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Keeping Your Cool: Exploring Interactions between Cortisol and **Emotional Regulation** on Test Performance.





- Exams are frequent and consequential educational experiences.
- Reducing exam stress has long been the focus of education research (e.g., McKeachie, Pollie, & Speisman, 1955, Brady, Hard, & Gross, 2018).
- Although motivation and emotion theory propose effects of beliefs and strategies during exams, research is typically conducted proximal to exams.
- Although research has demonstrated that self-reports of physiological arousal during exams are unreliable, self-report of stress are still used.
- We wondered if it is possible to explore student exam experience utilizing objective measures of student arousal.

Motivation and Emotion Regulation during performance.

- Self-Efficacy judgements effect and is effected by physiological responses (Bandura, 2006).
- Emotional Regulation strategies
 - Suppression Attempts to inhibit the expression of emotion.
 - Reappraisal reinterpreting an emotional or physiological sensation (Gross, 2014)







- Cortisol is the result of increased activity of the hypothalamus-pituitary adrenal axis (initiated by stress).
- Objective measure of stress.
- Salivary Cortisol is a quality indicator of HPA arousal.
- Salivary Cortisol research, however, is typically conducted in laboratory settings with "artificial" tasks.
- Question: Can we utilize salivary cortisol to better understand student's exam experiences?





- Will students' cortisol change over the course of a practice mid-term exam.
- If Yes
 - Will change in students cortisol over the course of the exam be related to their test self-efficacy?
 - Is there a relationship between students' emotional regulation strategies and their cortisol over the course of the exam.

Participants – 48 Engineering Students

We recruited students from a second year engineering gateway course.

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- 71% Identified as Male (34/48)
- 94% Identified as White non-Hispanic (45/48)
- 52% Second Year College Student (25/48)
 - 15% First Year Students (7/48)
 - 23% Third Year Students (11/48)
- 3.55/4.0 Average Self-reported Cumulative GPA

Authentic Exam Environment

- Students take the exam in a "testing center".
- Practice test is designed by instructor to match mid-term exam.
 - Length (21 questions, up to 55min 3.5 hours)
 - Difficulty
 - Content
- Practice exam is required by instructor (participation in the study was not).
- Practice exam is administered 1 week prior to mid-term.



Sample collection

- Testing occurred between 15:00 and 20:00.
- Measures:
 - At sign-up (2 weeks prior to exam)
 - Emotion Régulation Questionnaire (ERQ; Gross & John, 2003)
 - During practice exam
 - Exam Self-Efficacy Question (What % correct will you get on this exam)
 - Saliva samples were assayed in duplicate to determine cortisol levels using a highly sensitive enzyme immunoassay (Salimetrics, State College, PA).

~5 min. prior to exam	45 Min. into the exam	Immediately After Exam (20min to 3 hours delay)	20 min after exam
Salivettes Saliva	Salivettes Saliva	Salivettes Saliva	Salivettes Saliva collection
collection	Collection	collection	
Test Level Self-Efficacy	Test Level Self-Efficacy	Test Level Self-Efficacy	

Quadratic Latent Growth Curve Cortisol



Intercept = 0.248** Linear Slope = -0.122** Quadratic Slope = 0.034**

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Pre-test = 0.248During = 0.176Post-test = 0.140Post-post-test = 0.147



Cortisol by Self-efficacy Parallel Process Latent Growth Model



Greater Cortisol recovery is related to less of a **decrease** in self-efficacy

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Greater **decrease** in selfefficacy is related to **less** cortisol recovery

Greater Recovery Cortisol





Less Recovery in Cortisol





Cortisol and Emotional Regulation



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Suppression (just calm down) is bad Reappraisal (you are feeling excited – not anxious) is good

Quadratic Latent Growth Curve



Average Suppression (3.756) on Initial Level and Change in Cortisol



Intercept = 0.253 Linear Slope = -0.124 Quadratic Slope = 0.034

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Pre-test = 0.252 Mid-test = 0.179 Post-test = 0.141 Post-post-test = 0.149

-1 SD Suppression (2.456) on Initial Level and Change in Cortisol



Intercept = 0.225 Linear Slope = -0.110 Quadratic Slope = 0.034

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Pre-test = 0.225 Mid-test = 0.162 Post-test = 0.142 Post-post-test = 0.156

-2 SD Suppression (1.156) on Initial Level and Change in Cortisol



Intercept = 0.198 Linear Slope = -0.095 Quadratic Slope = 0.034

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Pre-test = 0.198 Mid-test = 0.146 Post-test = 0.143 Post-post-test = 0.160

+1 SD Suppression (5.056) on Initial Level and Change in Cortisol



Intercept = 0.280 Linear Slope = -0.138 Quadratic Slope = 0.034

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Pre-test = 0.280Mid-test = 0.20Post-test = -0.141Post-post-test = 0.149

+2 SD Suppression (6.356) on Initial Level and Change in Cortisol



Intercept = 0.307 Linear Slope = -0.153 Quadratic Slope = 0.034

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Pre-test = 0.307Mid-test = 0.212Post-test = 0.140Post-post-test = 0.138





- Students Cortisol does change across a practice midterm.
- Students' change in self-efficacy is related to the change in cortisol throughout the exam.
- Students' Suppression (but not Reappraisal) strategies are related to cortisol levels at the **start of exam**.





This material is based upon work supported by the National Science Foundation under Grant No. DUE-11661117 Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.



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Collection Procedures and determination of salivary cortisol

- Participants were provided with water upon arrival to the test center.
- To ensure the fidelity of samples, participants were asked to refrain from consuming food, caffeine, dairy, and brushing teeth 30 min prior to first saliva collection (Granger, Kivlighan, Fortunato et al., 2007).
- Samples were stored at -20c during exam.
- Participants donated saliva by holding salivettes under tongue (one min) at each time point.
- Aliquoted samples were stored at -80C until they were
- Saliva samples were assayed in duplicate to determine cortisol levels using a highly sensitive enzyme immunoassay (Salimetrics, State College, PA).
- Average intra-assay coefficient of variation of less than 5% and an average inter-assay coefficient of variation of 11%.



Why an Engineering Course?





- Unique population that is understudied.
- Engineering students face one of the most challenging (average amount of homework) majors.
- Engineering has several "gateway" courses, course outcomes are critical to success in major.

Latent Growth Curve Analysis Individually-varying times of Observation

Fit Statistics	Linear model	Quadratic model
LogLikelihood	189.169	201.156
Number of free parameters	9	13
AIC	-360.338	-376.312
BIC	-343.497	-351.987

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