How does stress affect working memory consolidation?

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How and when does stress affect working memory?

Previous research suggests that stress may improve[1,2], impair[3], or have no effect[4,5] on working memory performance.

Stress may impact working memory at different timepoints[6]: encoding, consolidation, maintenance, or retrieval.

Does stress specifically impact working memory consolidation? If so, does it affect the quality or speed of consolidation?

Two theories to explain stress effects

Attentional Narrowing

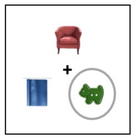
Resource Allocation

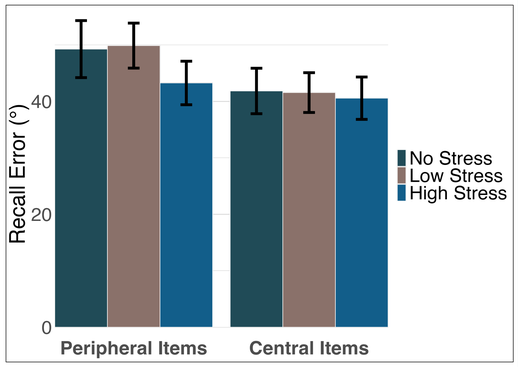
	Attentional Narrowing	Resource Allocation
Effect on Quality	↑ for central items, ↓ for peripheral items	↓ for all items
Effect on Speed	↑ speed (faster response time to secondary task)	↓ speed (slower response time to secondary task)

Effect on quality: no evidence of stress effect, yet

Stress & Item and Recall Error

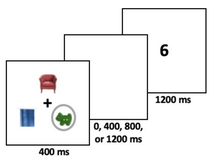
- No main effect of stress (BF_{10} = .09)
- Ambiguous main effect of item type (BF_{10} = .87)
- No interaction effect (BF_{10} = .01)

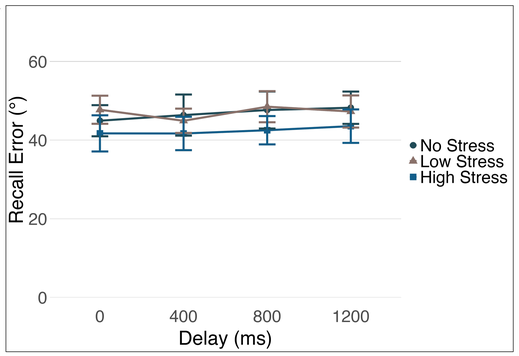




Stress & Delay and Recall Error

- No main effect of stress (BF_{10} = .14)
- No main effect of delay (BF_{10} = .02)
- No interaction effect (BF_{10} = 1.7 x 10^{-5})





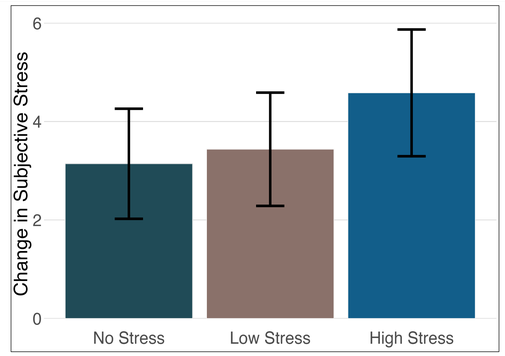
Error bars represent standard error.

Stress induction effectiveness

Subjective Stress Response

- 6-item State-Trait Anxiety Inventory
- Possible range 6 – 24

	Timepoint 1	Timepoint 2
No Stress	9.29 (SD = 2.7)	12.4 (SD = 2.7)
Low Stress	10.9 (SD = 3.0)	14.3 (SD = 5.2)
High Stress	11.4 (SD = 1.9)	16.0 (SD = 4.8)



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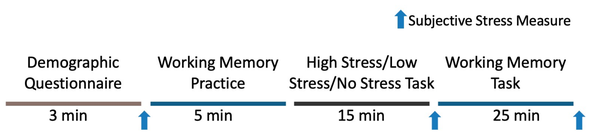
Methods

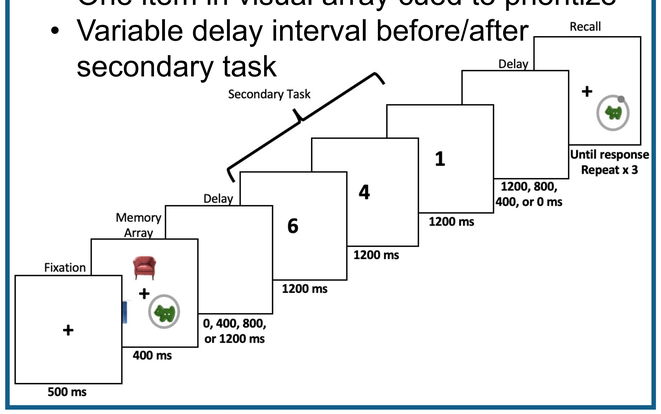
3 Stress Conditions:

No (n = 15) Low (n = 16) High (n = 14)



Working Memory Color Recall task

- One item in visual array cued to prioritize
- Variable delay interval before/after secondary task



1. Lai et al. (2014). *International Journal of Industrial Ergonomics* 2. Edwards et al. (2015). *Anxiety, Stress, & Coping*. 3. Shields et al. (2016). *Neuroscience & Biobehavioral Reviews*. 4. Pulopulos et al. (2015). *Stress*. 5. Sorg, B. & Whitney P. (1992) *Journal of Research in Personality*. 6. Stauble et al. (2013). *Stress*.

Effect on speed: stress increases consolidation speed

Stress & Delay and Secondary Task Response Time

Item 1

- **Main effect of delay (BF_{10} = 4.6 x 10^{21})**
- Ambiguous main effect of stress (BF_{10} = .77)
- No interaction effect (BF_{10} = .02)

Item 2

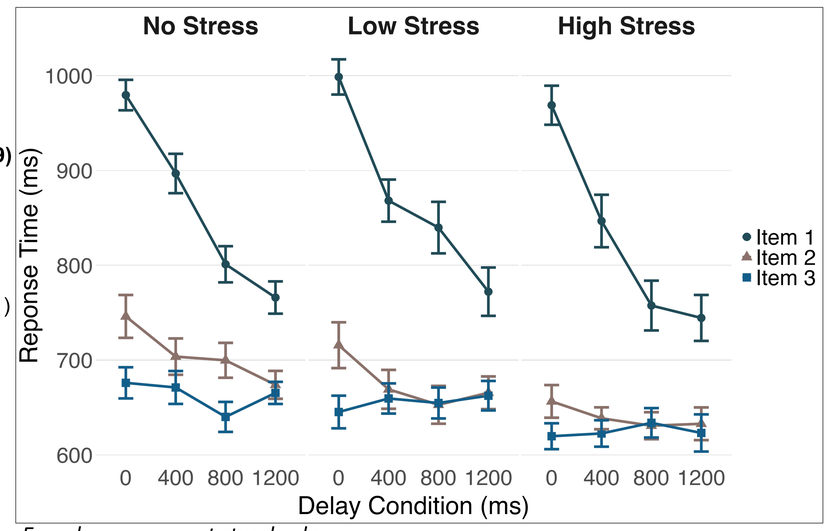
- **Main effect of delay (BF_{10} = 4.1)**
- **Main effect of stress (BF_{10} = 1839)**
- No interaction effect (BF_{10} = .02)

Item 3

- No main effect of delay (BF_{10} = .01)
- **Main effect of stress** (BF_{10} = 9.9)
- No interaction effect (BF_{10} = .0003)

1st Item Response Failure

- High Stress: 4.8%
- Low Stress: 8.6%
- No Stress: 6.7%



Error bars represent standard error.

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Stress primarily affects consolidation speed, not quality

Preliminary results found no evidence that stress affected recall error.

- Slightly better recall for central compared to peripheral items, but no stress effect
- No difference related to amount of consolidation time

Stress may lead to faster working memory consolidation.

- More consolidation time = faster response time, particularly for first item
- Response times for second item suggest that consolidation is faster in high stress group compared to no stress group

Neither theory fully accounts for results.

- Increased consolidation speed supports Attentional Narrowing, but no evidence of the predicted effect on quality