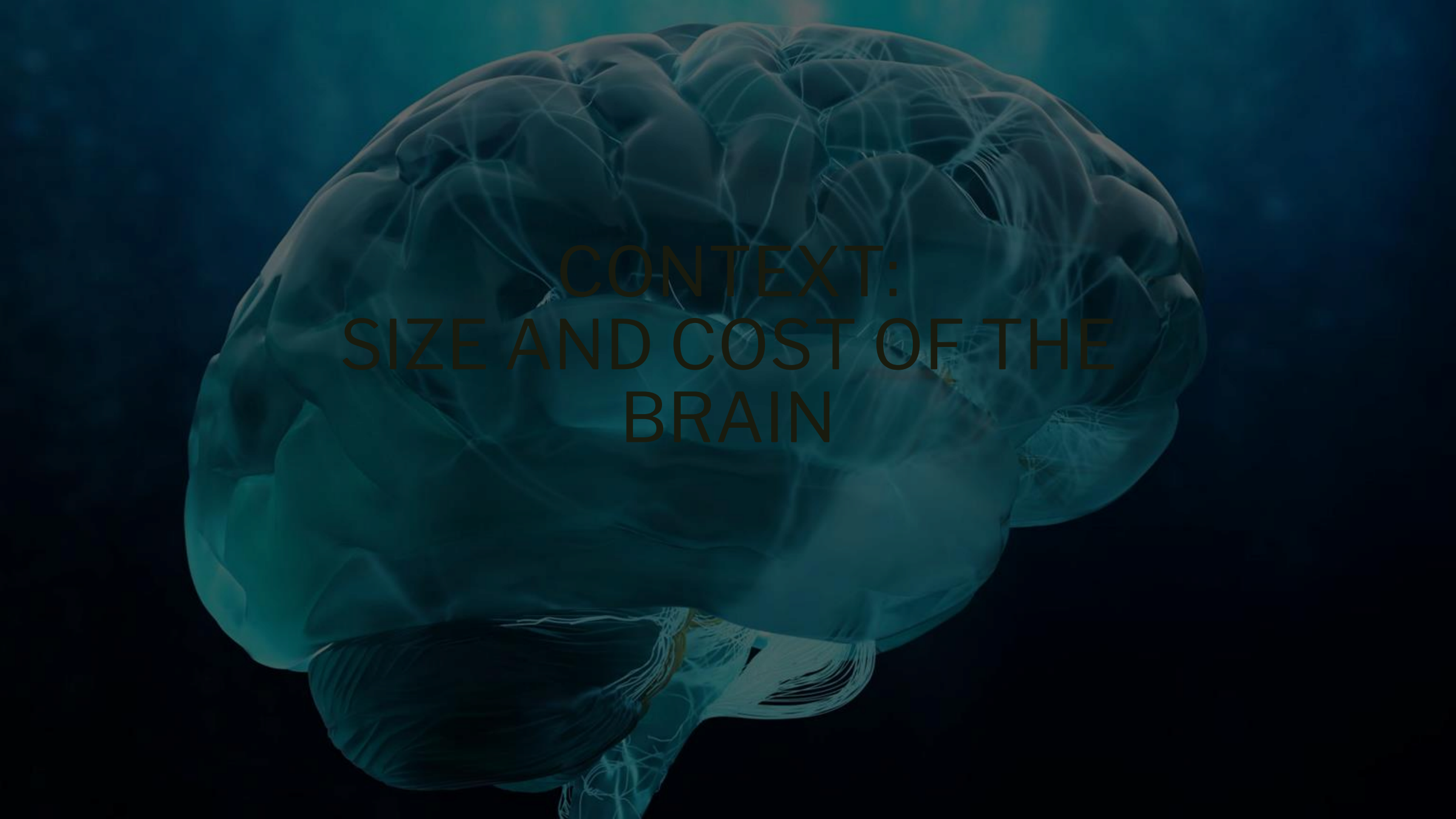


Fig. 2. Structural model of factors influencing multimorbidity.
Model adjusted for age, sex, income, smoking, nutrition, and alcohol consumption. Covariance between social engagement and allostatic load was included. All paths are statistically significant, $p < .0001$. ACEs = Adverse childhood experiences

Atkinson et al., 2023

THANK YOU!



CONTEXT:
SIZE AND COST OF THE BRAIN

Brain size and cost

1.5 kg of

- water and fat (85%)
- proteins, carbohydrates, salts (15%)

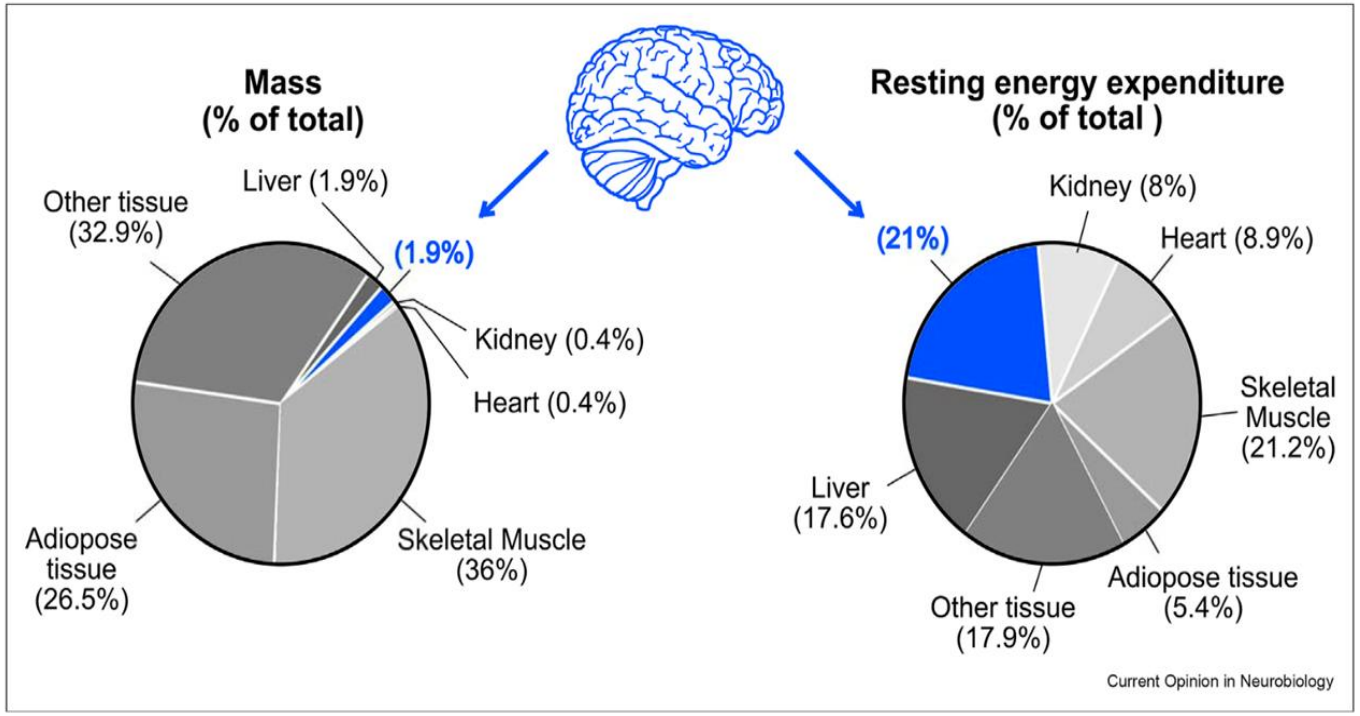
Average weight of Canadian adult = 77.35 kg

1.5 /77.35 = 2% of total human body weight …

Brain size and cost

2 **Metabolic underpinnings of normal and diseased neural function 2023**

Figure 1



The brain is energetically expensive given its mass. Depicted are pie charts showing the relative mass (left; % of total body mass) and relative levels of resting energy consumption (right; % of total energy consumption at rest) of various organs in the human body. The brain's relative mass and resting energy expenditure are depicted in blue. (Data from Ref. [1], brain image from doi.org/10.5281/zenodo.3925989).

But it consumes 21% of all metabolic resources needed

- *to produce energy*
- *maintain life*

At its peak, @ age 5, it requires 45% of caloric resources

The brain is energetically expensive

Brain size and cost


Available online at www.sciencedirect.com
ScienceDirect
Current Opinion in Neurobiology
ELSEVIER
Perspective

Paying the brain's energy bill

Zahid Padamsey[1] and Nathalie L. Rochefort[1,2]

Moreover, the brain costs go beyond the metabolic to include

- *Increased length of gestation*
- *Reduced pre- and post-natal growth rate*
  - particularly during times of faster brain development (falling to minimum around age five),
- *Delayed and less frequent reproduction (compared to smaller-brain species)*

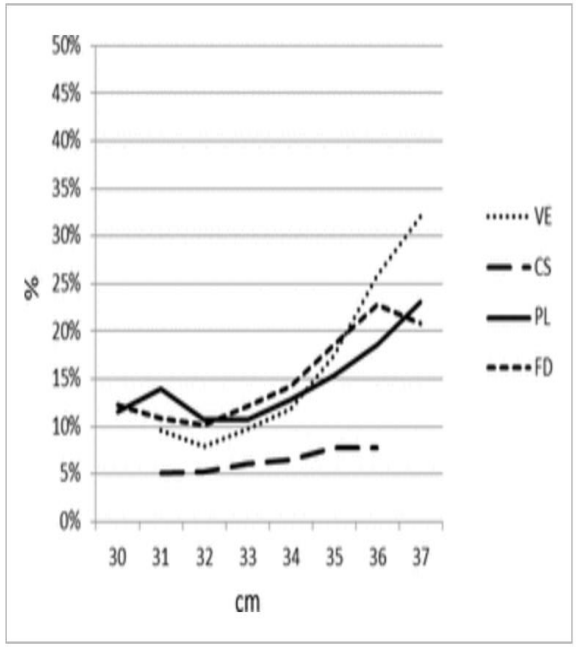


Figure 1

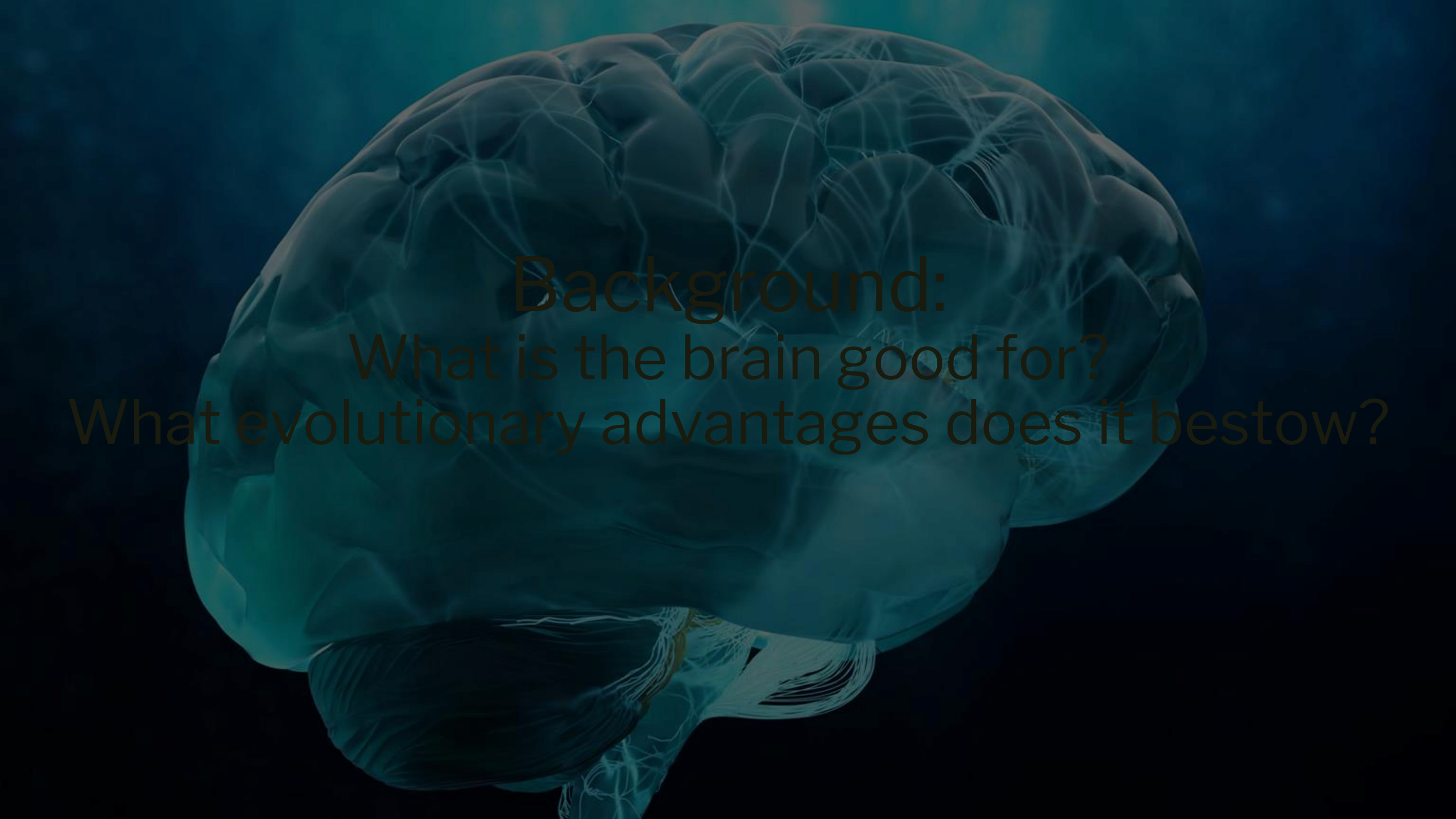
Open in figure viewer | PowerP

Proportion of the primary and secondary outcomes in relation to fetal head circumference (in centimeters) in low-birthweight infants (<3000 g, *n*=32 758).

Brain size and cost

The brain is expensive from developmental and evolutionary perspectives.

What do we get from our investment?


Background:
What is the brain good for?
What evolutionary advantages does it bestow?

What is the brain good for?
What evolutionary advantage does it bestow?

We’ve established that the brain is expensive

At the same time, the brain is not necessary to animal life

For a long time, the earth was ruled by organisms without brains (Barret, 2020)

What is is the brain good for?
What evolutionary advantage does it bestow?

- On the face of it, that seems a trivial question

What is it good for?
What evolutionary advantage does the brain bestow?

- On the face of it, that seems a trivial question

- The brain controls
  - thinking
  - feeling
  - learning
  - remembering
  - talking
  - …

What is it good for?
What evolutionary advantage does the brain bestow?

T.Rex with feathers

- But I would argue that all these functions are "*exaptations*"
  - *i.e., a feature that acquires a function for which it did not initially evolve; for which it was not originally adapted or selected*
  - An evolved element pressed into service for some other function or in some other context

What is it good for?
What evolutionary advantage does the brain bestow?

What evolutionary advantage did the brain *initially* bestow?
What is its core function?