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DYNAMIC ADJUSTMENTS IN WORKING MEMORY IN THE FACE OF AFFECTIVE INTERFERENCE

By

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DYNAMIC ADJUSTMENTS IN WORKING MEMORY IN THE FACE OF AFFECTIVE INTERFERENCE

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Cognitive control, which allows for the selection and monitoring of goal-relevant behaviors, is dynamically upregulated based on moment-to-moment cognitive demands. One route by which the magnitude of demand is registered by cognitive control systems is via detection of response conflict. Yet, working memory (WM) demands may similarly signal dynamic adjustments in cognitive control. In a WM delayed-recognition task, Jha and Kiyonaga (2010) demonstrated dynamic adjustments in cognitive control as a function of demand, via manipulation of mnemonic load and category-level delay-spanning cognitive interference. The current study aimed to replicate and extend prior work by investigating if the level of *affective interference* may similarly upregulate cognitive control. Participants (N = 89) completed a delayed-recognition WM task in which mnemonic load (memory load of 1 item vs. 2 items) and delay-spanning distracter interference (neutral vs. negative images) were manipulated in a factorial design. Similar to prior WM results, current trial performance varied as a function of load and interference. Performance was best on trials with low-load and neutral distraction and worst for trials with high-load and negative distraction. Analyses of previous trial demands, conducted to investigate dynamic adjustments in cognitive control, revealed

higher current trial performance when the preceding trial was high- vs. low-load. In addition, higher current trial performance was observed when the preceding trial contained negative vs. neutral distracters. These results suggest that affective interference, similar to cognitive interference (Jha & Kiyonaga, 2010), may trigger dynamic adjustments in cognitive control during a WM task.

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Chapter 1. Introduction

Appropriate behavior requires successfully adapting to unpredictable and ever-changing environments. Cognitive control, which refers to a family of higher order processes that allow for selection, maintenance, and monitoring of behavior in the service of goal attainment, is necessary for performance success (Botvinick, Braver, Barch, Carter, & Cohen, 2001; Braver, Gray, & Burgess, 2007; Dreisbach & Fischer, 2012a; Miller & Cohen, 2001; Redick, 2014). When task demands outweigh current processing resources, upregulation of cognitive control may be triggered in the service of benefitting ongoing goal-relevant information processing. To date, there is a paucity of research investigating the breadth of factors capable of triggering dynamic upregulation of cognitive control.

One prominent account of dynamic upregulation of cognitive control proposed by Botvinick and colleagues is the “conflict monitoring theory” (Botvinick et al., 2001; Botvinick, Cohen, & Carter, 2004; Botvinick, Nystrom, Fissell, Carter, & Cohen, 1999). This theory suggests that ongoing mental processes are monitored for “conflict,” which are instances when goal attainment may be jeopardized due to discrepancies between internal representations and prepotent behavioral tendencies. Consequently, the detection of conflict is proposed to trigger the upregulation of cognitive control. As a result of this upregulation, goal-relevant information processing may be facilitated in subsequent moments. The phenomenon of sequential performance benefits following conflict detection is referred to as *conflict adaptation* (Botvinick et al., 2001).

Studies investigating conflict adaptation have primarily utilized tasks involving response conflict, such as the Stroop, Simon, and Eriksen flanker tasks (Botvinick et al., 1999; Egner, 2007; Gratton, Coles, & Donchin, 1992; Hommel, Proctor, & Vu, 2004;

Kerns et al., 2004; Stürmer, Leuthold, Soetens, Schröter, & Sommer, 2002; Ullsperger, Bylsma, & Botvinick, 2005; Verbruggen, Notebaert, Liefooghe, & Vandierendonck, 2006). In these tasks, high-conflict trials are those in which task-irrelevant stimulus features directly interfere with response selection. In contrast, low-conflict trials have task-irrelevant stimulus features which facilitate response selection in favor of the desired response. For example, in the Stroop task, participants are asked to indicate the ink color of the presented word, which may or may not conflict with the meaning of the word (e.g. the word “Blue” presented in a green font represents a high-conflict trial, while the word “Blue” presented in a blue font represents a low-conflict trial). Response times (RTs) are slower and task accuracy is lower on high- vs. low-conflict trials (Botvinick et al., 1999; Gratton et al., 1992; Kerns et al., 2004; Stürmer et al., 2002).

Thus, according to the conflict monitoring theory, upregulation of cognitive control is triggered specifically by the detection of conflict, with greater upregulation on high- vs. low-conflict trials. Greater resource availability following high conflict trials is proposed to buffer against interference from task-irrelevant, distracting stimuli on subsequent high-conflict trials (Botvinick et al., 2001). As such, conflict adaptation leads to facilitated performance on trials following high- versus low-conflict trials (Egner, 2007; Gratton et al., 1992; Hommel et al., 2004; Kerns et al., 2004; Stürmer et al., 2002; Ullsperger et al., 2005; Verbruggen et al., 2006).

The presence of conflict has been conceptualized as an affectively negative experience (Botvinick, 2007; Dreisbach & Fischer, 2012a; Fritz & Dreisbach, 2013; Saunders, Lin, Milyavskaya, & Inzlicht, 2017). Evolutionarily, the salience of negative stimuli is thought to aid in survival via the upregulation of attentional resources (Bradley, 2009; Frijda, 1988; Levenson, 1994). Similarly, the upregulation of cognitive control in response to conflict has been proposed by Dreisbach and others to operate via the triggering of an aversive signal (see Dreisbach & Fischer, 2012a, Saunders et al., 2017). Neuroimaging studies also support the association between conflict signals and negative stimuli, as both activate overlapping regions of the anterior and mid-cingulate cortex (ACC and MCC, respectively, see Botvinick, 2007; Saunders et al., 2017). Prior evidence suggests that these regions play a role in integrating affective information and conflict signals to influence cognitive control and behavior.

A recent behavioral study investigated the link between conflict and negative affect by examining whether the presence of conflict in a response conflict task was a better predictor of subsequent performance benefits than the subjective experience of negative affect (Fröber, Stürmer, Frömer, & Dreisbach, 2017). Participants completed a Simon task and rated their affective experience after each trial as either “pleasant” or “unpleasant.” A typical conflict adaptation effect was observed, with facilitated performance following high-conflict vs. low-conflict trials. Strikingly, when results were analyzed as a function of the pleasantness rating, sequential performance benefits were observed following low-conflict trials rated as unpleasant but not those rated as pleasant. These findings suggest that negative affect can upregulate cognitive control, and in some cases, may be enough to produce sequential performance benefits even in the absence of response conflict.

Furthermore, several studies have suggested that affectively negative stimuli embedded within response conflict tasks leads to enhanced upregulation of cognitive control resources. A study by Melcher and colleagues demonstrated that negative images (vs. neutral images) presented between neutral Stroop trials resulted in enhanced activation of brain areas implicated in the upregulation of cognitive control (Melcher, Born, & Gruber, 2011). Behaviorally, a response conflict study in which task-irrelevant emotional stimuli were presented concurrently with the task-relevant stimulus set, negative words vs. neutral words enhanced sequential performance benefits (Zeng et al., 2017. However, other studies have found that negative stimuli did not trigger subsequent performance benefits moreso than neutral stimuli (Dignath et al., 2017; van Steenbergen et al., 2009), or even eliminated subsequent performance benefits (Padmala et al., 2011). Thus, while the literature is mixed, there is some evidence to suggest that the presentation of negative stimuli (vs. neutral stimuli) enhances the upregulation of cognitive control in response conflict tasks, and may trigger these subsequent performance benefits in the absence of response conflict.

Beyond response conflict and negatively-valenced stimuli, recent studies have investigated whether subsequent performance benefits can be triggered by cognitive task demands more broadly. A study by Fischer, Dreisbach, and Goschke (2008) combined a Simon task with a secondary number comparison task. As predicted, conflict adaptation effects were observed in response to the Simon task. Surprisingly, sequential performance benefits were also observed with increased difficulty in the number comparison task. Another study by Dreisbach and Fischer (2011) examined if cognitive demands, in the absence of conflict or response selection manipulations, resulted in subsequent performance benefits. Their task varied perceptual fluency across trials in a task known to elicit negative affect. Participants were shown hard-to-read and easy-to-read stimuli, and demonstrated that hard-to-read trials facilitated performance for the subsequent trial. Thus, sequential performance benefits are not restricted to the presence of response conflict or negative stimuli, but are triggered by broader manipulations of task demands.

The current study examines the factors which may contribute to subsequent performance benefits in the context of working memory (WM). WM is a key facet of cognitive control involving the maintenance and manipulation of information over short intervals. Working memory delayed-recognition tasks typically involve a series of successive processes including encoding, maintenance, distracter interference resolution, and retrieval processes (Baddeley, 1986; Cowan, 2016). Many aspects of this task can be manipulated to vary cognitive demands. Prior studies have manipulated mnemonic load (see Jha & McCarthy, 2000), delay-spanning interference (Sreenivasan & Jha, 2007; Dolcos, Miller, Kragel, Jha, & McCarthy, 2007), as well as retrieval demands (Cabeza, Dolcos, Graham, & Nyberg, 2002), finding that higher demands result in poorer current trial performance.

In a study by Jha and Kiyonaga (2010), mnemonic load and distractor inference were manipulated to investigate if current trial demands impact subsequent trial performance. At the beginning of each trial, participants were instructed to remember 1 or 2 memory item(s) (low load or high load, respectively) consisting of faces or shoes for the duration of delay interval. During the delay interval, participants were presented with two task-irrelevant distracters consisting of either faces or shoes that were of the same category (i.e. confusable, or high interference) or of a different category (i.e. non-confusable, or low interference) as the memory item(s). At the end of the delay, participants were presented with a test item and asked if the test item matched or did not match the memory array. Analyses of current trial effects demonstrated the expected effects of greater task accuracy and faster response times (RTs) for low-load vs. high-load trials and low-interference vs. high-interference trials. (Jha & McCarthy, 2000; Jha, Fabian, & Aguirre, 2004; Sreenivasan & Jha, 2007). Analysis of sequential performance benefits as a function of previous trial demands demonstrated greater task accuracy and faster RTs for trials following high-load vs. low-load trials, and trials following high-interference vs. low-interference trials. These results provide evidence that high load and high-interference distracters are effective in upregulating cognitive control in a WM task.

In the context of this task, the pattern of results observed as a function of the mnemonic load manipulation was akin to the results reported by Dreisbach and Fischer (2011) for high vs. low perceptual fluency, in that high vs. low cognitive demands not involving conflict were able to produce subsequent performance effects. The distracter manipulation, on the other hand, was somewhat analogous to the congruency manipulation in response conflict tasks. That is, high-interference distracter trials may have resulted in the experience of *conflict* as similar category memory items were to be maintained in WM during distractor presentation. In line with the conflict adaptation literature, high vs. low interference trials resulted in subsequent performance benefits.

Given prior evidence that response conflict and negative affect may activate similar brain regions to upregulate cognitive control (Botvinick, 2007; Cohen & Henik, 2012; Dreisbach & Fischer, 2012b, 2015; Saunders et al., 2017) and that conflict-like interference trials result in subsequent trial benefits, perhaps negative delay-spanning distractors might similarly result in subsequent trial benefits during delayed-recognition

WM tasks. Indeed, previous studies have found that negative (versus neutral) distracters impair current trial WM performance (Dolcos, Diaz-Granados, Wang, & McCarthy, 2008; Dolcos & McCarthy, 2006; Jha, Witkin, Morrison, Rostrup, & Stanley, 2017). Yet, these studies did not investigate subsequent trial effects as a function of distractor valence. To test this prediction, the present study investigates the impact of negative and neutral distracters on subsequent trial performance in a delayed-recognition WM task.

In addition to examining the impact of affective distraction on dynamic adjustments in cognitive control during a WM task, we investigated the effects of tonic mood. Prior studies have suggested that negative mood interferes with current trial performance in both response conflict and WM tasks (Dolcos, Wang, & Mather, 2014; Gray, Braver, & Raichle, 2002; Seibert & Ellis, 1991; Spies, Hesse & Hummitzsch, 1996), and that induction of negative mood may enhance conflict adaptation effects in response conflict tasks (Shuch & Koch, 2015; Shuch, Zweerings, Hirsch, & Koch, 2017; van Steenbergen et al., 2010, 2012). In the current study, mood was not manipulated but measured as a function of individual differences in self-reported mood, indexed by the Positive and Negative Affect Schedule (PANAS, Watson, Clark, & Tellegen, 1988).

Herein, a task similar to Jha and Kiyonaga (2010) was employed in which mnemonic load and affective interference were parametrically manipulated across trials to examine current and previous trial effects. We predicted that WM performance would be greater when current trial mnemonic load was low (1 item) vs. high (2 items), and distracter affect was neutral vs. negative. We also anticipated reproducing the findings of Jha and Kiyonaga (2010) regarding subsequent trial performance benefits as a function of high vs. low mnemonic load. Based on studies suggesting that negative affect and conflict are interrelated constructs (Botvinick, 2007; Dreisbach & Fischer, 2012b) and the conflict-like interference effects reported in Jha and Kiyonaga (2010), we predicted that subsequent trial performance benefits would be observed for negative vs. neutral distracter trials. Lastly, we predicted that those who reported high negative mood (vs. low negative mood) would demonstrate lower current trial performance for negative distracter trials, and may show a reduced magnitude of subsequent trial benefits following negative distracter trials.

Chapter 2. Method

Participants

A delayed-recognition WM task with affective distracters was administered to a group of healthy young adults recruited from the University of Miami community (*N* = 89, 35 males, age *M* = 19.35 years, *SD* = 1.69) who received course credit for their participation. Participants were excluded based on reported psychological diagnoses (depression and/ or anxiety) or psychotropic medications (*n* = 9) in order to prevent potential adverse reactions due to the presentation of distressing valenced images during the WM task. On average, participants responded to 86.15 trials (*SD* = 12.01). However, two participants were excluded from analysis because they responded to fewer than 1/3 of the task trials (24 and 15 trials out of 90 total trials). Thus, 78 participants were retained for analysis (32 males, *M* = 19.37 years, *SD* = 1.79). Informed consent was obtained in accordance with the Institutional Review Boards of the University of Miami.

Experimental Stimuli and Design

WM with Affective Distracters Task. Participants were instructed to remember an array of faces or shoes over a delay interval that included distracting images. The task was similar to those used in previous studies of WM utilizing undergraduate and military populations (Jha & Kiyonaga, 2010; Jha et al., 2017). Figure 1 presents a schematic of the progression of each trial of the WM task. During each trial, participants were instructed to keep their gaze in the center of the screen at all times. Trials began with a memory array (S1) presented for 3000 ms containing either two memory items (high mnemonic load) or one memory item paired with a noise mask (low mnemonic load). S1 was followed by a delay interval of 3000 ms which included a task-irrelevant distracter image (neutral or negative in valence) displayed for 2000 ms. Following the delay, a single test item (S2) was presented for 2500 ms. Participants were instructed to determine whether S2 was an image that appeared in S1 (match trials) or a novel image (non-match trials) that did not appear in S1, and were instructed to respond by pressing a designated key. Participants were asked to respond quickly and accurately, with greater emphasis on accuracy. S2 was always of the same category (face or shoe) as S1. Memory item(s) and distracter stimuli were not repeated throughout the task, with the exception of S2 on match trials. Half of the trials utilized neutral faces as stimuli and the other half utilized shoes, with both trial types intermixed throughout the task. In addition, half of the trials utilized neutral distracter images, while the remaining trials utilized negative distracter images. The task consisted of a 30-trial practice block (with accuracy feedback), and three 30-trial experimental blocks (90 total experimental trials). The duration of the task was approximately 20 minutes, with self-timed breaks between each block.

Distracter images were drawn from the International Affective Picture System (Lang, Bradley, & Cuthbert, 2008), and were neutrally valenced (normative valence: *M* = 5.36, *SD* = 1.33, arousal: *M* = 3.43, *SD* = 2.03), or negatively valenced (normative valence: *M* = 2.53, *SD* = 1.54, arousal: *M* = 5.91, *SD* = 2.23, Lang et al., 2008). Negative images were composed of aggressive or aversive scenes and objects, while neutral images were matched to negative images in terms of scene composition and chromatic structure.

Thus, WM demands were manipulated along two levels of mnemonic load (low vs. high) and two levels of affective interference (neutral vs. negative distracters), yielding four distinct trial types that were used for analysis: low load/ neutral distracter, low load/ negative distracter, high load/ neutral distracter, and high load/ negative distracter. Each trial type occurred with approximately equal frequency (low load/ neutral distracter condition: 22 trials, low load. negative distracter condition: 23 trials, high load/ neutral distracter condition: 23 trials, high load/ negative distracter condition: 22 trials). Across the experiment, trials varied along four variables: S1/S2 category (faces/shoes), match vs. non-match trials, mnemonic load level (low/high), and affective interference (neutral/negative). Trial order was pseudo-randomly intermixed along these four variables so that identical trial types were never consecutively presented.

Image Ratings.

After completing the WM task, participants were asked to rate the arousal and valence of the images presented during the delay utilizing a 9-point scale ranging from 1 to 9. For valence, 1 represented highly negative emotional content, 5 represented neutral emotional content, and 9 represented highly positive emotional content. For arousal, 1 represented the lowest level of arousal and 9 represented the highest level of arousal. Participants were given as much time as needed to complete the rating scales.

Participants rated images in accordance with Lang et al. (2008), which confirmed our manipulation of negative and neutral distracters in the task. Neutral distracters (M = 5.31, SD = 0.483) were rated as less negative than negative distracters (M = 2.27, SD = 0.667, $t(77) = 30.55$, $p < 0.001$, *95% CI* [2.839, 3.235], $d_z = 3.459$). Additionally, neutral distracters (M = 2.20, SD = 1.44) were rated as less arousing than negative distracters (M = 3.73, SD = 2.13, $t(77) = -5.29$, $p < 0.001$, *95% CI* [-2.110, -0.955], $d_z = 0.599$).

Positive and Negative Affect Schedule (PANAS). The PANAS (Watson, Clark, & Tellegen, 1988) is a self-report measure that captures state positive and negative affect. Ten items were presented to assess feelings of positive affect (e.g., enthusiastic, active, alert) and 10 items assessed feelings of negative affect (e.g., anger, disgust, fear). Participants rated the extent to which they felt the identified emotion at the present moment on a 5-point Likert scale from 1 (*very slightly or not at all*) to 5 (*extremely*). Positive and Negative scores were calculated separately as the sum of all 10 of their respective items. The two scales have demonstrated high internal consistency and stability over time as well as strong validity with measures of depression, general distress, and emotional dysfunction (Watson et al., 1988).

Procedures

A trained experimenter proctored the administration of the WM task to groups of up to 10 participants, each at their own PC laptop workstation. Testing occurred in a quiet room where participants sat approximately 57 cm from a PC laptop display and performed the task, image ratings, and questionnaire. The PANAS was administered at the beginning of the session in order to measure baseline mood state. At the end of the test battery, participants viewed a decompression condition with positively-valenced images to counterbalance any sustained effect of negative mood induced by viewing negative images. Each session lasted approximately 2 hours and comprised the WM task as well as behavioral tasks and questionnaires outside the scope of the current study. All procedures were approved by the Institutional Review Boards of the University of Miami.

Analysis

The primary outcome measure of interest was WM accuracy for each trial, as this aspect of performance was emphasized in task instructions to participants. Previous studies involving delayed-recognition WM tasks have also focused on accuracy as the primary outcome (Dolcos, Diaz-Granados, Wang, & McCarthy, 2008; Dolcos & McCarthy, 2006; Jha & Kiyonaga, 2010; Jha et al., 2017). Response time data (RT, in milliseconds) were also analyzed. RT outliers were assessed by examining standardized residuals of individual means collapsed across trials for RT. RT trials more than 4 standard deviations from the mean were considered outliers. There was no significant difference between the results when outliers were excluded or retained, thus, the full dataset including outliers was retained for all analyses.

We analyzed these dependent measures using hierarchical linear modeling (HLM; Woltman et al., 2012). Each trial was included as an observation in the analysis, and the fixed effects of mnemonic load (low vs. high), affective interference (neutral vs. negative), and their interaction, were entered as level-1 predictors nested within each participant. Mnemonic load (0 = low, 1 = high) and affective interference (0 = neutral, 1 = negative) were entered as dummy-coded factor variables. To examine the effects of dynamic adjustments in WM based on previous trial demand, variables representing the mnemonic load (low vs. high) and affective interference (neutral vs. negative) of each prior trial were created. Including both current and previous trial demand types in the same model allowed for the independent assessment of the effects of previous trial demands while controlling for current trial demands. Thus, mnemonic load and affective interference were entered as current trial variables in an initial model (Model 1), and previous trial variables were added to the initial model (Model 2), while controlling for Model 1.

Trial accuracy was analyzed using hierarchical generalized linear models (HGLM) with PROC GLIMMIX in SAS version 9.4. We utilized a Bernoulli distribution for the binary response variable (0 = incorrect, 1 = correct) and a logit link function, with a random intercept for each subject. The link function transformed the distributions of the predictors to fit the dichotomous response distribution. Parameters were estimated utilizing maximum likelihood estimation based on numerical integration (adaptive quadrature). RT was analyzed utilizing hierarchical linear modeling with PROC MIXED in SAS version 9.4, where RT was a response variable with a continuous distribution. Restricted estimation maximum likelihood was utilized to estimate a random intercept for each subject and the fixed effects. Chi-square Type III tests of fixed effects are reported herein, alongside Odds Ratios (ORs),parameter estimates, and 95% confidence intervals. Standardized effect sizes for accuracy are reported as ORs (Haddock, Rindskopf, & Shadish, 1998; Valentine & Cooper, 2003) and effect sizes for RT are reported as Cohen's f^2 (Selya, Rose, Dierker, Hedeker, & Mermelstein, 2012).

In order to determine whether mood affected task performance, and/ or moderated the effects of WM demand on task performance, we entered two PANAS scores as level-2 predictors, including baseline Positive PANAS score (Positive PANAS) and baseline Negative PANAS score (Negative PANAS). Positive and Negative PANAS were examined in separate models. PANAS scores were grand-mean centered so that a value of 0 indicated the mean PANAS score across individuals.

Chapter 3. Results

Current Trial Analyses

Accuracy. The pseudo-Intraclass Correlation (ICC) was evaluated on the null (intercept-only) model by approximating the variance distribution. The null model examining subjects as random intercepts (pseudo-ICC = 0.14) suggested that 14% of the variability in the latent continuous variable underlying task accuracy could be explained by between-subject differences. Thus, the majority (~86%) of the variance in WM accuracy occurred within subjects, indicating significant fluctuations in WM capacity over trials.

To address whether current WM demands influenced accuracy, the first analysis included the fixed effects of mnemonic load (low vs. high), affective interference (neutral vs. negative distracters), and their interaction (Table 1, Model 1). We observed a significant main effect of current mnemonic load ($F(1, 6705) = 32.19$, $p < 0.001$), a main effect of current affective interference ($F(1, 6705) = 100.94$, $p < 0.001$), and no significant interaction between load and affective interference ($F(1, 6705) = 1.77$, $p = 0.184$) (Figure 2a, b). Specifically, low-load trials (odds = 16.30, $p < 0.001$) were more than twice as likely to be correct ($OR = 0.423$, $p < 0.001$, 95% CI [0.358, 0.500]) compared to high-load trials (odds = 6.89, $p < 0.001$). Furthermore, neutral distracter trials (odds = 13.51, $p < 0.001$) were almost twice as likely to be correct ($OR = 0.616$, $p < 0.001$, 95% CI [0.521, 0.728]) compared to negative distracter trials (odds = 8.32, $p < 0.001$).

RT. The null model examining within and between-subject differences demonstrated that ICC = 0.194, suggesting that 19.4% of the variance in RT could be explained by between-subject differences. Similar to the results for accuracy, roughly 80% of the variance in RT could be attributed to within-subjects differences.

To address whether current WM demands influenced RT, the first analysis (Table 2, Model 1) included the fixed effects of mnemonic load (low vs. high), affective interference (neutral vs. negative distracters), and their interaction. We observed a significant main effect of current mnemonic load ($F(1, 6705) = 372.24$, $p < 0.001$, $f^2 = 0.05$), a main effect of current affective interference ($F(1, 6705) = 40.25$, $p < 0.001$, $f^2 = 0.01$), and no significant interaction between load and affective interference ($F(1, 6705) = 0.77$, $p = 0.379$) (Figure 3a, b). Specifically, high-load trials were significantly slower than low-load trials ($\beta = 142.92$, $p < 0.001$), and negative distracter trials were significantly slower than neutral distracter trials ($\beta = 47.00$, $p < 0.001$).

Previous Trial Analyses

Accuracy. To address whether the WM demands of preceding trials influenced accuracy for latter trials, we included the fixed effects of previous trial mnemonic load, previous trial affective interference, and the interaction between previous load and previous affective interference, alongside the fixed effects from Model 1 (Table 1, Model 2). In addition to the effects of current load and affective interference, we observed a significant main effect of previous trial mnemonic load ($F(1, 6702) = 24.26$, $p < 0.001$), a main effect of previous affective interference ($F(1, 6702) = 16.39$, $p < 0.001$), and a significant interaction between previous load and previous interference ($F(1, 6702) = 4.99$, $p = 0.026$). Specifically, trials were almost twice as likely to be correct ($OR = 1.496$, $p < 0.001$, 95% CI [1.275, 1.176]) when preceded by high-load trials (odds = 13.24, $p < 0.001$) compared to trials preceded by low-load trials (odds = 8.85, $p < 0.001$).

The level of affective interference of the prior trial also influenced trial accuracy such that trials preceded by neutral distracter trials (odds = 9.18, $p < 0.001$) were more likely to be correct (*OR* = 1.393, $p < 0.001$, 95% CI [1.186, 1.635]) compared to trials preceded by negative distracter trials (odds = 12.78, $p < 0.001$) (Figure 2c).

There was a significant interaction between previous mnemonic load and previous affective interference, such that the benefits to accuracy from preceding high-load and negative distracter trials were no greater than the effect of either demand type alone, but all were more likely to be correct than trials preceded by low-load/ negative distracter (Figure 2d). Thus, trials preceded by high-load / negative distracter trials (odds = 14.27, $p < 0.001$) were no more likely to be correct (*OR* = 1.160, $p = 0.224$, *95% CI* [0.913, 1.474) than trials preceded by high-load / neutral distracter trials (odds = 12.30, $p < 0.001$). Additionally, trials preceded by high-load / negative distracter trials were no more likely to be correct (*OR* = 1.247, $p = 0.069$, *95% CI* [0.983, 1.582) than trials preceded by low-load / negative distracter trials (odds = 11.44, $p < 0.001$). However, current trial accuracy was worst when preceded by low-load / neutral distracter trials (odds = 6.85, $p < 0.001$). Specifically, trials were twice as likely to be correct when preceded by high-load / negative distracter trials (*OR* = 2.084, $p < 0.001$, *95% CI* [1.657, 2.621]), and almost twice as likely be correct when preceded by high-load / neutral distracter trials (*OR* = 1.796, $p < 0.001$, *95% CI* [1.449, 2.227]), or low-load / negative distracter trials (*OR* = 1.672, $p < 0.001$, *95% CI* [1.351, 2.069]), compared to trials preceded by low-load / neutral distracter trials.

RT. To address whether the WM demands of preceding trials influenced RT for latter trials, we included the fixed effects of previous trial mnemonic load, previous trial affective interference, and the interaction between previous trial load and interference, alongside the fixed effects from Model 1 (Table 2, Model 2). In addition to the effects of current load and interference, we observed a significant main effect of previous trial mnemonic load ($F(1, 6702) = 4.88$, $p = 0.027$, $f^2 = 0.001$), a main effect of previous affective interference ($F(1, 6702) = 4.05$, $p = 0.044$, $f^2 = 0.001$), and a significant interaction between previous load and previous affective interference ($F(1, 6702) = 6.58$, $p = 0.010$, $f^2 = 0.001$). Specifically, trials preceded by high-load trials were significantly faster compared to trials preceded by low-load trials ($\beta = -16.38$, $p = 0.027$), and trials preceded by negative distracter trials were significantly faster compared to neutral distracter trials ($\beta = -14.92$, $p = 0.044$) (Figure 3c). There was a significant interaction, however, such that trials preceded by high-load / negative distracter trials did not demonstrate significantly different RTs than trials preceded by high-load / neutral distracter trials ($\beta = 4.08$, $p = 0.695$) or trials preceded by low-load / negative distracter trials ($\beta = 2.63$, $p = 0.801$) (Figure 3d). However, trials preceded by low-load / neutral distracter trials had significantly slower RTs compared to trials preceded by high-load / negative distracter trials ($\beta = -31.30$, $p = 0.004$), high-load / neutral distracter trials ($\beta = -35.38$, $p < 0.001$), and low-load / negative distracter trials ($\beta = -33.93$, $p = 0.001$).

PANAS as a Moderator

Positive PANAS.

Accuracy. Positive PANAS ($M = 31.10$, $SD = 7.55$) was added to Model 1 as a level-2 predictor to examine main effects (Table 3, Model 1). There was no main effect of Positive PANAS ($F(1, 6702) = 0.21$, $p = 0.645$). Analyses proceeded by examining all interactions between current and previous trial demand types and Positive PANAS (Table

3, Model 2). There was no significant moderation effect of Positive PANAS on task accuracy (all *p* values > 0.1).

RT. There was no main effect of Positive PANAS (*F*(1, 6702) = 1.42, *p* = 0.234) (Table 4, Model 1). Analysis of Positive PANAS as a moderator of current and/or previous trial demand on RT demonstrated no significant interactions (Table 4, Model 2, all *p* values > 0.1).

Negative PANAS.

Accuracy. Negative PANAS (*M* =17.16, *SD* = 5.84) was added to Model 1 as a level-2 predictor (Table 3, Model 3). There was no main effect of Negative PANAS (F(1, 6702) = 3.19, *p* = 0.074). Analysis of Negative PANAS as a moderator of current and/or previous trial demand on accuracy, however, revealed a significant Negative PANAS by previous load interaction (F(1, 6698) = 5.81, *p* = 0.016) (Table 3, Model 4). No other interactions between Negative PANAS and current and previous trial demand types were significant (all *p* values > 0.05).

Negative PANAS was a significant moderator of previous load on accuracy (*B* = -0.03, *SE* = 0.014, *p* = 0.016). When Negative PANAS was 1SD below the mean (score = 11.35), trials preceded by high-load trials (odds = 18.33, *p* < 0.001) were almost twice as likely to be correct (*OR* = 1.859, *p* < 0.001, 95% CI [1.463, 2.363]) than trials preceded by low-load trials (odds = 9.86, *p* < 0.001). When Negative PANAS was at the mean (score = 17.15, *p* < 0.001), trials preceded by high-load trials (odds = 13.62, *p* < 0.001) were 1.5 times more likely to be correct (*OR* = 1.534, *p* < 0.001, 95% CI [1.304, 1.805]) than trials preceded by low-load trials (odds = 8.88, *p* < 0.001). However, when Negative PANAS was 1SD above the mean (score = 22.95), trials preceded by high-load trials (odds = 10.11, $p < 0.001$) were slightly but significantly more likely to be correct (*OR* = 1.266, $p = 0.028$, 95% CI [1.026, 1.562]) than trials preceded by low-load trails (odds = 7.99, $p < 0.001$). These results suggest that for participants who reported higher negative mood, the benefits to subsequent performance due to previous high-load trials decreased. The odds of a correct trial when preceded by a high-load trial decreased for participants who reported higher negative mood, but the odds of a correct trial when preceded by a low-load trial remained relatively unchanged across Negative PANAS scores.

RT. PANAS scores were initially added to Model 1 as level-2 predictors to examine main effects (Table 4, Model 3). There was no main effect of Negative PANAS ($F(1, 6702) = 0.63$, $p = 0.428$). Analyses proceeded by examining all interactions between current and previous trial demand types and Negative PANAS (Table 4, Model 4). The interaction between Negative PANAS score and current load was significant ($F(1, 6698) = 5.76$, $p = 0.016$, $f^2 = 0.001$). No other interactions between Negative PANAS and current and previous trial demand types were significant (all *p* values > 0.2).

Negative PANAS score was a significant moderator of current load on RT ($B = -3.06$, $SE = 1.28$, $p = 0.016$, *95% CI* [-5.56, -0.561]). When Negative PANAS score was 1SD below the mean (score = 11.35, $p < 0.001$), the expected RT was 160.60 ms faster for low-load trials versus high-load trials ($p < 0.001$, *95% CI* [140.08, 181.12]). When Negative PANAS score was at the mean (score = 17.15), the expected RT was 142.84 ms faster for low-load trials versus high-load trials ($p < 0.001$, *95% CI* [128.33, 157.36]). At 1SD above the mean of Negative PANAS (score = 22.95), the expected RT was 125.09 ms faster for low-load trials versus high-load trials ($p < 0.001$, *95% CI* [104.57, 145.61]). These results suggest that for participants who had higher Negative PANAS scores, the difference between low-load and high-load RTs decreased. For high-load trials, participants who reported higher levels of negative mood exhibited faster RTs than participants who reported lower levels of negative mood. For low-load trials, the RTs were relatively equal, suggesting there was no impact of Negative PANAS on low-load trials.

Exploratory Current by Previous Trial Interactions

Accuracy. To explore whether dynamic adjustments in WM depend on current WM demands, we examined the two-way interactions between current mnemonic load, previous mnemonic load, current affective interference, and previous affective interference (Table 5, Model 1). In addition to the current demand and previous demand effects, we observed a significant interaction between current load and previous load ($F(1, 6698) = 6.81$, $p = 0.009$), a significant interaction between current interference and previous load ($F(1, 6698) = 42.80$, $p < 0.001$), but no significant interaction between current mnemonic load and previous affective interference ($F(1, 6698) = 0.03$, $p = 0.855$), and no significant interaction between current affective interference and previous affective interference ($F(1, 6698) = 0.04$, $p < 0.836$). In particular, the benefits to accuracy from preceding high-load trials depended on current mnemonic load and affective interference.

The benefit to accuracy from preceding high-load trials occurred primarily in current low-load trials. Low-load trials preceded by high-load trials (odds = 23.41, $p < 0.001$) were almost twice as likely to be correct (*OR* = 1.818, $p < 0.001$, 95% CI [1.375, 2.404]) compared to low-load trials preceded by low-load trials (odds = 12.87, $p < 0.001$), whereas high-load trials preceded by high-load trials (odds = 7.71, $p < 0.001$)

were no more likely to be correct ($OR = 1.149$, $p = 0.184$, 95% CI [0.936, 1.412]) than high-load trials preceded by low-load trials (odds = 6.71, $p < 0.001$) (Figure 4a). In contrast, high mnemonic load in previous trials appeared to exclusively benefit current negative distracter trials. Current negative distracter trials preceded by high-load trials (odds = 14.19, $p < 0.001$) were more than twice as likely to be correct ($OR = 2.518$, $p < 0.001$, 95% CI [2.014, 3.147]) than negative distracter trials preceded by low-load trials (odds = 5.64, $p < 0.001$). However, neutral trials preceded by high-load trials (odds = 12.72, $p < 0.001$) was no more likely to be correct ($OR = 0.830$, $p < 0.157$, 95% CI [0.641, 1.075]) than neutral distracter trials preceded by low-load trials (odds = 15.33, $p < 0.001$). (Figure 4b).

RT. To explore whether dynamic adjustments of WM depend on current WM demands, we examined the two-way interactions between current mnemonic load, previous mnemonic load, current affective interference, and previous affective interference (Table 5, Model 2). Similar to the results for accuracy, we observed a significant interaction between current mnemonic load and previous load ($F(1, 6698) = 8.68$, $p = 0.003$, $f^2 = 0.001$), a significant interaction between current affective interference and previous load ($F(1, 6698) = 8.54$, $p = 0.004$, $f^2 = 0.001$), but no significant interaction between current mnemonic load and previous affective interference ($F(1, 6698) = 0.02$, $p = 0.886$), and no significant interaction between current affective interference and previous affective interference ($F(1, 6698) = 0.05$, $p = 0.831$). Thus, the benefits to RT from preceding high-load trials depended on the current trial mnemonic load and affective interference.

Similar to the results for accuracy, the benefit to RT from previous high-load trials occurred primarily in current low-load trials. Low-load trials preceded by high-load trials were significantly faster than low-load trials preceded by low-load trials (*B* = -37.22, $p < 0.001$). However, high-load trials preceded by high-load trials did not demonstrate significantly different RTs from high-load trials preceded by low-load trials (*B* = 6.46, $p = 0.540$) (Figure 5a). In contrast, previous high mnemonic load exhibited benefits to current negatively valenced trials only. Negative distracter trials preceded by high-load trials demonstrated faster RTs than negative distracter trials preceded by a low-load trials (*B* = -37.05, $p < 0.001$). However, neutral distracter trials preceded by high-load trials did not show significantly different RTs from neutral distracter trials preceded by low-load trials (*B* = 6.29, $p = 0.555$) (Figure 5b).

Chapter 4. Discussion

The present study investigated dynamic adjustments in cognitive control triggered by the manipulation of task demands (e.g. mnemonic load and affective interference) within a delayed-recognition WM task. Our results demonstrated that current trial performance was worse for high-demand trials (compared to low mnemonic load), and negative distracters (compared to neutral distracters) presented during the delay interval. Current trial performance, however, benefitted from previous high-demand trials. Specifically, sequential performance benefits were observed for preceding high-load vs. low-load trials, and negative vs. neutral distracter trials. Moreover, a significant interaction between previous mnemonic load and previous affective interference demonstrated that sequential performance benefits were no greater for trials with both high-load and negative distracters than trials of either demand type alone. Additional exploratory analyses revealed that previous high-load trials benefitted specific current trial conditions, while previous negative interference trials benefitted all current trial conditions. Furthermore, negative mood was found to moderate the relationship between mnemonic load and WM performance. Overall, our results demonstrate that high WM demand, including high mnemonic load and negative affective interference, upregulates cognitive control resources to benefit subsequent performance in a WM task.

It has been widely established that demands placed on WM impair task performance, but evidence of the detrimental effects of load and affective interference stem from separate lines of research. Mnemonic load has been shown to vary inversely with WM performance, such that higher mnemonic load results in worse performance (Jha & Kiyonaga, 2010; Jha & McCarthy, 2000). Studies involving affective distraction in delayed-recognition WM tasks have also demonstrated that negative distraction leads to worse performance (Dolcos & McCarthy, 2006). The current study manipulated both mnemonic load and affective distraction within the same task, demonstrating the worst performance for trials with high load and negative distracters. These findings are consistent with a previous study utilizing the same task in a military cohort (Jha et al., 2017). Thus, the task manipulation of mnemonic load and affective interference utilized herein effectively influenced performance on the current trial.

The presence of dynamic adjustments triggered by mnemonic load and affective interference are consistent with previous studies that have found sequential trial performance benefits with higher cognitive demands, including high vs. low task difficulty (Dreisbach, Fischer, & Goschke, 2008) and high vs. low perceptual fluency (Dreisbach & Fischer, 2011). Taken together, there is increasing support for the notion that increased cognitive task demands drives dynamic adjustments in cognitive control to facilitate subsequent trial performance. The high mnemonic load condition in the current study increased task difficulty, and thus, the dynamic adjustments observed can be explained by the upregulation of cognitive control to meet higher WM demands.

The ability of mnemonic load to trigger dynamic adjustments in cognitive control also replicates prior findings by Jha and Kiyonaga (2010), and strengthens the claim that WM demands upregulate cognitive control in the service of task goals. In both studies, a delayed-recognition WM task was employed and memory items comprised face and shoe images. In addition, both studies presented distracter stimuli in the delay interval and demonstrated sequential performance benefits due to distracter interference.

However, the current study employed affective interference (neutral vs. negative distracters) vs. cognitive interference (distracters confusable or non-confusable with the memory items) used in Jha and Kiyonaga (2010). While negative affect has been previously shown to upregulate cognitive control in the context of response conflict tasks (Zeng et al., 2017), the current study demonstrated that negative affective interference triggers dynamic adjustments in the absence of response conflict. One explanation of these findings is that emotion regulation processes lead to the resolution of negative affective interference by upregulating cognitive resources, perhaps in the service of emotion regulation, to consequently benefit performance. Indeed, previous studies have found that emotion regulation strategies activate brain regions implicated in the upregulation of cognitive control (Ochsner, 2014; Ochsner & Gross, 2005). Furthermore, recent findings suggest that response conflict trials employing negative stimuli upregulate cognitive control processes to suppress the processing of task-irrelevant negative stimuli on the subsequent trial, thereby facilitating performance (Steinhauser, Flaisch, Meinzer, & Schupp, 2016). As such, participants viewing negatively valenced distracters may engage in emotion regulation strategies to increase the availability of cognitive resources. This upregulation of resources may support the suppression of task-irrelevant affective processing in subsequent moments, and thus reduce the impairing effect of negative stimuli and enhance performance on the following trial.

A debated topic in the conflict adaptation literature is whether task demands triggering the upregulation of cognitive control are domain general or domain specific (Botvinick et al., 2001; Egner, 2008; Freitas, Bahar, Yang, & Banai, 2007). There is theoretical and empirical evidence suggesting that conflict monitoring of cognitive and affective conflict engages overlapping mechanisms, but cognitive and affective post-conflict adjustments and performance benefits engage distinct mechanisms (Soutschek & Schubert, 2013; Etkin, Egner, Peraza, Kandel, & Hirsch, 2006; Egner, Etkin, Gale, & Hirsch, 2008). However, other accounts have proposed that dynamic adjustments in cognitive control utilize a domain-general control system for both cognitive and affective conflict resolution (Chiew & Braver, 2011; Ochsner, Hughes, Robertson, Cooper, & Gabrieli, 2009). In the context of WM, it is unclear whether cognitive interference and affective interference upregulate cognitive control through overlapping or distinct mechanisms to benefit subsequent performance.

Comparing the findings from the present study to those from Jha & Kiyonaga (2010) suggests that cognitive and affective interference interact with mnemonic load in distinct ways to benefit subsequent trial performance, and thus, suggests that cognitive and affective interference may upregulate cognitive control via distinct mechanisms. That is, we observed that mnemonic load and affective interference did not combine to facilitate subsequent performance to a greater degree than the impact of either alone. Specifically, performance on current trials preceded by high-load/ negative distracter trials, did not significantly differ from performance on current trials when preceded by low-load/ negative distracter or high-load/ neutral distracter trials. In contrast to this interaction, Jha and Kiyonaga (2010) found an additive effect of mnemonic load and cognitive interference to benefit performance on subsequent trials, where current trial performance was best when preceded by high-load/ high interference trials. This suggests that mnemonic load and cognitive interference may involve overlapping mechanisms of upregulation, while mnemonic load and affective interference may trigger dynamic adjustments through dissociable mechanisms.

While the WM task utilized in the present study was not designed to disentangle previous trial effects on current trial demands, our exploratory analyses may provide support for a domain-general mechanism by which affective interference upregulates cognitive control. Specifically, we found that previous high-load trials showed the greatest benefits to current low-load trials or negative distracter trials. However, previous negative-distracter trials facilitated performance for all current trial demands. In other words, interference resolution of affective stimuli benefitted subsequent task performance regardless of current task demand, but increasing memory load upregulated cognitive control only in specific cases. In contrast, Jha and Kiyonaga (2010) found that previous high-load trials benefitted all current trial demands except low-interference trials, and previous high-interference trials benefited only current low-load trials and current high-interference trials. Thus, the specificity of cognitive interference in triggering dynamic adjustments in Jha and Kiyonaga (2010), and the lack of specificity of affective interference to induce dynamic adjustments in the current study, may indicate that valenced distracters upregulate cognitive control resources in a global manner. One interpretation of our findings could indicate that the presence of negative stimuli signals the upregulation of attentional salience networks to globally increase attentional resources towards task-relevant stimuli. Brain imaging and electrophysiological studies may help delineate whether dynamic adjustments benefit stimulus encoding, maintenance, or retrieval, and whether these effects induce global or specific upregulation of cognitive control resources.

It is critical to acknowledge the possibility that subsequent performance benefits due to increased task demands may not necessarily reflect the upregulation of cognitive control processes (Egner, 2008). Alternative accounts, including the repetition priming or feature binding accounts (Hommel et al., 2004; Mayr, Awh, & Laurey, 2003), suggest that facilitated performance following high-demand trials may occur due to the formation of episodic memories of conflicting stimuli. For example, a high-demand trial may create a memory representation specific to the presentation of the task-relevant and task-irrelevant stimuli. Subsequent presentations of the same stimulus associations activate the memory features which, in turn, facilitates performance. Another account, the repetition expectancy account, suggests that upregulation of attentional resources is not in the service of resolving conflict, but instead on conscious expectancies regarding the nature of the subsequent trial (Egner, 2008; Gratton et al., 1992). For example, two consecutive presentations of high-load / negative distracter trials may result in sequential performance benefits due to activation of memory representations just encountered, or due to expectations that a subsequent trial will be of the same type as the previous trial.

However, our results are not wholly consistent with either of these accounts. The repetition priming account cannot explain our results, as stimuli (memory items or distracters) were randomized across trials and no stimulus was repeated except for test items on match trials. In addition, the use of two stimulus categories (e.g. faces and shoes) reduced the chances of repetition priming due to serial presentation of stimuli from one category. Moreover, the interaction of previous trial demands with current trials demands are not consistent with the repetition expectancy account. According to this account, we should have observed that previous high-load trials benefitted current high-load trials and previous negative-distracter trials benefitted current negative-distracter trials to a greater extent than other trial types. The results of the present study showed different patterns, suggesting that our findings cannot be explained by either repetition priming or expectancy effects alone.

An important consideration when utilizing a task with affective distracters is the broader impact of overall mood on affective processing. In the present study, participants were administered PANAS (Watson et al., 1988) before the task. This allowed us to examine whether baseline mood affected the relationship between WM demand and task performance. Our findings demonstrated that negative mood significantly moderated the relationship between accuracy and previous load, and the relationship between RT and current load. Higher negative mood reduced the magnitude of dynamic adjustments due to previous high-load trials on accuracy, whereas high negative mood resulted in faster RTs for high-load but not low-load trials. These findings suggest that individual differences in mood influence the effect of WM demands on current trial performance as well as dynamic adjustments due to previous trial WM demand. This is consistent with previous studies (Shuch & Koch, 2015; Shuch et al., 2017; van Steenbergen et al., 2010, 2012) that found negative mood induction (vs. positive mood induction) significantly enhances the magnitude of dynamic adjustments in cognitive control.

While this is the first study to investigate dynamic adjustments in response to both mnemonic load and affective interference in a delayed-recognition WM task, the present study is not without limitations. A significant limitation to the current study is the small number of trials included in our exploratory analyses. The investigation of all possible two-way interactions yielded an average of 11 trials per subject for analyses, and thus, it was not possible to investigate any three-way or four-way interactions between previous trial demand and current trial demand. Future studies should increase the number of trials and blocks to allow for higher-powered previous by current demand analyses.

In addition, the previous trial effect sizes reported herein are smaller than those reported in the existing literature. Previous studies involving dynamic adjustments have reported medium to large effect sizes for current trial demands and small effect sizes for previous trial demands (Dignath, Janczyk, & Eder, 2017; Jha & Kiyonaga, 2010; Larson, Kaufman, & Perlstein, 2009; Padmala et al., 2011). Importantly, these studies utilized ANOVAs and reported partial η^2. In the current study, we utilized HLM and observed small to medium current trial effect sizes and small previous trial effect sizes for accuracy (reported as ORs). We also reported small current and previous trial effect sizes for the secondary outcome, RT (reported as Cohen's f^2). As HLM is still a relatively novel and uncommon statistical approach, there currently exists no consensus as to the most appropriate measure of effect size (Peugh, 2010). Thus, it is unclear whether the reported effect sizes are due to the differences in the selected effect size measures, or whether they reflect smaller previous trial effects on WM performance.

The findings of the present study suggest that WM demands, including mnemonic load and affective interference, induce dynamic adjustments to facilitate subsequent trial performance. Our results suggest that dynamic adjustments triggered by affective interference is behaviorally different from cognitive interference, but further studies examining neural correlates of interference effects are required to further delineate these processes. Future studies should also increase the number of trials in order to better examine the effects of previous trial demands as a function of current trial demands.

Overall, the present study highlights the ability for multiple aspects of demand to upregulate the availability of resources in the service of adapting to challenging and unpredictable situations.

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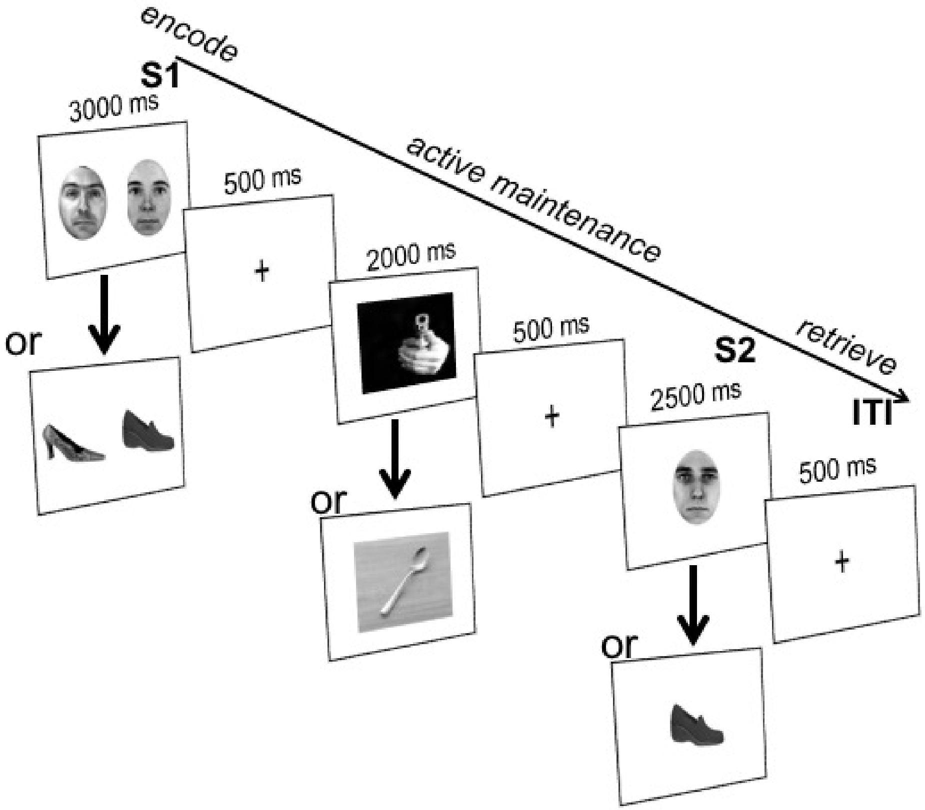

Figure 1. Time course progression of a sample delayed-recognition working memory task trial (high mnemonic load). A trial with low mnemonic load utilized a noise mask in place of the second image in S1. During a high-load trial, participants were shown 2 images of either faces or shoes (S1), and asked to remember them over a delay interval during which they were shown a distracter image (either neutral or negative in valence). After the delay interval, participants were shown a single face or shoe (S2), and asked to determine whether the image matched either of the images seen in S1. S1 image type (faces vs. shoes) varied randomly across trials, but S2 type always matched S1 type within trials.

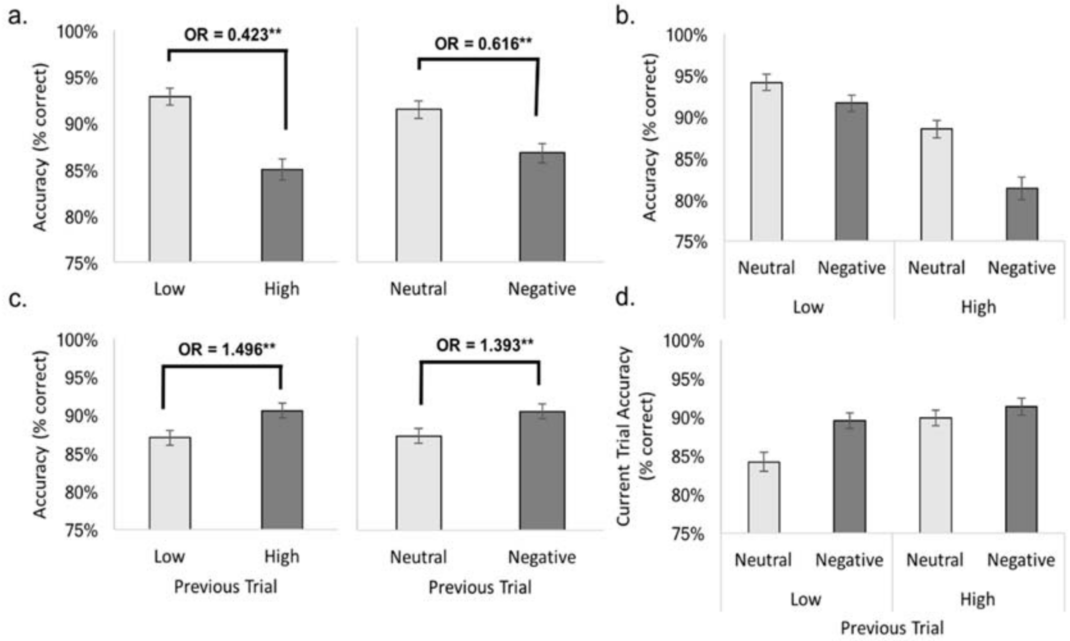

Figure 2. Effects of current and previous trial demand on accuracy. Raw data plotted as mean percentage correct for all trials collapsed across individuals. a) Current trial main effects of mnemonic load (low, high) and affective interference (neutral, negative). Odds ratios (OR) demonstrated greater likelihood for low-load trials to be correct versus high-load trials, and a greater likelihood for trials with neutral distracters to be correct versus trials with negative distracters. b) Current trial demand effects on accuracy. Odds ratios (OR) demonstrated greatest likelihood for low-load / neutral distracter trials to be correct, followed low-load / negative distracter trials, high-load / neutral distracter trials, and lowest likelihood for a high-load / negative trial to be correct. c) Previous trial main effects of mnemonic load (low, high) and affective interference (neutral, negative). Odds ratios (OR) demonstrated greater likelihood for a trial to be correct following high-load trials versus low-load trials, and a greater likelihood for a trial to be correct following trials with negative distracters versus trials with neutral distracters. d) Previous trial demand effects on current trial accuracy. Odds ratios (OR) demonstrated significantly lower likelihood for trials to be correct following low-load / neutral-distracter trials versus trials following low-load / negative distracter trials, high-load / neutral-distracter trials, and high-load / negative distracter trials. * = $p < 0.05$, ** = $p < 0.01$

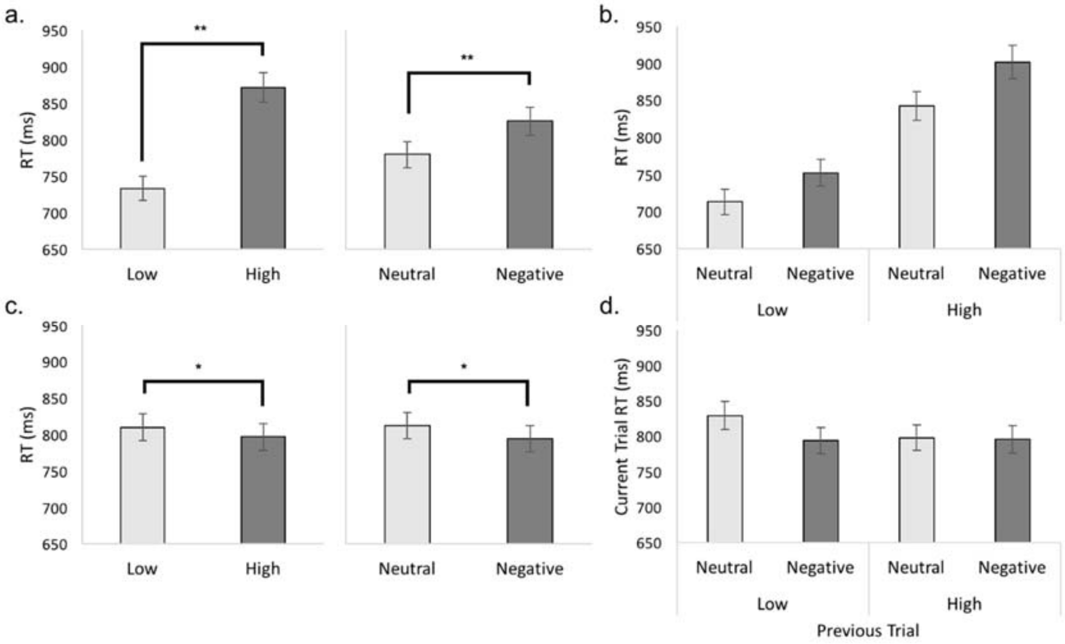

Figure 3. Effects of current and previous trial demand on RT. Raw data plotted as mean RT for all trials collapsed across individuals. a) Current trial main effects of mnemonic load (low, high) and affective interference (neutral, negative). Low-load trials demonstrated faster RTs than high-load trials, and trials with neutral distracters demonstrated faster RTs than trials with negative distracters. b) Current trial demand effects on RT. Low-load / neutral distracter trials showed the fastest RTs, slower RTs for low-load / negative distracter trials and high-load / neutral distracter trials, and slowest RTs for high-load / negative distracter trials. c) Previous trial main effects of mnemonic load (low, high) and affective interference (neutral, negative). Trials following high-load trials demonstrated faster RTs than trials following low-load trials, and trials following trials with negative distracters showed faster RTs than trials following trials with neutral distracters. d) Previous trial demand effects on current trial RT. Trials following low-load / neutral distracter trials exhibited significantly slower RTs than trials following low-load / negative distracter trials, high-load / neutral distracter trials, and high-load / negative distracter trials. * = $p < 0.05$, ** = $p < 0.01$

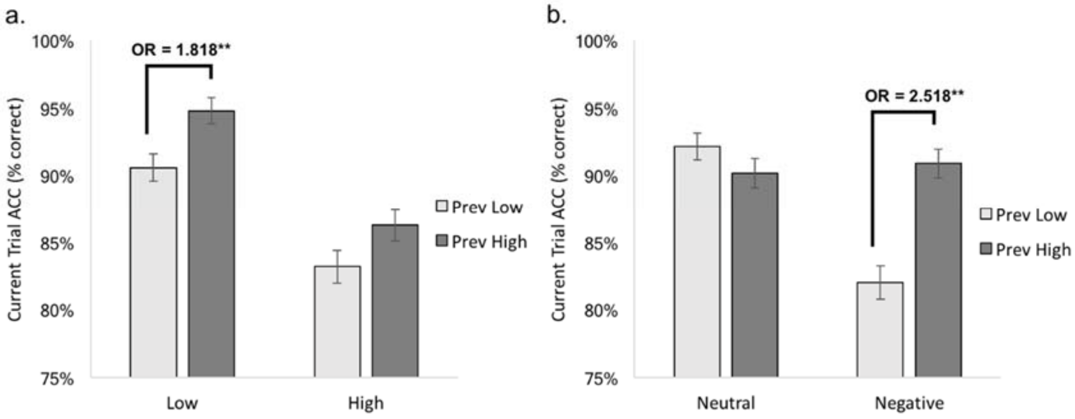

Figure 4. Interactions between current and previous trial demand on accuracy. Raw data plotted as mean percentage correct for all trials collapsed across individuals. a) Current load by previous load interaction. Odds ratios (OR) demonstrated a greater likelihood of current low-low trials to be correct when preceded by high-load trials versus a low-load trials. b) Current affective interference by previous load interaction. Odds ratios (OR) demonstrated a greater likelihood of current trials with a negative distracter to be correct when preceded by high-load trials versus low-load trials. * = $p < 0.05$, ** = $p < 0.01$

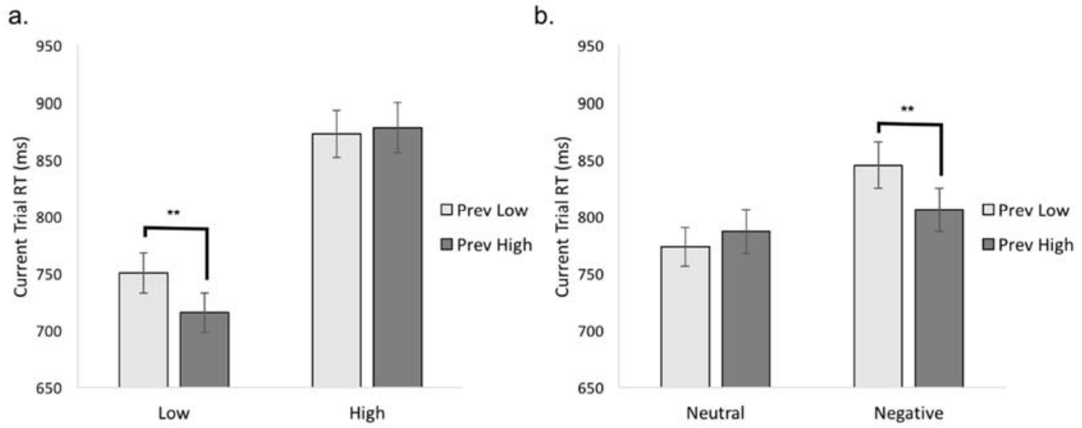

Figure 5. Interactions between current and previous trial demand on RT. Raw data plotted as mean RT for all trials collapsed across individuals. a) Current load by previous load interaction. Low-load trials demonstrated faster RTs when the preceding trial was a high-load trial versus a low-load trial. b) Current affective interference by previous load interaction. Trials with negative distracters showed faster RTs when the preceding trial was high-load trials versus low-load trials. * = $p < 0.05$, ** = $p < 0.01$

Table 1. Aim 1 Task Accuracy

	Log-Odds (*SE*)	
Model Effects	Model 1	Model 2
Fixed effects		
Intercept	2.977 (0.137)**	2.552 (0.149)**
Current Load	-0.747 (0.132)**	-0.757 (0.133)**
Current Interference	-0.372 (0.137)**	-0.393 (0.137)**
Previous Load	-	0.586 (0.110)**
Previous Interference	-	0.514 (0.109)**
Current Load* Current Interference	-0.227 (0.171)	-0.216 (0.172)
Previous Load* Previous Interference	-	-0.365 (0.164)*
Random Effects		
Intercept Variance	0.536	0.547
N_{obs}	6786	6786
Fit statistics		
-2 Log-likelihood	4399.89	4351.39

Note: Estimates are reported as log-odds and standard errors are reported in parentheses. For fixed effects, the *p* values are reported from *t* statistics. * $p < 0.05$, ** $p < 0.01$.

Table 2. Aim 1 Task RT

	Parameter Estimates (*SE*)	
Model Effects	Model 1	Model 2
Fixed effects		
Intercept	711.64 (18.97)**	737.21 (20.12)**
Current Load	136.41 (10.65)**	136.48 (10.66)**
Current Interference	40.48 (10.42)**	41.16 (10.42)**
Previous Load	-	-35.38 (10.55)**
Previous Interference	-	-33.93 (10.55)**
Current Load* Current Interference	13.03 (14.82)	12.73 (14.81)
Previous Load* Previous Interference	-	38.01 (14.82)*
Random Effects		
Intercept Variance	23654	23656
Residual Variance	92964	92802
N_{obs}	6786	6786
Fit statistics		
-2 Log-likelihood	97104.0	97070.3

Note: For fixed effects, the *p* values are reported from *t* statistics. * $p < 0.05$, ** $p < 0.01$.

Table 3: PANAS on Task Accuracy

	Log-Odds (SE)	
Positive PANAS	Model 1	Model 2
Fixed effects		
Intercept	2.553 (0.149)**	2.586 (0.150)**
Current Load	-0.757 (0.133)**	-0.760 (0.133)**
Current Interference	-0.393 (0.137)**	-0.392 (0.138)**
Previous Load	0.586 (0.110)**	0.586 (0.110)**
Previous Interference	0.514 (0.109)**	0.514 (0.109)**
Current Load* Current Interference	-0.216 (0.172)	-0.217 (0.172)
Previous Load* Previous Interference	-0.366 (0.164)*	-0.367 (0.164)*
PrePANAS Pos	0.006 (0.013)	-0.018 (0.017)
Current Load *PrePANAS Pos	-	0.016 (0.011)
Current Interference *PrePANAS Pos	-	-0.002 (0.011)
Previous Load *PrePANAS Pos	-	-0.000 (0.011)
Previous Interference*PrePANAS Pos	-	0.006 (0.011)
Random Effects		
Intercept Variance	0.547	0.548
N_{obs}	6786	6786
Fit statistics		
-2 Log-likelihood	4351.18	4348.95
Negative PANAS	Model 3	Model 4
Fixed effects		
Intercept	2.552 (0.148)**	2.584 (0.150)**
Current Load	-0.757 (0.133)**	-0.788 (0.135)**
Current Interference	-0.393 (0.137)**	-0.423 (0.139)**
Previous Load	0.586 (0.110)**	0.620 (0.111)**
Previous Interference	0.514 (0.109)**	0.506 (0.109)**
Current Load* Current Interference	-0.216 (0.172)	-0.197 (0.173)
Previous Load* Previous Interference	-0.366 (0.164)*	-0.384 (0.164)*
PrePANAS Neg	-0.028 (0.016)	-0.053 (0.022)*
Current Load * PrePANAS Neg	-	0.023 (0.014)
Current Interference *PrePANAS Neg	-	0.023 (0.014)
Previous Load *PrePANAS Neg	-	-0.033 (0.014)*
Previous Interference*PrePANAS Neg	-	0.023 (0.014)
Random Effects		
Intercept Variance	0.519	0.521
N_{obs}	6786	6786
Fit statistics		
-2 Log-likelihood	4348.26	4334.38

Note: Estimates are reported as log-odds and standard errors are reported in parentheses. *p* values are reported from *t* statistics for fixed effects. * $p < 0.05$, ** $p < 0.01$.

Table 4: PANAS on Task RT

	Parameter Estimates (SE)	
Positive PANAS	Model 1	Model 2
Fixed effects		
Intercept	737.21 (20.08)**	737.21 (20.08)**
Current Load	136.48 (10.66)**	136.48 (10.66)**
Current Interference	41.16 (10.42)**	41.16 (10.42)**
Previous Load	-35.38 (10.55)**	-35.38 (10.55)**
Previous Interference	-33.93 (10.55)**	-33.93 (10.55)**
Current Load* Current Interference	12.73 (14.81)	12.73 (14.80)
Previous Load* Previous Interference	38.01 (14.82)*	38.01 (14.82)*
PrePANAS Pos	-2.82 (2.37)	-2.04 (2.58)
Current Load *PrePANAS Pos	-	-0.069 (0.987)
Current Interference *PrePANAS Pos	-	-1.40 (0.987)
Previous Load *PrePANAS Pos	-	-0.587 (0.988)
Previous Interference*PrePANAS Pos	-	0.561 (0.988)
Random Effects		
Intercept Variance	23523	23523
Residual Variance	92802	92819
N_{obs}	6786	6786
Fit statistics		
-2 Log-likelihood	97065.4	97055.4
Negative PANAS	Model 3	Model 4
Fixed effects		
Intercept	737.21 (20.16)**	737.21 (20.16)**
Current Load	136.48 (10.66)**	136.48 (10.65)**
Current Interference	41.16 (10.42)**	41.16 (10.41)**
Previous Load	-35.38 (10.55)**	-35.38 (10.55)**
Previous Interference	-33.93 (10.55)**	-33.93 (10.55)**
Current Load* Current Interference	12.73 (14.81)	12.73 (14.81)
Previous Load* Previous Interference	38.01 (14.82*	38.01 (14.82)*
PrePANAS Neg	-2.44 (3.08)	-2.15 (3.35)
Current Load * PrePANAS Neg	-	-3.06 (1.28)*
Current Interference *PrePANAS Neg	-	0.953 (1.28)
Previous Load *PrePANAS Neg	-	1.36 (1.28)
Previous Interference*PrePANAS Neg	-	0.094 (1.28)
Random Effects		
Intercept Variance	23777	23777
Residual Variance	92802	92754
N_{obs}	6786	6786
Fit statistics		
-2 Log-likelihood	97065.6	97048.9

Note: p values are reported from t statistics for fixed effects. * $p < 0.05$, **$p < 0.01$.

Table 5. Exploratory Current by Previous Trial Interactions

	ACC	RT
	Log-Odds (*SE*)	Parameter Estimates (*SE*)
Model Effects	Model 1	Model 2
Fixed effects		
Intercept	2.682 (0.179)**	737.64 (21.54)**
Current Load	-0.468 (0.177)**	114.54 (15.16)**
Current Interference	-0.819 (0.173)**	62.07 (15.15)**
Previous Load	0.244 (0.185)	-35.54 (15.07)*
Previous Interference	0.581 (0.187)**	-35.50 (14.91)*
Current Load* Current Interference	-0.332 (0.176)	13.05 (14.81)
Previous Load* Previous Interference	-0.402 (0.168)*	39.98 (14.82)**
Current Load* Previous Load	-0.459 (0.176)**	43.68 (14.83)**
Current Interference* Previous Interference	-0.031 (0.169)	3.17 (14.83)
Current Load* Previous Interference	-0.036 (0.171)	-2.13 (14.82)
Current Interference* Previous Load	1.110 (0.170)**	-43.33 (14.83)**
Random Effects		
Intercept Variance	0.559	23658
Residual Variance	-	92613
N_{obs}	6786	6786
Fit statistics		
-2 Log-likelihood	4301.22	97023.8

Note: For accuracy, estimates are reported as log-odds and standard errors are reported in parentheses. For RT, parameter estimates are reported and standard errors are reported in parentheses. *p* values are reported from *t* statistics for fixed effects. * $p < 0.05$, ** $p < 0.01$.