Don't go NUTS

A Case Study on the Physiology of Stress

Part One: Exercise for the Sake of Science

Since its opening in 1965, Oral Roberts University in Tulsa, Oklahoma, has required all students to participate in a minimum of 150 minutes of physical activity per week as part of their Whole Person Education program. For the past 50 years, the achievement of this graduation requirement has been tracked through the students manually logging their exercise. In January 2017, the administration of the University introduced a means by which all Freshmen could digitally record their exercise by wearing a FitBit.

There were many individuals upset with the decision to transition to portable fitness trackers, with complaints ranging from the cost of the FitBits to the breach in privacy for the wearer. While the administration intended for the students to be able to log their required physical activity through the fitness tracking device, Dr. Hernandez saw far greater potential in the data. Dr. Hernandez was one faculty member who was very excited about the initiative; she had been looking for ways to study physiological stress responses in young adults. Dr.Hernandez worked with her undergraduate research assistant Maria to draft a pilot protocol to submit to the Research Ethics Board.

Questions:

1. What is physiological stress?

2. How could the FitBit data allow for the study of physiological stress?

3. What homeostatic changes would you predict to see in response to physiological stress?

    a) Cardiovascular system:
    b) Respiratory system:
    c) Endocrine system:

4. Which hormones would be ideal to monitor as indicators of physiological stress?

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Part Two: Spit it Out

Dr. Hernandez could hardly contain her excitement. "Great news! The Research Ethics Board is going to allow us to run a trial study. We have been granted access to the FitBit heart rate data and permission to collect saliva samples from all students currently taking Introduction to Biology."

"Really?!?" Maria exclaimed! "I have the consent forms ready and will prepare the saliva collection kits tonight. We can bring them to tomorrow's midterm exam review class?"

"Sounds good to me" Dr. Hernandez responded. "If we get good results from this pilot project, we may be able to submit a full research protocol in time to receive approval for next semester."

Maria was excited; if she worked fast, the data could also be ready just in time to use for her final paper for her Human Physiology Course. She quickly prepared the saliva collection kits and attached the following instructions:

Saliva Collection Instructions

THANK YOU for participating in my study on physiological stress. Please spit into the enclosed tubes, labelled 1 to 5, on **WEDNESDAY**, then snap the tube shut. Write the time of day that you collected each sample on the tube and store them in the fridge.

1. When you wake up
2. After your morning PhysEd class
3. Lunch time
4. Dinner time
5. At bedtime

You can drop your samples off during your lab next week! Please include the signed consent form with your samples. Let me know if you have any questions. Good luck on your midterm! 😊

Maria

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PS- Remember to wear your FitBits.

Crash Course in Stress Hormones

Cortisol:

- Secreted by the adrenal cortex as the final hormone released by the HPA axis
- Functions as a glucocorticoid to increase blood glucose levels
- Secreted in a daily pattern

Epinephrine and Norepinephrine:

- Released by the adrenal medulla in response to stimulation by the sympathetic nervous system
- Levels of **salivary alpha amylase** are used to infer the circulating levels of epinephrine and norepinephrine

As she gave the kits to Greg, Maria explained "All the information is on the consent form. If students ask, we are only going to be measuring saliva for the presence of stress hormones, we will not be doing any DNA studies, I promise." Greg shrugged his shoulders and pointed towards the lab bench, signalling to Maria to put the box down and leave him alone, he was overwhelmed with all the students asking for help before their evening midterm exam on Wednesday. He didn't even glance twice at the collection kits and Maria was left wondering why he wasn't as excited as she was.

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Questions:

5. Complete the table below with the results you would expect from the data collected at the following five time points.

	Wake-Up	After PhysEd	Lunch time	Dinner time	Bedtime
Heart Rate: ↑, ↓ or = to average resting heart rate					
Cortisol: high, average or low					
Salivary α-amylase: high, average or low					
ANS Dominance: parasympathetic or sympathetic?					

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Part Three: It's all Relative

Maria performed the assays on the saliva and collected the heart rate data to graph the results for her research project. As she sat down to analyze the data she needed to get some help from Greg, as she just could not make sense of it.

"Greg, I have been looking through my data and I cannot think this through! Figures 1, 2 and 3 all have unexpected results. The data collected during exercise is just as I predicted, but I have no explanation for the data collected at dinner time. Can you help me please?" Maria did not like how desperate she sounded, she was sure that Greg would lose respect for her, but she was running out of time to complete her final paper.

Greg looked over the results and seemed confused, so Maria started to relax. Greg kept glancing between the three graphs Maria had generated, and he then asked to see the instructions she had sent out to the students. With a quick glance at her instructions, and a wicked gleam in his eye, Greg smugly smiled. "I know EXACTLY what generated the unexpected blip, and it has produced some great results in support of Dr. Hernandez's research on relative stress. Mind if we work on this together?"

Questions:

6. What is relative stress?
7. Analyze the data and explain the rationale for Greg's conclusion that the students were experiencing relative stress.
8. What did Greg find in the instructions to students to explain the incidence of relative stress observed in the results?
9. When you are under relative stress, what changes do you observe in your organ systems?
10. Is the body's response to physiological stress different than its response to relative stress?

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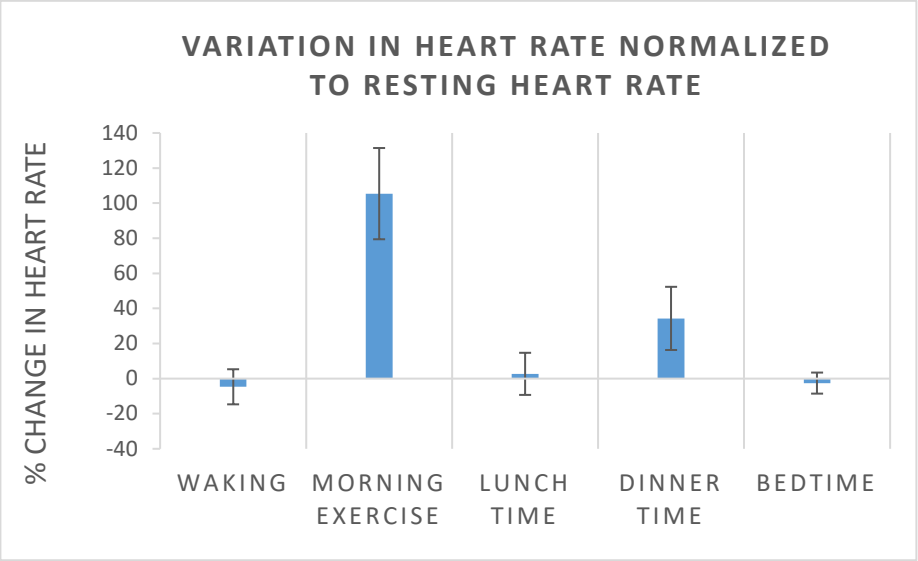

Figure 1: Average variations in heart rate for students taking Introduction to Biology in Spring 2017

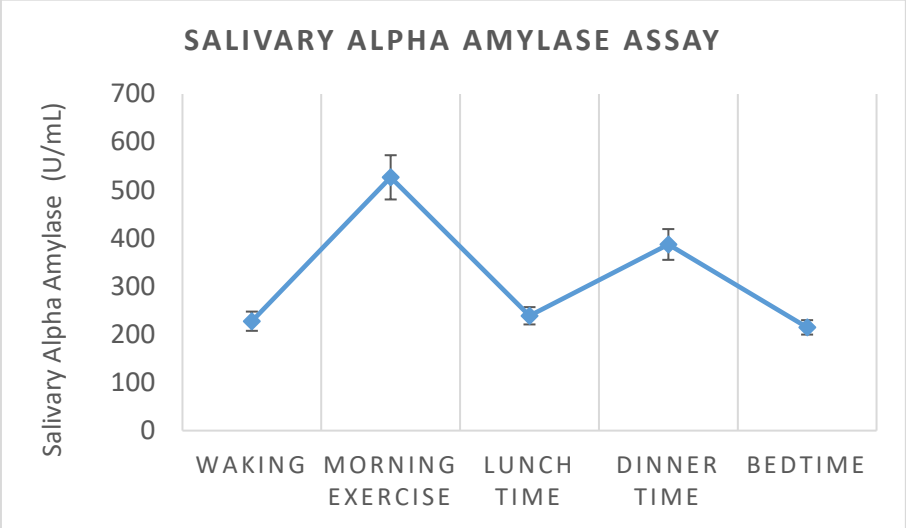

Figure 2: Average variations in salivary alpha amylase for students taking Introduction to Biology in Spring 2017

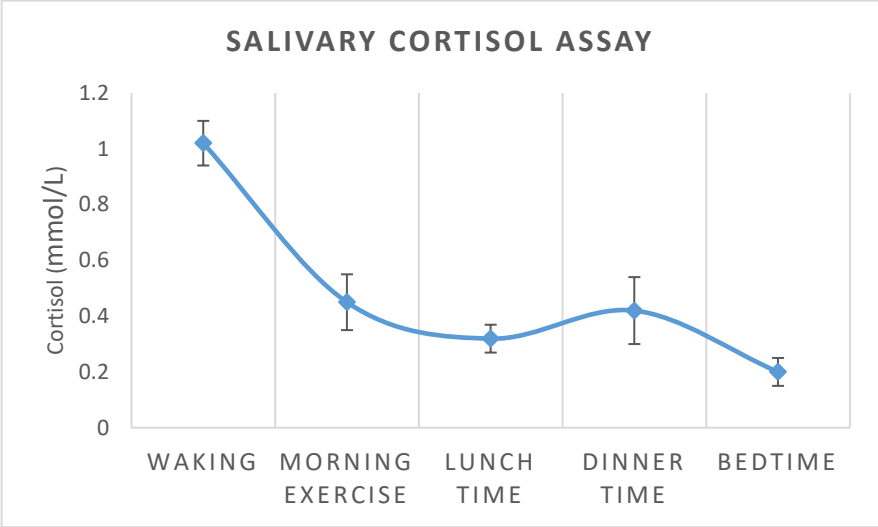

Figure 3: Average variations in salivary cortisol for students taking Introduction to Biology in Spring 2017

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Teaching notes:

Cortisol increases 2-4 fold above baseline in 30 minutes after the stressor

Salivary cortisol represents that amount of free cortisol and impacts the amount of cortisol that can cross the blood brain-barrier, having an impact on learning, memory and emotional state

Salivary alpha amylase production increases during sympathetic stimulation and is used as a marker of catecholamine activity

Physiological stress – exercise

Relative Stress– test taking

Data Table: HR data from Fitbit, Salivary assays for Cortisol and sAA – Wakeup, Exercise, Test Taking, Relaxing in the Evening

Increase in BP, HR

Organ systems involved at rest?

Organ systems involves in fight or flight?

Physiological Stress – observe S&S

Psychological Stress – observe S&S

Dual Innervation of Organ Systems

Hormonal difference between the physiological and psychological form of stress

What causes you psychological stress?

HPA axis

Novel

Unpredictable

Threat to Ego

Sense of Loss of Control

What mechanisms do people use to defeat the feeling of stress? Deep breathing, relaxation

Defeat the Stress: Dancing/Singing Video?

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