Reduced Working Memory Capacity Under a Threatening Context

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Introduction

Working memory allows for the active representation of information over a brief interval[1,2]. Contralateral delay activity (CDA), an event-related potential (ERP), indexes the quantity of items stored in working memory[11, 12].

Prior work indicates that working memory capacity is reduced in an unpleasant emotional state[3,13] and during the experience of active worry[9], as indicated by reduced CDA amplitude. In addition, threatening stimuli are more difficult to filter from entry into working memory than non-threatening stimuli[10].

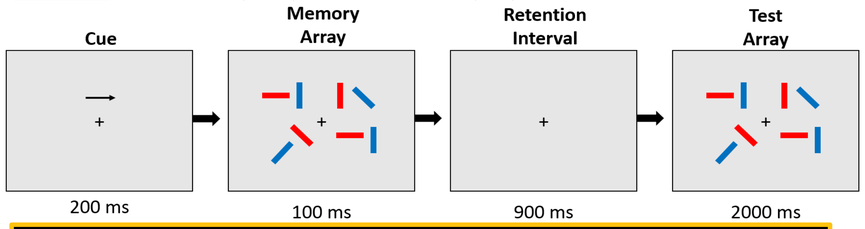
We investigated the effects a threatening context (i.e., threat of shock) has on overall working memory capacity, and the ability to efficiently filter out irrelevant neutral distractors.

Task & Procedure

Sample: 46 (29 Female) undergraduates following artifact rejection

Set Sizes: 2 targets (NT2), 2 targets & 2 distractors (ND), 4 targets (NT4)

Conditions: Threat of Shock (Shock) & No Threat of Shock (Safe)



EEG Processing & CDA Quantification

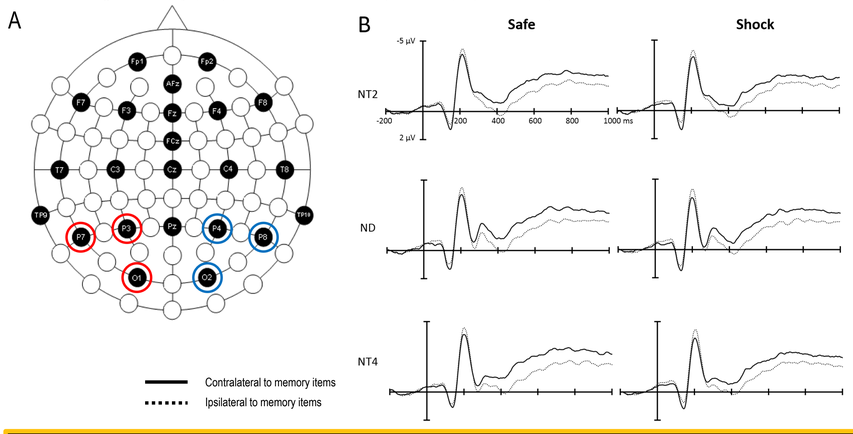
32 Ag-AgI electrode cap recorded through *asalab*™ referenced to left mastoid at a 512 Hz sampling rate.

Re-reference to average mastoids, Butterworth bandpass filter (0.01 - 30 Hz), & ICA used to identify blinks.

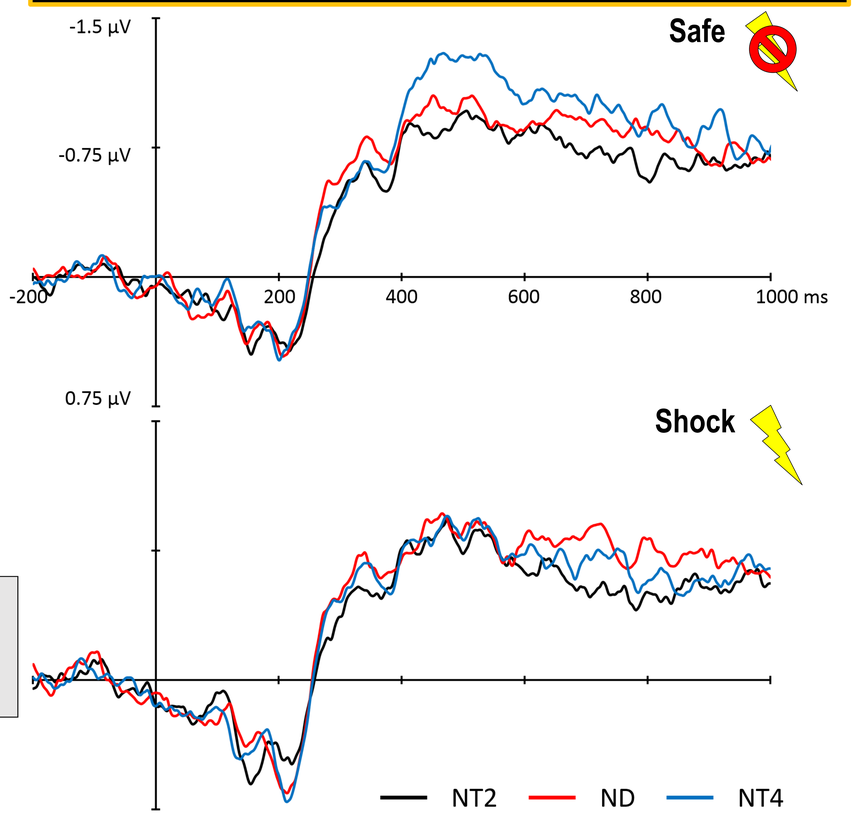
Artifact rejection thresholds +/-75 µV (All EEG and VEOG), +/- 60 µV (HEOG), & visual inspection.

Channel clusters O1/O2, P3/P4, & P7/P8 were averaged together (**A**), and CDA calculated by contralateral minus ipsilateral waveforms for Shock and Safe conditions (**B**).

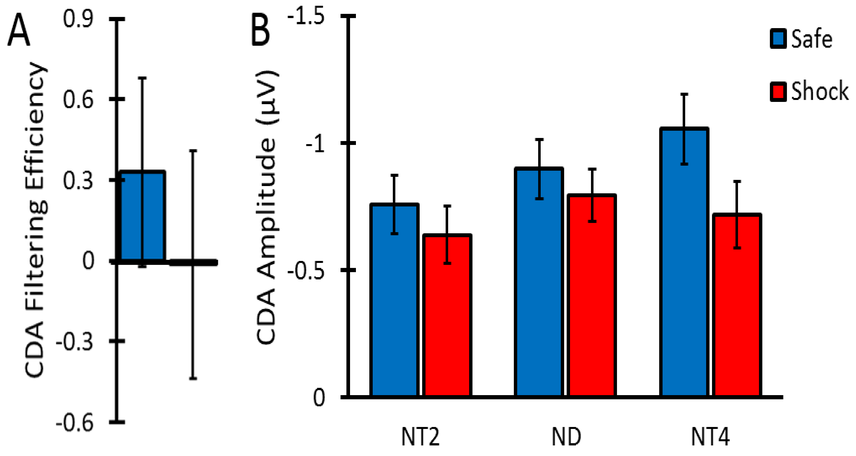
CDA Filtering Efficiency (FE) calculated as: FE = (NT4-ND) / (NT4-NT2).



CDA Waveforms



CDA Results



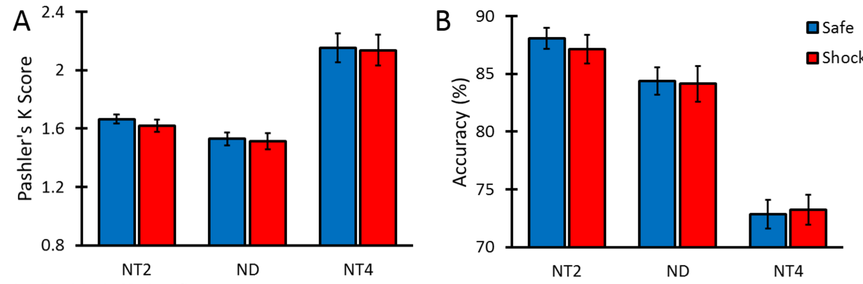
A. CDA Filtering Efficiency no significant Condition difference, $F(1, 45) = 0.628$, $p = 0.432$

B. CDA significantly greater in Safe vs Shock Condition, $F(1, 45) = 8.059$, $p < 0.01$, $\eta_p^2 = 0.152$

CDA significant Set Size differences in Set Sizes, $F(1.936, 87.125) = 3.947$, $p < 0.05$, $\eta_p^2 = 0.081$

- NT2 CDA < NT4 CDA ($p < 0.05$)

Behavioral Results



A. Pashler's K significant Set Size differences, $F(1.136, 51.137) = 64.248$, $p < 0.001$, $\eta_p^2 = 0.588$

- NT4 K Score > NT2 K Score ($p < 0.001$) & ND K Score ($p < 0.001$)
- NT2 K Score > ND K Score ($p < 0.001$)

B. Accuracy significant Set Size differences, $F(1.756, 79.003) = 243.559$, $p < 0.001$, $\eta_p^2 = 0.844$

- NT2 Accuracy > NT4 Accuracy ($p < 0.001$) & ND Accuracy ($p < 0.001$)
- ND Accuracy > NT4 Accuracy ($p < 0.001$)

C. Anxiety significantly greater in Shock vs Safe Condition, $F(1, 45) = 42.004$, $p < 0.001$, $\eta_p^2 = 0.483$

D. Response Time significant Set Size differences, $F(1.612, 72.558) = 31.883$, $p < 0.001$, $\eta_p^2 = 0.415$

- NT2 Response Time < NT4 Response Time ($p < 0.001$) & ND Response Time ($p < 0.001$)

Conclusions

Threat of shock reduced CDA amplitude relative to safe contexts, but did not affect CDA filtering efficiency. Despite this, our behavioral findings do not imply any impairment in working memory as the result of a threatening context.

Our findings have implications for the impact of stress and anxiety on cognition. It is likely that shock-induced anxiety restricts working memory capacity, but this can be compensated for by engaging in greater mental effort during the retrieval phase. This notion reflects tenets in Attentional Control Theory[4,5]. However, our findings suggest that a threatening context does not affect one's ability to filter neutral information from entering working memory.

Personality factors, such as trait anxiety, have also been linked to reduced working memory capacity[6,7] and impaired filtering efficiency[8]. Future work will investigate the interactions between trait anxiety and threat of shock CDA waveforms.

References

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