

# Context Dependent Memory and Stress: A Preliminary Investigation using Multi-Task Induced Stress

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## Introduction

The context-dependent memory effect refers to the facilitative effect of reinstating the context present at learning during recall. It is argued that environment is incidentally encoded alongside the to-be-remembered material (e.g. see Godden and Baddeley, 1975). Consequently, reinstatement of this environment during recall operates as a memory cue, thereby facilitating recall.

Context dependent memory has been reported for a range of contexts, including diving (Godden and Baddeley, 1975), alcohol intoxication (Goodwin et al., 1969), elevated heart rate (Miles and Hardman, 1998), odours (Aggleton and Waskett, 1999; Ball et al., in press), and chewing gum (Baker et al., 2004; although see Johnson and Miles, 2007, 2008, for controversy).

In a recent study Schwabe et al. (2009) demonstrated that a (vanilla) odour-induced context dependent memory effect was abolished via the administration of a stressor (the Socially Evaluated Cold Pressor Task). One interpretation of this finding is that the stressor operated as a dominant context, overshadowing the olfactory context (e.g. see Smith and Vela, 2001). The present study therefore examines whether stress can operate as a sufficiently salient context to induce a context-dependent memory effect.

## Stressor Task

The Defined Intensity Stressor Simulation (DISS) is a multi-tasking framework used to induce cognitive-load stress. Previous studies have shown, for example, that completion of the DISS can increase both secretory immunoglobulin (e.g. Wetherell and Sidgreaves, 2005) and self-rated stress (Scholey et al., 2009). The DISS can be manipulated to present single or multiple tasks. In the present study high stress and low stress configurations were employed.

**High Stress:** Participants received four concurrent tasks presented for 10-minutes. They were instructed to divide cognitive resources equally across the tasks and informed that their score would be recorded. The tasks comprised: (i) an auditory monitoring task, (ii) a visual tracking task, (iii) a Stroop task, and (iv) a three integer addition task (see Figure 1a).

**Low Stress:** Participants received a single visual tracking task presented for 10-minutes. Participants were informed that their score would be recorded (see Figure 1b).

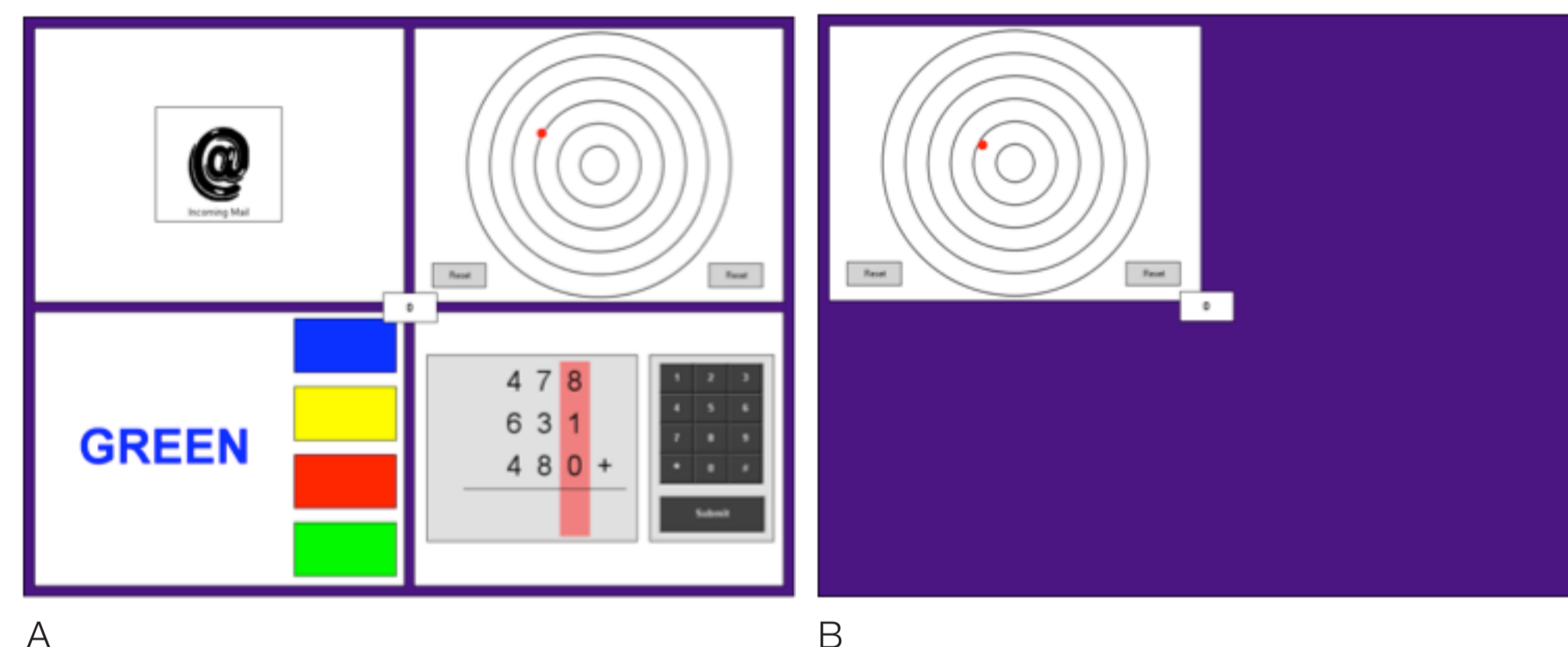


Figure 1: (a-b): Screenshots of the (a) high and (b) low (DISS) stress conditions.

## Method

A two-factor (2x2) within-participants design examined the effect of stress on learning and recall. Participants received a high or low stress task prior to learning and a high or low stress task prior to recall. This produced four conditions: stress/stress, stress/no stress, no stress/stress, and no stress/no stress (the order of which was counterbalanced).

Twenty-five Coventry University undergraduate volunteers (16 females, 9 males, mean age = 20.08 years) were tested on eight occasions across four weeks. Participants were tested at the same time of day, wherein each week they performed an encoding and recall session on consecutive days. Participants were tested in a darkened basement laboratory in order to minimise any extraneous contextual cues (i.e. reduce overshadowing, Smith and Vela, 2001).

For each learning phase participants performed the 10-minute high or low stress task. They were then given 2-minutes to learn a list of 15 disyllabic nouns matched on frequency and image-ability (Morrison et al., 1997). A different set of words was used for each condition (with lists counterbalanced across conditions). For each recall phase participants performed the high or low stress task. They were then given 2-minutes to write down the to-be-remembered words from the preceding day.

As a context manipulation check (see also Johnson and Miles, 2008), mood measures (VAMS: Bond and Lader, 1974, VAMS) were taken at baseline, post-task, and following learning/recall. The VAMS included an imbedded stress measure with the antonym 'no stress at all/ worst stress imaginable.'

## Results

### (i) Effect of Stressor

The effect of the task at inducing a stressful context was examined by comparing the shift in self-rated stress following the high stress and low stress tasks (see Figure 2). A paired t-test revealed a significantly higher shift in self-rated stress following the high stress task,  $t(24)=4.05$ ,  $p<0.001$ .

### (ii) Context-Dependent Effects

Word recall was collapsed for the conditions where learning and recall stress contexts were consistent (stress/stress and no stress/no stress) and inconsistent (stress/no stress and no stress/stress). A paired t-test was conducted and revealed that the higher recall for the consistent conditions approached significance,  $t(24)=1.83$ ,  $p=0.08$ .

## Discussion

The present data provides preliminary evidence that cognitive stress may induce a sufficiently salient context to induce a context-dependent memory effect ( $p=0.08$ ). Indeed, analysis of the self-rated stress data provides evidence that a stressful context was successfully induced. The preliminary context-dependent memory effect is consistent with reports of other internal states providing a cue to recall (e.g. aerobic state: Miles and Hardman, 1998). However, context-dependent memory effects are notoriously difficult to obtain; more data is, therefore, required to ascertain the validity of such an effect. Notwithstanding, the present study may suggest that a context-driven ironic rebound effect may detriment students who engage in (relaxed) organised revision. That is, the incongruity between the calm context of revision and high stress examination context may inhibit recall of material.

## Key References

- Godden, D. R., & Baddeley, A. D. (1975). Context-dependent memory in two natural environments: On land and under water. *British Journal of Psychology*, *66*, 99-104.
- Goodwin, D. R., Powell, B., Bremer, D., Hoine, H., & Stern, J. (1969). Alcohol and recall: State dependent effects in man. *Science*, *163*(#3873), 1358-1360.
- Miles, C., & Hardman, E. (1998). State-dependent memory produced by aerobic exercise. *Ergonomics*, *41*(1), 20-28.
- Schwabe, L., Böhringer, A., and Wolf, O.T. (2009). Stress disrupts context-dependent memory. *Learning and Memory*, *16*, 110-113.
- Wetherell, M.A. and Sidgreaves, M.C. (2005). Secretory immunoglobulin-A reactivity following increases in workload intensity using the Defined Intensity Stressor Simulation (DISS). *Stress and Health*, *21*(2), 99-106.

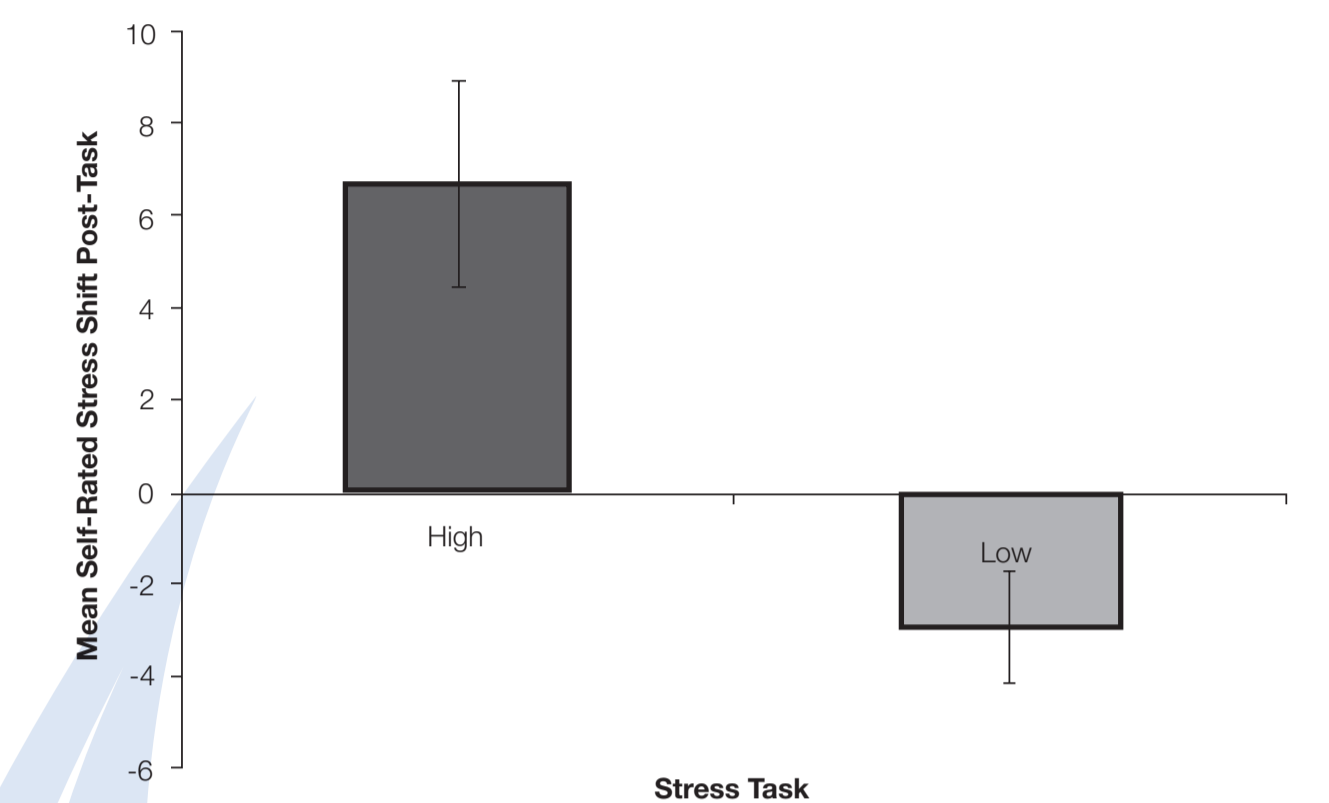


Figure 2: Mean shift in self-rated stress following the high stress and low stress tasks. Error bars denote +/- SEM.

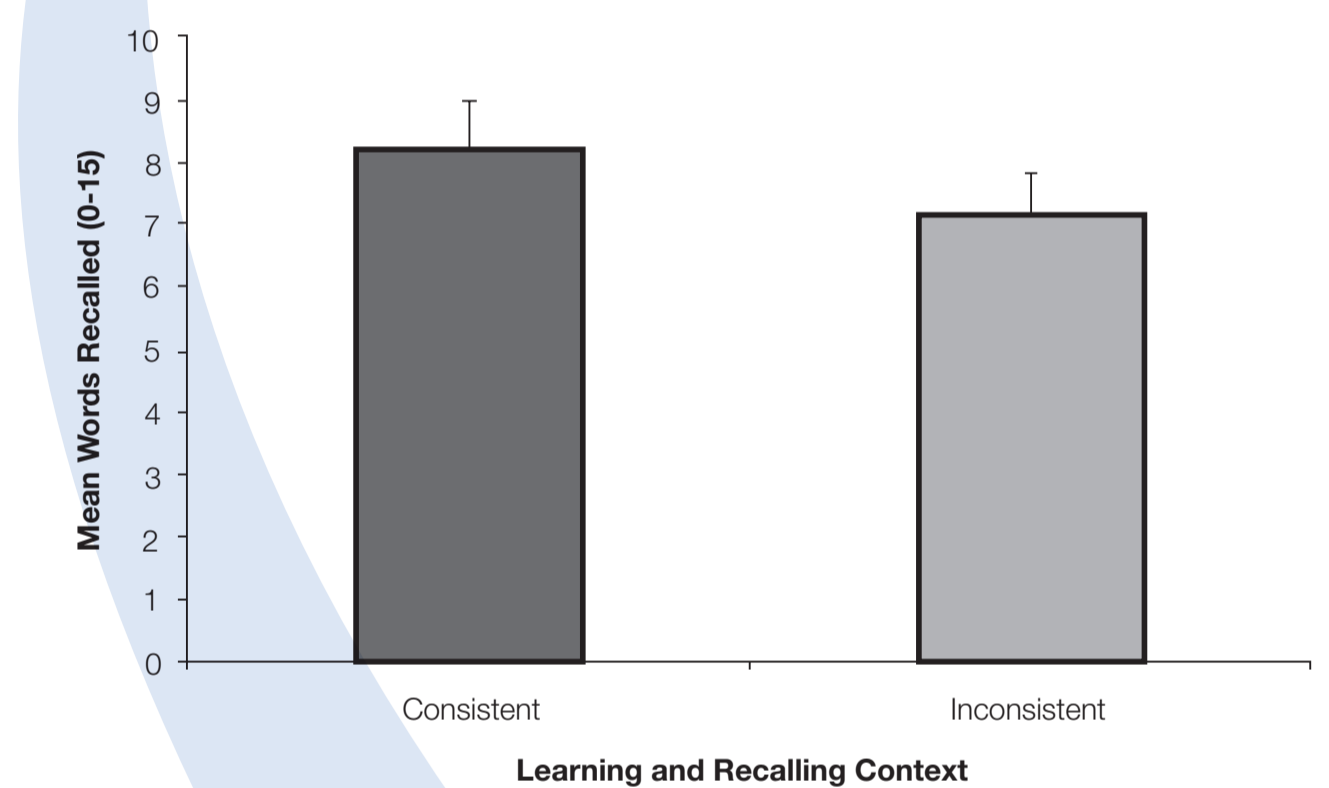


Figure 3: Mean number of words recalled for the consistent (stress/stress and no stress/no stress) and inconsistent (stress/no stress and no stress/stress) contexts. Error bars denote +/- SEM.