Acute stress modulates the use of hippocampal subsystems during learning

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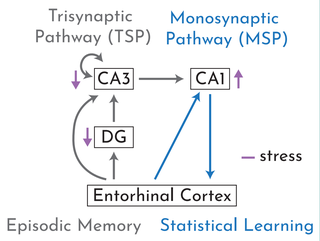
Introduction

Stress tends to negatively affect the hippocampus & episodic memory[1,2]

However, stress may have diverging effects across hipp. subregions[3,4]

Different kinds of memory may rely on distinct hippocampal pathways (episodic memory: TSP, statistical learning: MSP)[5]



Stress response is temporally dynamic[6]; delay between stress and encoding can affect how stress influences memory

How (and when) does acute stress differentially affect episodic memory & statistical learning?

Hypothesis:
Acute stress will enhance statistical learning and impair episodic memory

Study Design

Day 1 Both sessions collected 12-6pm

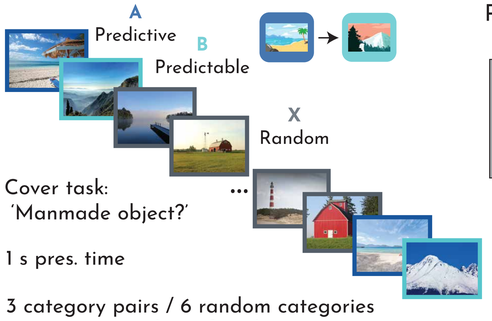
saliva samples

Acclimation/ questionnaires — 10 min
SECPT/ Control[7] — 3 min
Rest (stress-long condition only) — 10 min
Learning Task[8] — 7 min

Day 2

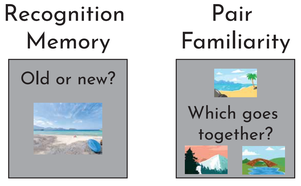
Acclimation/ questionnaires — 10 min
Memory and Familiarity Tasks — ~25 min

Learning Task



3 category pairs / 6 random categories
- 16 exemplars of each

Memory Tasks



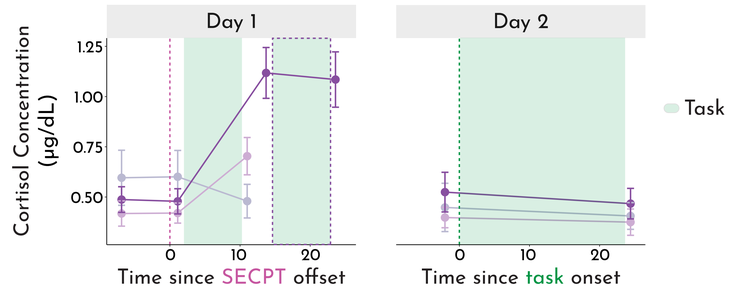
Ns: 36 NS / 36 S-S / 35 S-L
Planned Ns: 45/group
Groups matched on age, sex, race

1. McEwen, B.S. Nasca, C., Gray, J.D. (2016). *Neuropsychopharmacology*. **2.** Shields, G.S. et al (2017). *Psych. Bull*. **3.** Chen, C.C. et al (2010). *Neuropsychopharmacology*. **4.** Vandael, D. et al (2021). *Translational Psychiatry*. **5.** Schapiro, A.C. et al (2017). *Philosophical Transactions of the Royal Society B*. **6.** Lupien, S.J. et al (2007). *Brain and Cognition*. **7.** Schwabe, L. & Schächinger, H. (2018). *Psychoneuroendocrinology*. **8.** Sherman, B.E. & Turk-Browne, N.B. (2020). *PNAS*. **9.** Goldfarb, E.V. & Phelps, E.A. (2017). *Current Opinion in Behavioral Sciences*.

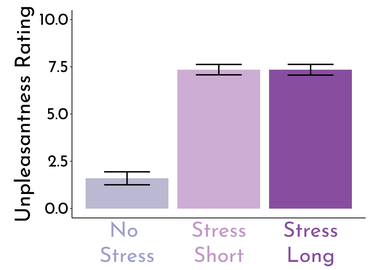
Stress Induction

Salivary Cortisol

Ns: 30 NS / 28 S-S / 30 S-L



Subjective Stress



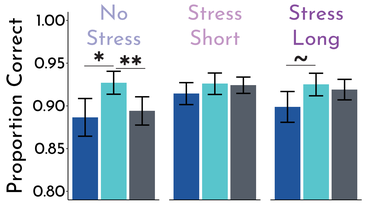
Effective stress induction:

- increased subjective stress ratings
- increased cortisol ~15 min post-stressor
- no elevated cortisol during memory tests

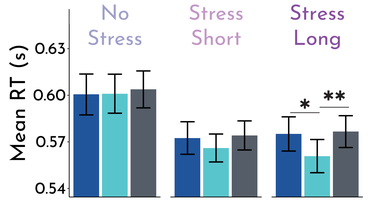
Stress Effects on Statistical Learning

Error bars: +/- 1 SEM
~p < 0.10; *p < 0.05; **p < 0.01

Accuracy



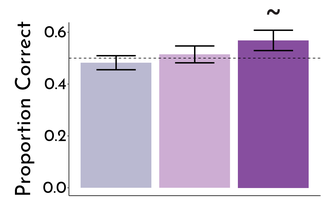
Response Times



Accuracy and RT data for second half of learing only; RTs for correct trials only

A / B / X

Pair Familiarity



Predictability facilitates RTs only in the stress groups (esp. stress-long)

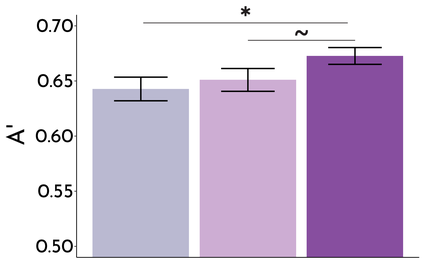
(Marginal) evidence of retention of regularities in stress-long group

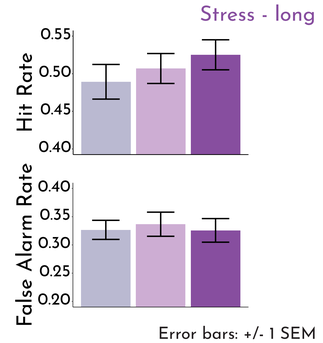
Consistent with stress enhancing statistical learning

Stress Effects on Episodic Memory

No Stress
Stress - short
Stress - long

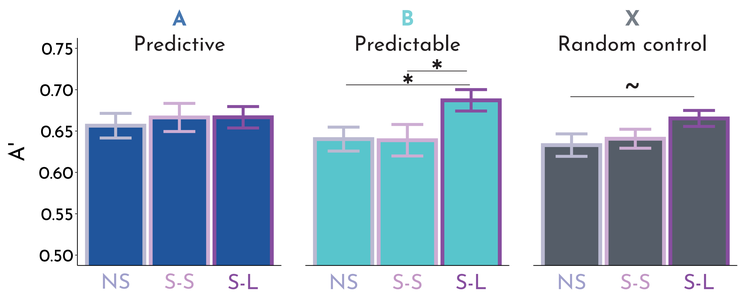
Overall Memory Performance





Error bars: +/- 1 SEM
~p < 0.10; *p < 0.05

Memory by Predictability



Stress (~15 min prior to learning) *enhances* episodic memory, particularly for predictable items

Discussion

Preliminary analyses suggest that acute stress (particularly when encountered ~15 min before learning) may promote the adaptive use of learned statistical regularities
- greater RT facilitation
- enhanced retention of regularities 24h later
- enhanced memory (consolidation?) of predictable items

Strongest effects with ~15 minute stress-learning delay; may suggest role of glucocorticoids[6] in mediating effects

Suggests a broader role for stress in promoting integrative representations, in line with the role of stress in biasing behavior towards stimulus-response learning[9]

How does acute stress modulate connectivity among hippocampal subregions (i.e., the pathways supporting these processes)?

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