

Session 04: Circadian Rhythm and Exercise

November 24, 2025

BOTTOM-UP
EXECUTIVE FUNCTIONING

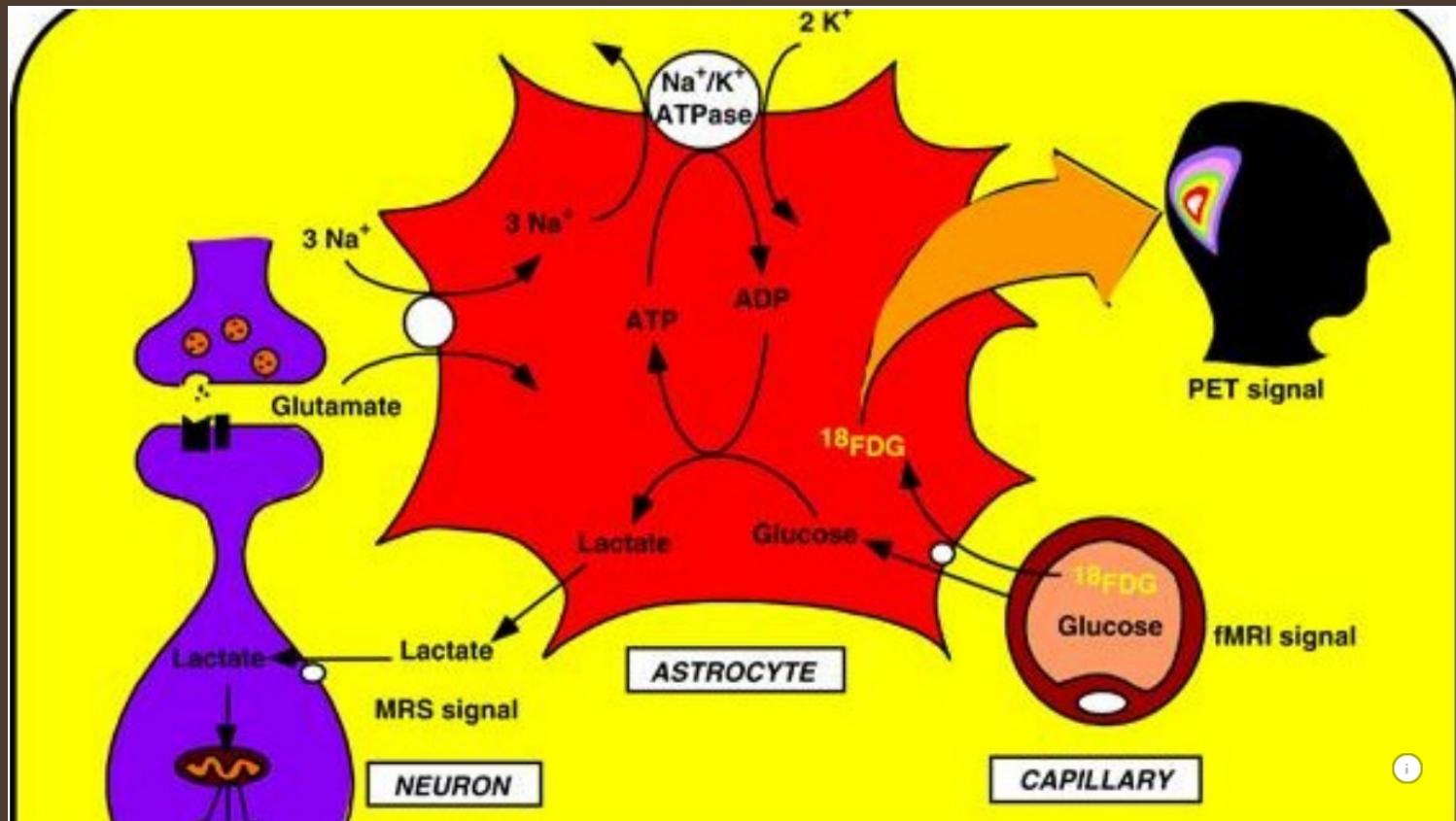
Quick Strategy #1

Neuroenergetics Theory
Norepinephrine as the
“Gas Pedal.”

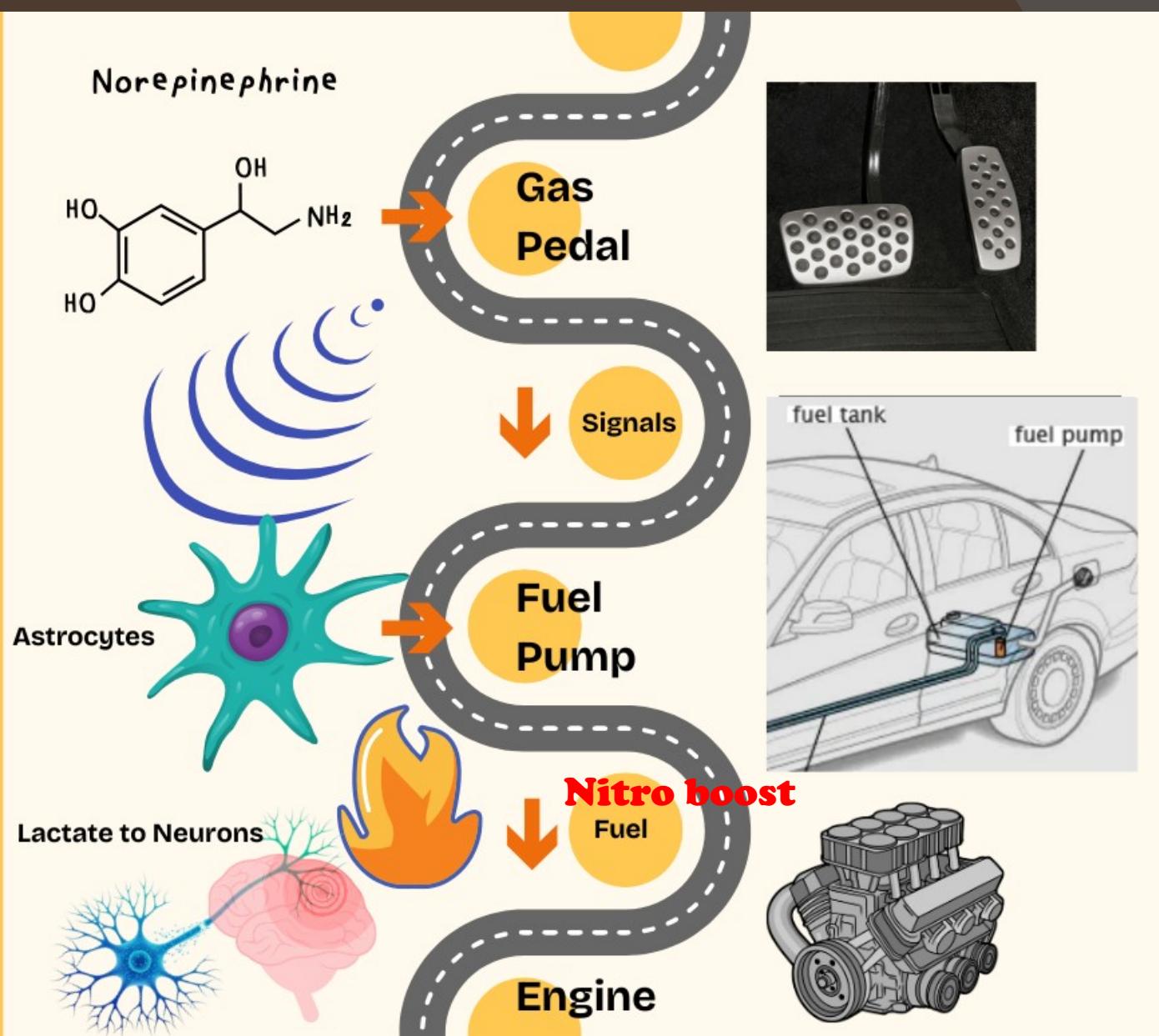
Neuroenergetics Theory (NeT) of ADHD (Killeen et al, 2013)

○ Astrocyte-Neuron Lactate Shuttle (ANLS)

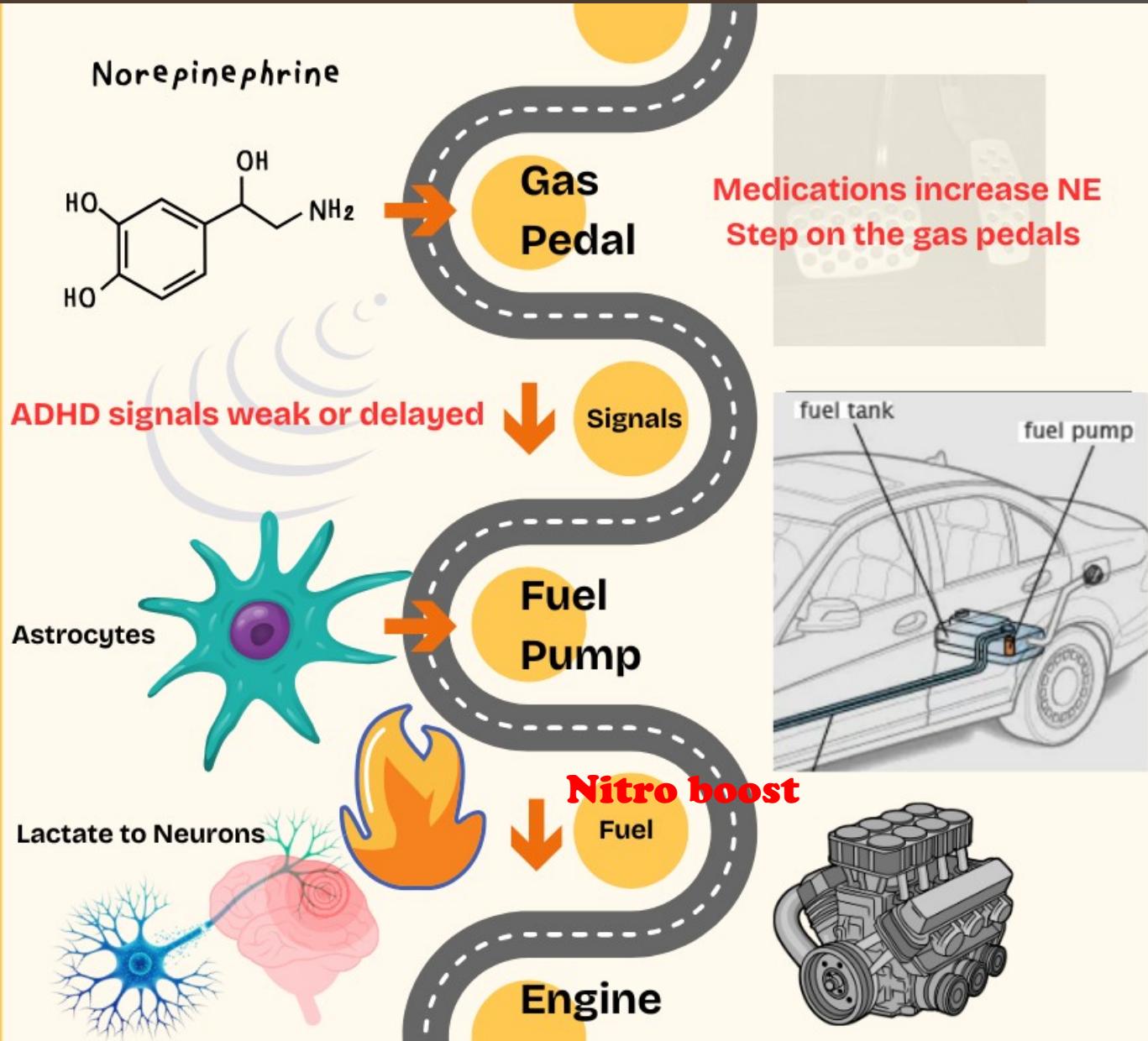
(Pellerin & Magistretti, 2011)



Astrocyte Neuron Lactate Shuttle (ANLS)



Astrocyte Neuron Lactate Shuttle (ANLS) in ADHD



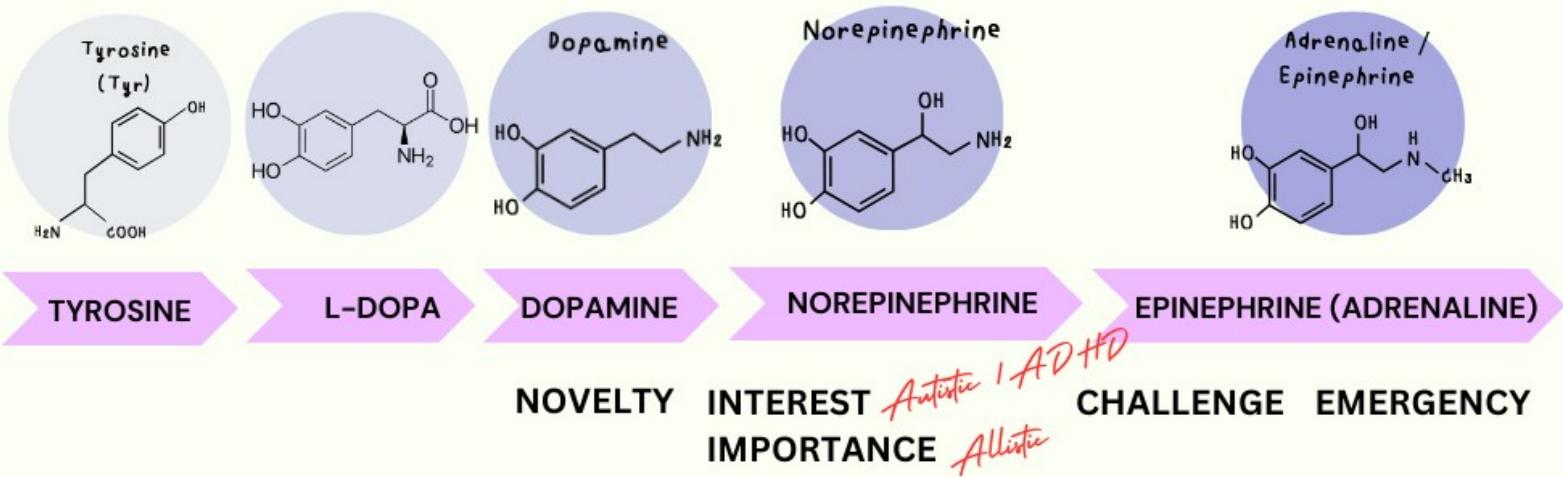
Neuroenergetics Theory

- ◉ It is not about time management.
- ◉ It is about energy management.
- ◉ Activate your brain for a task.
- ◉ Maybe a delay before astrocytes pump the fuel to your brain.
- ◉ Or maybe the alertness signal is weak, and the astrocytes don't boost energy delivery

All about the gas pedal: Norepinephrine

- ◉ Wakefulness
- ◉ Attention
- ◉ Engagement
- ◉ Surprise
- ◉ Notice

ADRENALINE SYNTHESIS PATHWAY

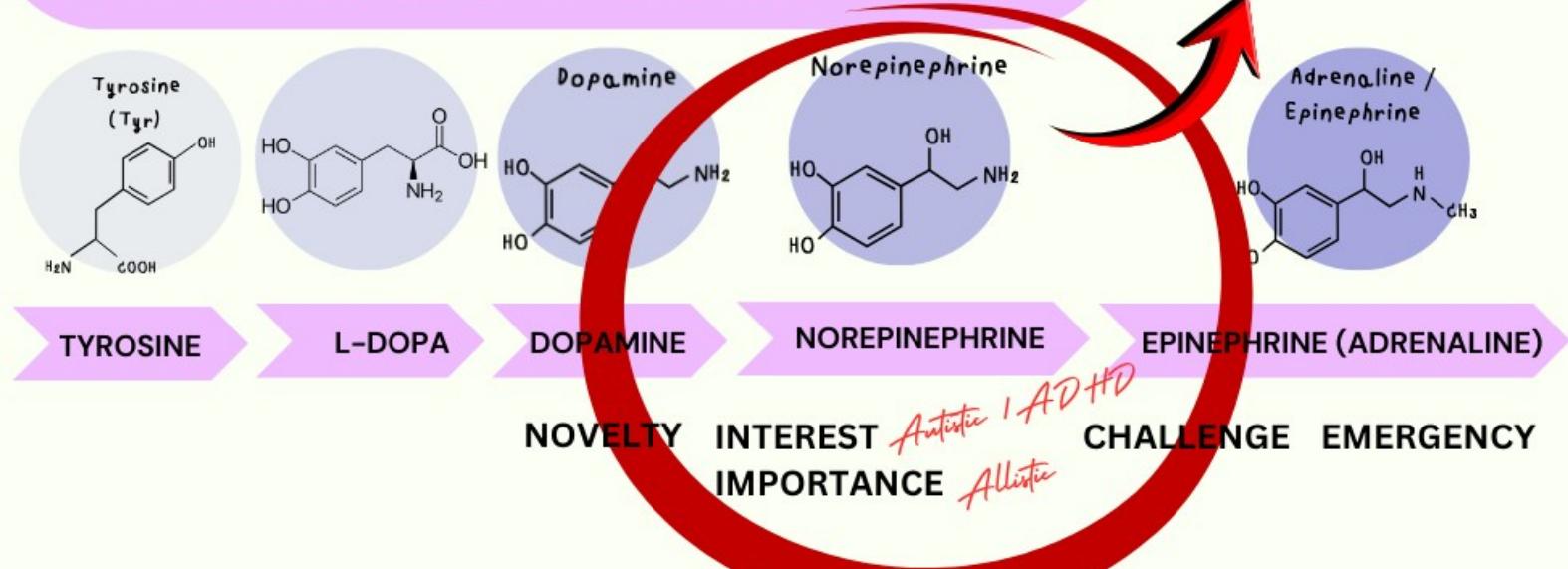


Parallels

The
N
Strategy

I**C****E**

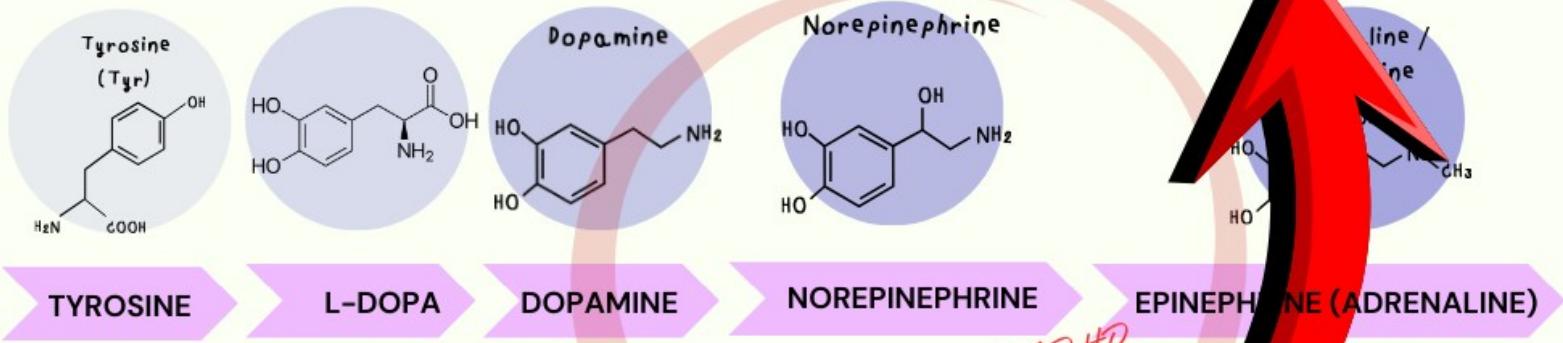
ADRENALINE SYNTHESIS PATHWAY



Parallels

*The N
I
C
E
Strategy*

ADRENALINE SYNTHESIS PATHWAY



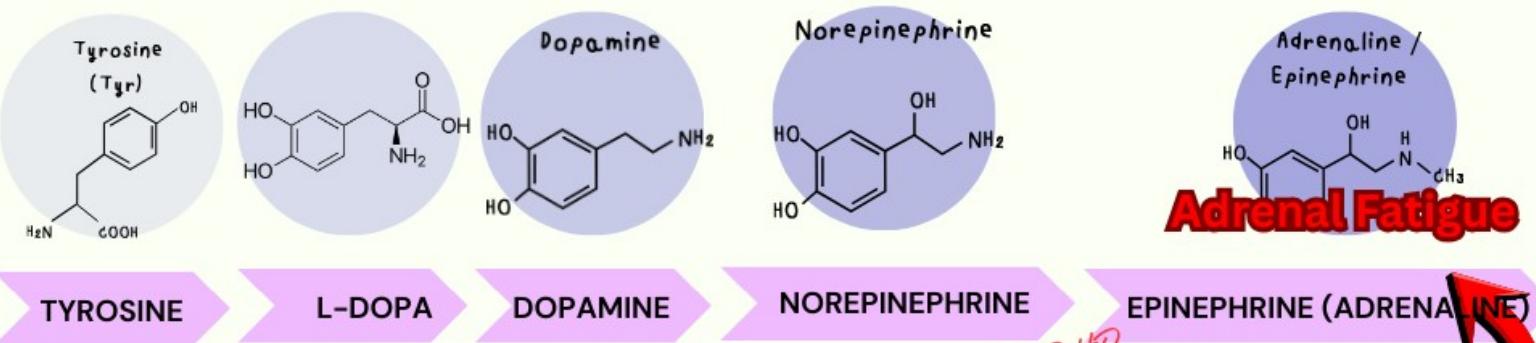
Parallels

The N I D E Strategy

A red circle highlights the letters N, I, and D, with arrows pointing from the text "The N I D E Strategy" to these letters.

Gas Pedal
in ANLS

ADRENALINE SYNTHESIS PATHWAY



Emergency works.
Use sparingly.



Adrenal Fatigue

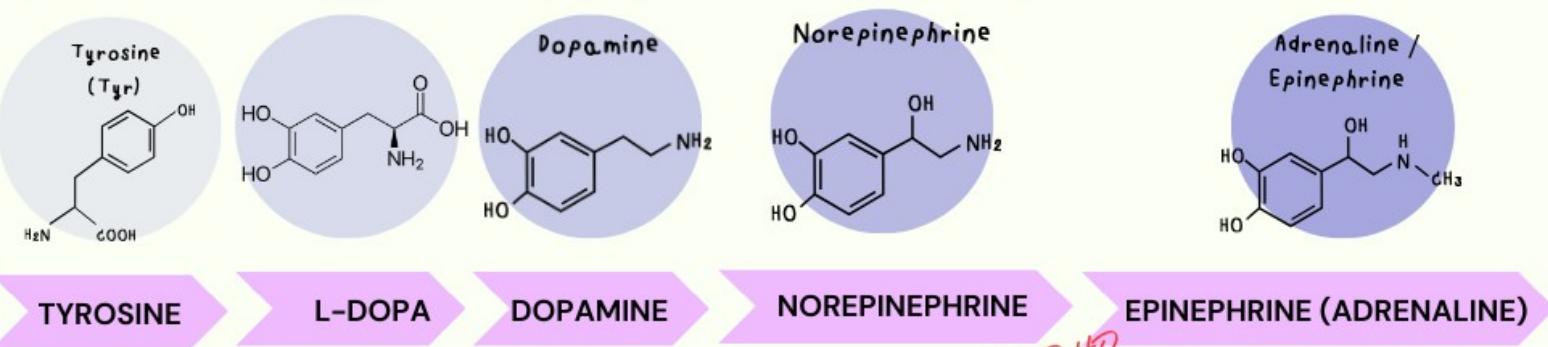
Parallels

*The N
I
C
Strategy*

The “Spoon Mafia”

ADRENALINE SYNTHESIS PATHWAY

**Emergency works.
Use sparingly.**



Parallels

NOVEL

Y INTE

NOREPINEPHRINE

► EPINEPHRINE (ADRENALINE)

NOVELTY INTEREST *Autistic / ADHD* CHALLENGE EMERGENCY
IMPORTANCE *Autistic*

Feeling N

1

1

C

E

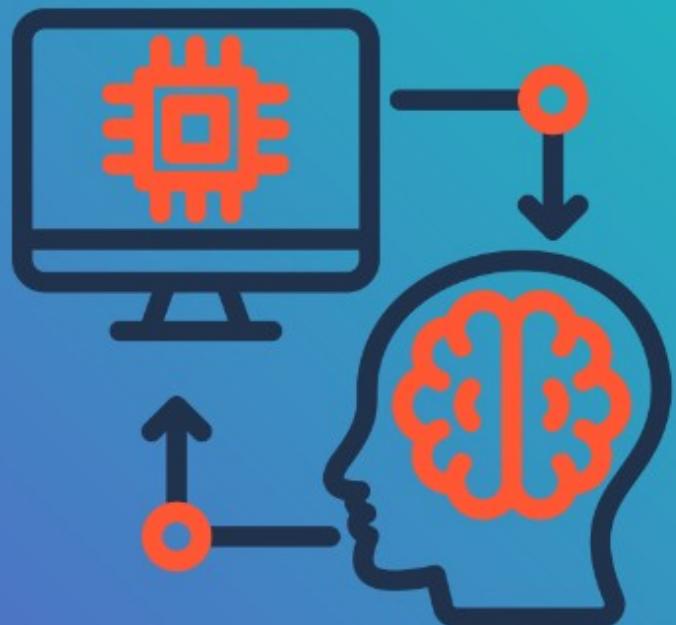
The diagram shows the acronym NICE in blue boxes. A red circle highlights the letters I, C, and I. Above the acronym, the word 'Feeling' is written in red cursive on the left, and 'Sparing' is written in red cursive on the right, with red arrows pointing from these words to the highlighted letters.

How do you tie INTEREST into your tasks?

- ◉ Discussion

Quick Strategy 2

Screen Refresh Rates SSVEP / SSAEP



Brain Computer Interface (BCI) Research



Screen refresh rates:

1 Hertz = 1 refresh / second

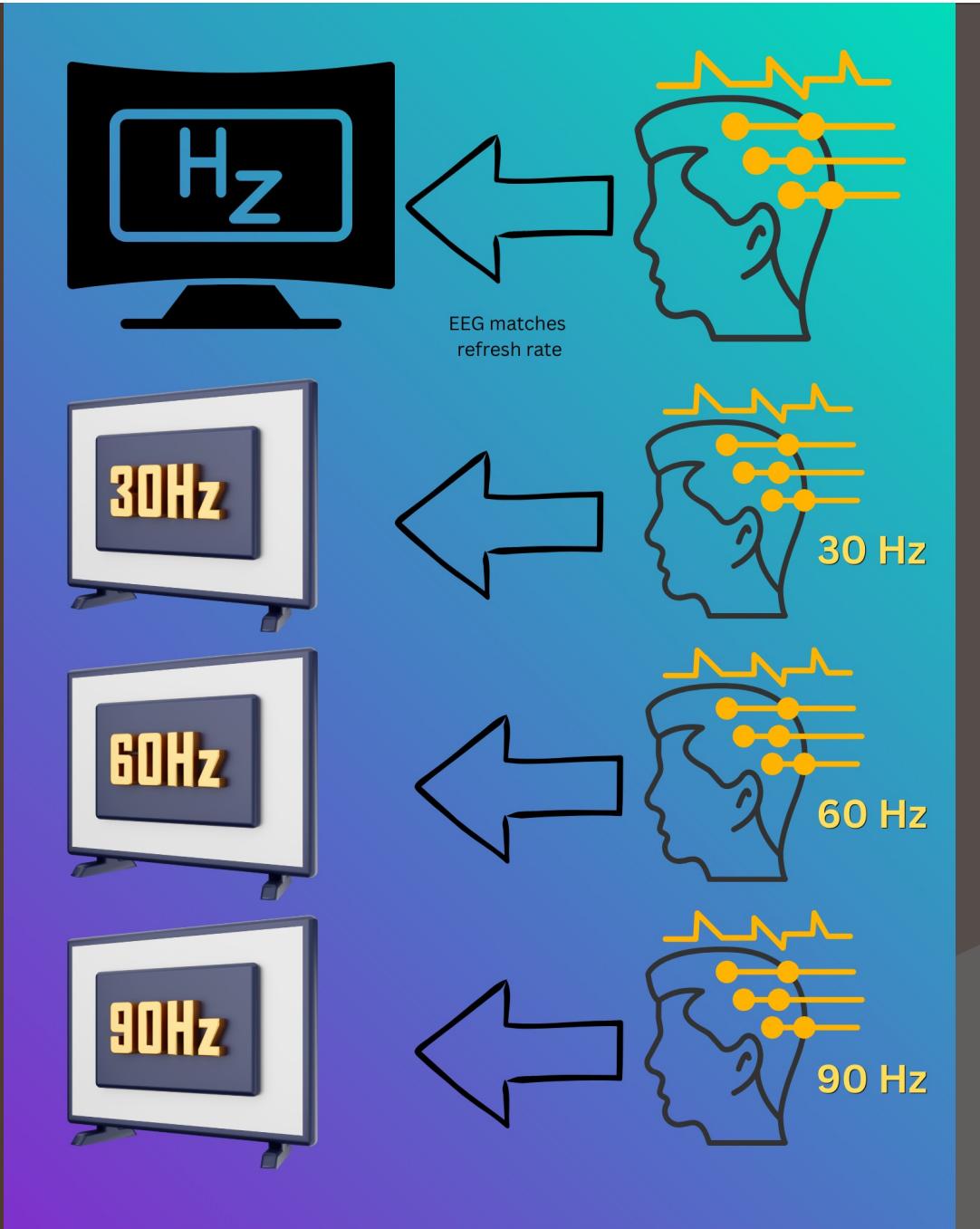
5 Hertz = 5 refresh / second

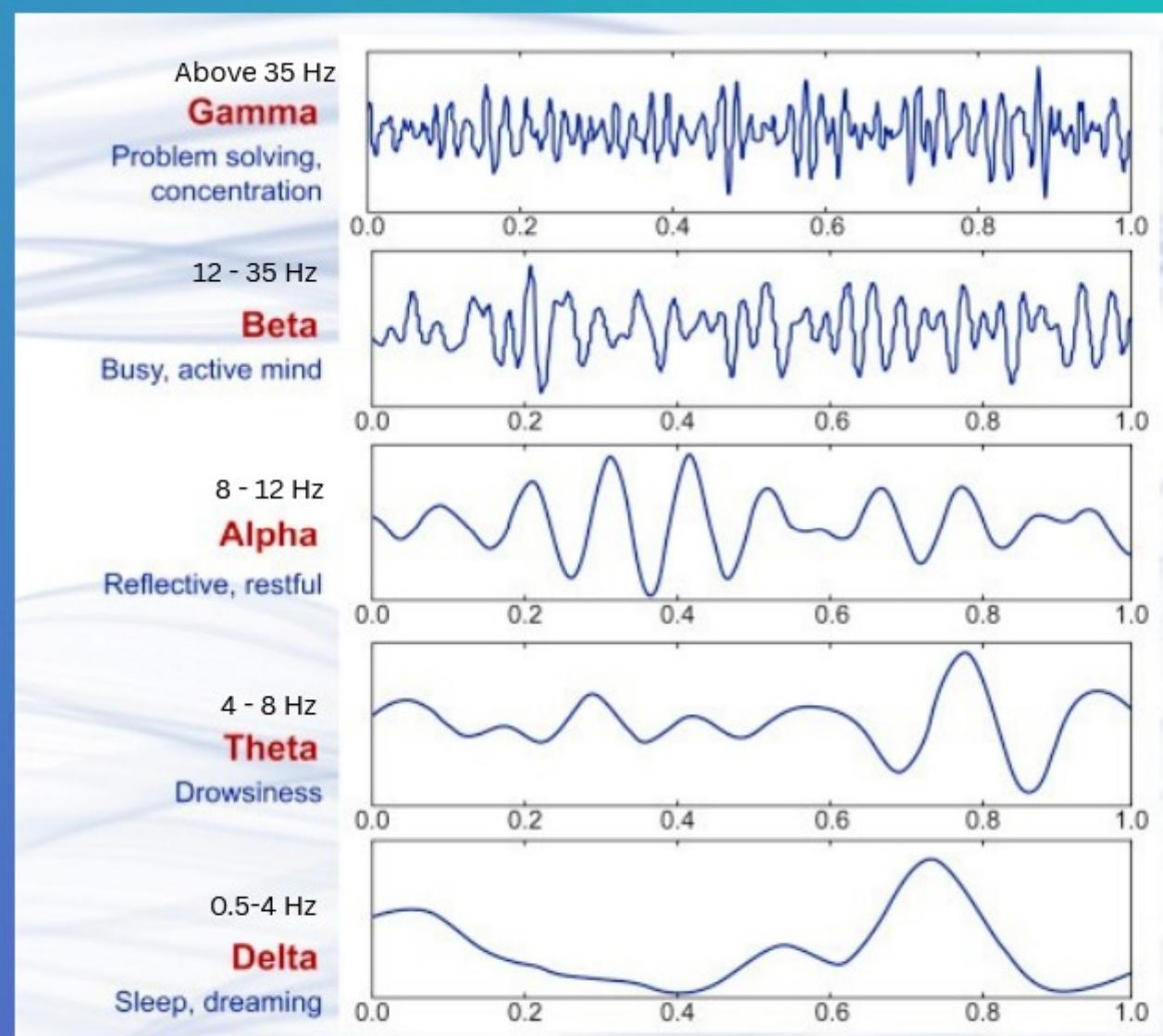
30 Hertz = 30 refresh / second

SSVEP
Steady-state
Visual Evoked Potential

SSAEP
Steady-state
Auditory Evoked Potential

Brain locks into the same
frequency.





Increased
energy
consumption



(ScienceDirect Topics, n.d.)

Screen time is energy intensive

- Screens refresh at 30 – 120 Hz.
- Your brain in front of a screen is automatically turbo-charged.
- Screen time can FEEL relaxing and regulating, because of dopamine and stimming.
- ALL screen time is using up precious brain energy. Decide if it is worth the cost.
- Experiment with relaxing without screens and how that affects your executive functioning.

What is one cool thing you can do that is relaxing in the physical world?

- ◉ Discussion

Circadian Rhythm

Body's Internal Clock

(Reddy et al, 2025)

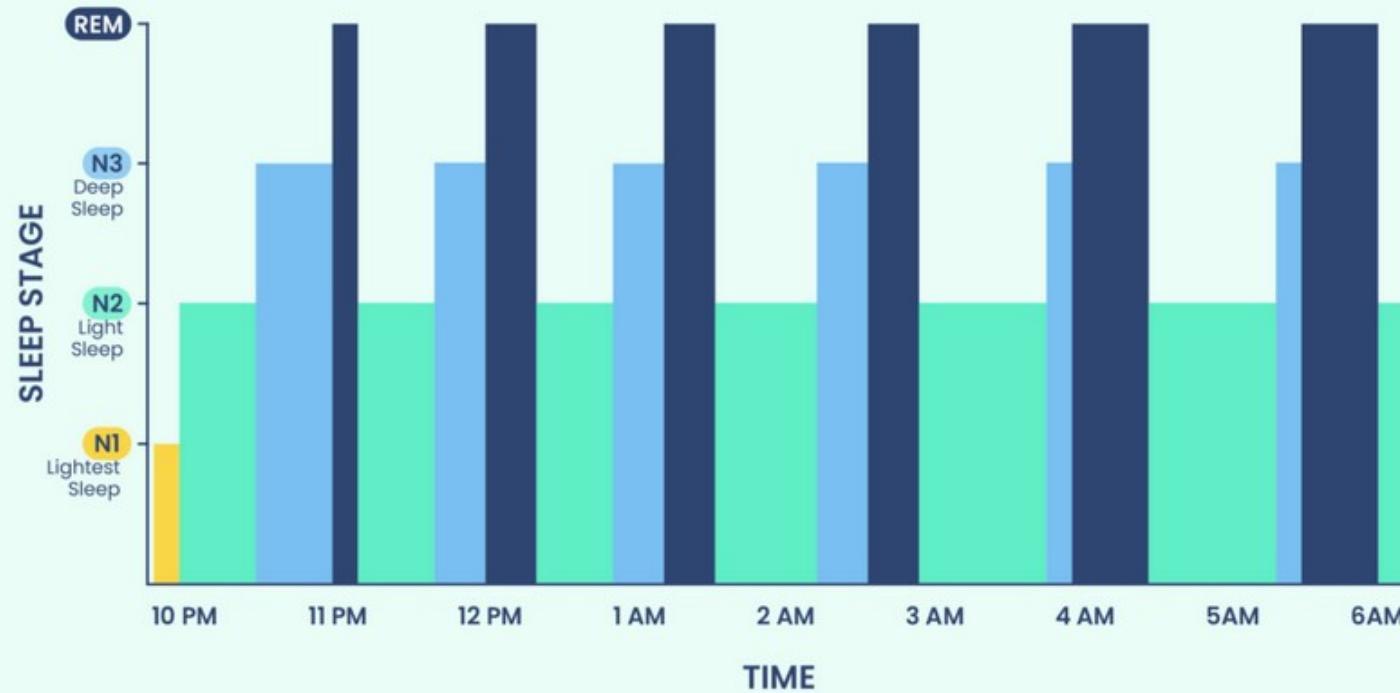
- Sleep-wake cycle
- Hormone production (melatonin, cortisol, insulin)
- Body temperature
- Heart rate
- Blood pressure
- Metabolism
- Digestion
- Immune functions (Ding et al, 2024)

Circadian Rhythm in ADHD

- ◉ Link between symptoms and delays in circadian rhythm (Kooij & Bijlenga, 2013)
- ◉ Chronotherapy with melatonin resulted in 14% reduction of ADHD symptoms (van Andel et al, 2020)

Sleep Architecture

Sleep Cycles Through the Night



Sleep Architecture

(Patel et al, 2025)

- N1: Light sleep, theta waves (4-8 Hz), (5%)
- N2: Deeper sleep, sleep spindles (short bursts of 12 – 16 Hz), (45%)
- N3: Deepest Non-REM sleep, “slow-wave sleep” delta waves (0.5 - 2 Hz), (25%)
- REM: Dreaming, gamut of waves (4 - 32 Hz), “increased brain metabolism by up to 20%” (25%)

Glymphatic System

Glial-dependent lymphatic transport

(Reddy & van der Werf, 2020)

- Discovered in 2012
- Occurs mainly in slow-wave sleep (N3)
- Norepinephrine declines, cells shrink, more space, cerebrospinal fluid (CSF) floods the brain, interstitial fluid flows out
- <https://youtu.be/ci5NMscKJws?si=tAvb0zZom4O106> (University of Rochester Medicine, n.d.)
- One study found impaired glymphatic system in ADHD children, and an association with speech and language delay (Li et al, 2025)

Circadian rhythm is essential

- Social Rhythm Therapy developed for bipolar disorder (Frank et al, 1994)
- In “Tick tock tactics,” psychiatrist Tracey Marks, MD (2023), talks about applying it to ADHD.
 - Anchor the internal clock by doing the same things every day at the same time.
 - Time cues (light and dark cues)
 - Melatonin supplementaton

Possible Rhythm Anchors

- Wake times
- Breakfast times
- Bright light exposure
- Cold exposure
- Exercise times
- Time to start working
- Time when first socializing
- Lunch times
- Dinner times
- Time to stop working
- Time to stop socializing
- Time to stop blue light exposure
- Time to go to bed
- Time to sleep
- Add whatever activity is meaningful to you.

In Practice

- Start with one anchor. Start with one you enjoy.
- Add activities in the same order. Don't worry about the time. (E.g. wake, breakfast, outside in the sun in the backyard.)
- When there are things that throw the schedule off, give yourself external cues to skip.

In Practice

- If you have a rhythm for alternating days, you can go through the same motions but “fake” it on the off days. (E.g. if working from home, still get dressed as if going to work.)
- Remember why the activity is important to you.
- Do things “by this time.”
- Real life example.

What rhythm anchor would you add to your life?

- ◉ Discussion

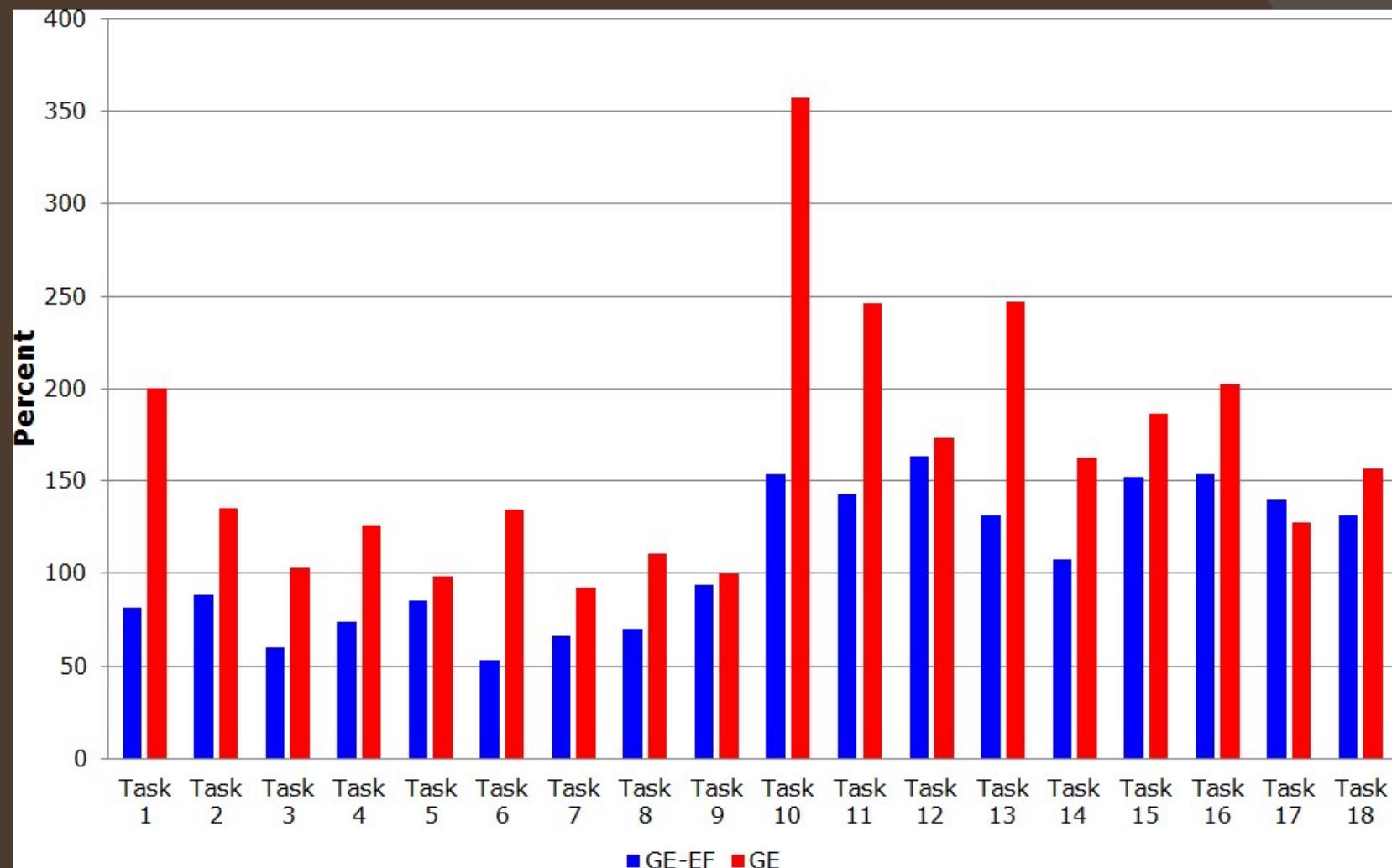
How would you make prioritization decisions?

- ◉ If one week is thrown off, how do you decide what to keep?
- ◉ Discussion

If you go off the rails, how do you get back on?

- ◉ Discussion

Exercise



ADHDers who exercised
ADHDers who did not exercise

Silva et al, 2015

Research

- Improves EF by improving self-efficacy (belief in one's ability to achieve goals) and mood (Zhao et al, 2024)
- Girls showed most EF improvement with coordination exercises; boys showed most improvement with aerobic exercises (Tao et al, 2025)
- Some studies showed inconsistent outcomes (Vysniauske et al, 2020).

Exercise benefits

- Some show direct improvement in working memory and time needed to do things
- Many studies show indirect benefits: better sleep, better health, better energy levels overall, better self-confidence, better mood, etc.
- Reverses insulin resistance, better immune recovery, healthier gut.

Eat well, sleep well, move well

- If you take care of your body, your brain will work better.
- If you neglect your body, you can't expect your brain to be 100%.
- **Interoceptive Trust.** Study that autistic people's interoception did not predict burnout any more than in controls. BUT, autistic people did not trust their interoception, and THAT was associated with burnout (Lach, 2025)

What is one activity that you want to do that makes you feel better physically when you do it?

- Discussion

Trust yourself

◎ Discussion

References

- Ding, J., Chen, P., & Qi, C. (2024). Circadian rhythm regulation in the immune system. *Immunology*, 171(4), 525–533. <https://doi.org/10.1111/imm.13747>
- Frank, E., D. J. Kupfer, C. L. Ehlers, T. H. Monk, C. Cornes, S. Carter and D. Frankel (1994). "Interpersonal and social rhythm therapy for bipolar disorder: Integrating interpersonal and behavioral approaches." *Behavior Therapist* 17(7): 143-149.
- Killeen, P. R., Russell, V. A., & Sergeant, J. A. (2013). A behavioral neuroenergetics theory of ADHD. *Neuroscience & Biobehavioral Reviews*, 37(4), 625–657. <https://doi.org/10.1016/j.neubiorev.2013.02.011>
- Kooij, J. J., & Bijlenga, D. (2013). The circadian rhythm in adult attention-deficit/hyperactivity disorder: current state of affairs. *Expert review of neurotherapeutics*, 13(10), 1107–1116. <https://doi.org/10.1586/14737175.2013.836301>
- Lach, E. (2025, November 12–15). The role of interoception and perceived stress in predicting burnout rates: A spoon theory framework examining neurodivergent and neurotypical university students [Conference presentation]. Psychological Society of Ireland Annual Conference, Athlone, Ireland.
- Li, Y., Wang, J., Yuan, X., Zhang, L., Yan, Y., Yang, Y., & Wang, L. (2025). Impaired glymphatic system function and its association with speech and language delay in children with ADHD: a prospective study. *Frontiers in human neuroscience*, 19, 1612997. <https://doi.org/10.3389/fnhum.2025.1612997>
- Marks, Tracey. (2023) *Tick tock tactics to utilize the body clock to manage ADHD* [webinar]. PESI. <https://catalog.pesi.com/item/tick-tock-tactics-utilize-body-clock-manage-adhd-131133>
- Patel, A. K., Reddy, V., Shumway, K. R., & Araujo, J. F. (2025). Physiology, sleep stages. In StatPearls. StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK526132/>
- Pellerin, L., & Magistretti, P. J. (2012). Sweet sixteen for ANLS. *Journal of cerebral blood flow and metabolism : official journal of the International Society of Cerebral Blood Flow and Metabolism*, 32(7), 1152–1166. <https://doi.org/10.1038/jcbfm.2011.149>
- Reddy, S., Reddy, V., & Sharma, S. (2025). Physiology, circadian rhythm. In StatPearls. StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK519507/>
- Reddy, O. C., & van der Werf, Y. D. (2020). The sleeping brain: Harnessing the power of the glymphatic system through lifestyle choices. *Brain Sciences*, 10(11), Article 868. <https://doi.org/10.3390/brainsci10110868>
- ScienceDirect Topics. (n.d.). Brain waves. Elsevier. <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/brain-waves>
- Silva, A. P., Prado, S. O., Scardovelli, T. A., Boschi, S. R., Campos, L. C., & Frère, A. F. (2015). Measurement of the effect of physical exercise on the concentration of individuals with ADHD. *PLoS one*, 10(3), e0122119. <https://doi.org/10.1371/journal.pone.0122119>
- Tao, Y., Zhang, Y., Qian, H., & Cao, Z. (2025). Long term effects of physical activity types on executive functions in school aged children. *Scientific reports*, 15(1), 30303. <https://doi.org/10.1038/s41598-025-09674-9>
- University of Rochester Medicine. (n.d.). The Glymphatic System. [Video]. YouTube. <https://youtu.be/ci5NMscKJws?si=rK455h5uLMpmyzA2>
- van Andel, E., Bijlenga, D., Vogel, S. W. N., Beekman, A. T. F., & Kooij, J. J. S. (2020). Effects of chronotherapy on circadian rhythm and ADHD symptoms in adults with attention-deficit/hyperactivity disorder and delayed sleep phase syndrome: a randomized clinical trial. *Chronobiology International*, 38(2), 260–269. <https://doi.org/10.1080/07420528.2020.1835943>
- Vysniauske, R., Verburgh, L., Oosterlaan, J., & Molendijk, M. L. (2020). The Effects of Physical Exercise on Functional Outcomes in the Treatment of ADHD: A Meta-Analysis. *Journal of attention disorders*, 24(5), 644–654. <https://doi.org/10.1177/1087054715627489>
- Zhao, G., Sun, K., Fu, J., Li, Z., Liu, D., Tian, X., Yang, J., & Zhang, Q. (2024). Impact of physical activity on executive functions: a moderated mediation model. *Frontiers in psychology*, 14, 1226667. <https://doi.org/10.3389/fpsyg.2023.1226667>

Links

- Nutritionfacts.org. (n.d.). How much sleep is needed for glymphatic flow (brain cleaning)? [Video]. YouTube. <https://youtu.be/NxeiSJfI9Ll>