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Working memory capacity and spontaneous emotion regulation:

High capacity predicts self-enhancement in response to negative feedback

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Abstract

Although previous evidence suggests that working memory capacity (WMC) is important for success at emotion regulation, that evidence may reveal simply that people with higher WMC follow instructions better than those with lower WMC. The present study tested the hypothesis that people with higher WMC more effectively engage in spontaneous emotion regulation following negative feedback, relative to those with lower WMC. Participants were randomly assigned to receive either no feedback or negative feedback about their emotional intelligence. They then completed a disguised measure of self-enhancement and a self-report measure of affect. Experimental condition and WMC interacted such that higher WMC predicted more self-enhancement and less negative affect following negative feedback. This research provides novel insight into the consequences of individual differences in WMC and illustrates that cognitive capacity may facilitate the spontaneous self-regulation of emotion.

KEYWORDS: ego threat, emotion regulation, negative feedback, working memory, self-enhancement

Working memory capacity and spontaneous emotion regulation: High capacity predicts self-enhancement in response to negative feedback

Does cognitive ability contribute to emotion regulation? In the present article, we examine the extent to which individual differences in working memory capacity (WMC) facilitate the spontaneous self-regulation of emotion. WMC represents a person's capability to maintain goal-relevant information processing in the face of competing information or other distractions (e.g., Conway et al., 2005). A sizable literature in cognitive psychology reveals that individual differences in WMC reliably predict performance on other "cold" cognitive tasks. For example, WMC predicts reading comprehension (Daneman & Carpenter, 1980) and logical reasoning (Kyllonen & Christal, 1990), among many other cognitive tasks (for a review, see Barrett, Tugade, & Engle, 2004). Research regarding the relationship between WMC and "hot" emotional or motivational processes is rare and generally treats WMC as a dependent variable. For example, stress (Klein & Boals, 2001), stereotype threat (Schmader & Johns, 2003), and prior acts of self-control (Schmeichel, 2007) may temporarily reduce WMC.

Our nascent understanding of the impact of individual differences in WMC on emotional processes is increasing. Recent research has revealed that WMC predicts success at emotion regulation. More specifically, a series of studies by Schmeichel, Volokhov, and Demaree (2008) observed that individuals with higher WMC more capably suppress facial expressions of emotion and more successfully adopt an unemotional attitude while viewing emotionally-charged stimuli. Although the studies by Schmeichel et al. (2008) suggested that high WMC contributes to success at emotion regulation, a more mundane explanation for their results is possible. Because participants in those studies were instructed by the experimenter to regulate their emotional responses, the results may show simply that individuals higher in WMC are more adept at

following instructions. This explanation is consistent with evidence that WMC predicts success at following instructions in a classroom setting (Engle, Carullo, & Collins, 1991). The purpose of the present investigation was to test the hypothesis that WMC contributes to spontaneous emotion regulation (Egloff, Schmukle, Burns, & Schwerdtfeger, 2006; Pu, Schmeichel, & Demaree, in press)—emotion regulation not specifically instructed by the experimenter.

Research in social psychology reveals that most people are motivated to sustain positive self-views most of the time (e.g., Sedikides, Gaertner, & Toguchi, 2003; for a review, see Baumeister, 1998). This motive is manifest in people's responses to failure or other self-relevant negative feedback. People often respond to negative feedback in a defensive or self-enhancing manner. For example, several studies have observed that people respond to negative feedback about important aspects of self by increasing how favorably they view themselves and their own abilities (e.g., Baumeister, Heatherton, & Tice, 1993; Greenberg & Pyszczynski, 1985). Research and theory suggest that self-enhancing responses to negative feedback are a form of emotion regulation; enhancing the self in response to failure may help to maintain psychological equanimity (e.g., Gross & Thompson, 2007; Koole, 2009; Tesser, 2000).

We tested the hypothesis that WMC facilitates self-enhancement and reduces negative affect following negative feedback. In the current study, participants were not instructed how to respond to the negative feedback. Rather, their responses were assessed with a disguised measure of self-enhancement tendencies known as the Over-Claiming Questionnaire (OCQ; Paulhus, Harms, Bruce, & Lysy, 2003). The OCQ provides an objective assessment of the tendency to inflate or enhance oneself by claiming knowledge that one cannot possibly have. Given that people are typically motivated to maintain positive self-views, we reasoned that negative feedback would lead to a self-enhancing response bias (i.e., over-claiming). More importantly,

we predicted that both self-enhancement and negative affect following negative feedback would be moderated by individual differences in WMC, such that higher WMC predicts more self-enhancement and less negative affect. This pattern would support the idea that WMC facilitates spontaneous emotion regulation.

Method

Participants. One hundred two undergraduate students (77 females, 25 males) participated in exchange for partial credit toward a course requirement. Students reported to a laboratory on two separate occasions. Twenty-four additional subjects attended the first session of the study but failed to return for the second session; data from these subjects were excluded from all analyses.

Procedure for Session 1. At the initial session participants completed the Positive and Negative Affectivity Schedules (PANAS; Watson, Clark, & Tellegen, 1988) and a test of working memory capacity. On the PANAS, participants indicated the extent to which they currently felt each of 10 positive (e.g., inspired, excited, proud; $\alpha = .84$) and 10 negative (e.g., upset, distressed, ashamed; $\alpha = .85$) emotional states using a scale from 1 (*very slightly or not at all*) to 5 (*extremely*).

Following the PANAS, participants completed a widely-used measure of working memory known as the operation span task (OSPAN; Turner & Engle, 1989). The OSPAN task measured participants' abilities to maintain information in memory while performing concurrent cognitive operations. One aspect of the OSPAN task required participants to solve mathematical equations. For example, participants saw "(9 X 3) – 1 = 2" and had to indicate whether the given answer was correct. (In the example, the correct answer was "No.") The second aspect of the OSPAN task required participants to read and recall target words. One target word (e.g., *house*)

was presented after each mathematical equation. Thus, participants read an equation, evaluated whether it was correct, read a target word, and then advanced to the next equation, the next target word, and so on. Participants viewed sets of 2, 3, 4, or 5 equation/word pairings before being prompted to recall all the target words in the set. Participants worked through 16 sets totaling 56 equation/word pairings in all, presented in the same order for each participant. Consistent with past work, we operationalized WMC as the number of words comprising only word sets recalled in full (see Conway et al., 2005). WMC scores in the present sample ranged from 4 to 51, and the average score was 19.38 (*SD* = 8.93).

Procedure for Session 2. The second session, held one week after the first, was described as an investigation of the link between emotional intelligence and crystallized intelligence. As part of the cover story, participants were told they would complete both a computer-based measure of emotional intelligence that had been shown to predict emotional well-being and a paper-and-pencil measure of crystallized intelligence that had been shown to predict college grade point average. The experimenter explained that, to minimize any possible order effects, the order in which participants completed the two tests would be determined by the roll of a 6-sided die. Participants rolled the die and then the experimenter pretended to consult a chart to determine which test would be completed first. By design, all participants completed the emotional intelligence test first.

The so-called "MacMillan Lifestyles Test" asked participants twenty multiple-choice questions about their socio-emotional preferences. For example, one question asked, "Which of these characteristics do you find most important in a friendship? A) Understanding; B) Loyalty; C) Similarity; D) Compassion," and another asked, "What would you rather do on a Friday night? A) Go to the movies; B) Go to a party; C) Relax at home; D) Go on a date".

The negative feedback manipulation followed the bogus emotional intelligence test and was based on research on the Barnum effect (e.g., Forer, 1949). Participants were randomly assigned to one of two conditions. In the *no feedback condition*, participants were instructed by the computer screen simply to "Please tell the experimenter that you have completed the test." In the *negative feedback condition*, the computer screen read "Processing. Please wait…" for 12 sec, after which the following text appeared onscreen:

> Your responses indicate that you lack some of the emotional abilities that contribute to psychological well-being. For example, you may have a few close friends at this stage in your life, but if you fail to mature emotionally or change your lifestyle, you may have difficulty maintaining those friendships and are likely to form insecure relations in the future. Your responses indicate that you have a tendency to be egotistical, placing your own needs ahead of the interests of others. Your responses indicate a tendency to overestimate your own importance. The lack of emotional maturity revealed by your responses indicates that you are likely to experience distress (perhaps even depression) when you encounter failure or other hardships that are inevitable in life.

After alerting the experimenter (who was blind to feedback condition) that they had completed the (bogus) emotional intelligence test, participants completed a paper-and-pencil measure that was purported to measure crystallized intelligence. In fact, this was the Over-Claiming Questionnaire (OCQ; Paulhus et al., 2003). The OCQ asked participants to rate their familiarity with a diverse list of people, places, and things using a scale from 0 (*not familiar at all*) to 6 (*completely familiar*). The list included 72 real items (e.g., Mae West, hydroponics) as well as 18 "foil" or fake items that do not actually exist (e.g., Queen Alberta, plates of parallax).

We tallied the hit rate (i.e., proportion of actual items with which the participant claimed some familiarity) and the false alarm rate (i.e., the proportion of foil items which with the participant claimed some familiarity) on the OCQ and plugged them into the two "common-sense" formulas for accuracy and bias recommended by Paulhus and Harms (2004). In the analyses reported below, accuracy represents a difference score (hit rate minus false alarm rate) and self-enhancing response bias represents the yes rate (hit rate plus false alarm rate).[1] We also report and present the results for hit rate and false alarm rate separately.

After the crystallized intelligence test (i.e., the OCQ), participants again completed the PANAS**,** were debriefed about the true purpose of the experiment, probed for suspicion, and dismissed.

Results

Table 1 presents the means and standard deviations for the variables of interest in this study, as well as the simple correlations among them.

Accuracy and bias on the OCQ. We hypothesized that feedback condition would interact with WMC to influence self-enhancement. More precisely, we predicted that participants with higher WMC would exhibit an increase in self-enhancing response bias (i.e., hit rate plus false alarm rate) on the OCQ following negative feedback versus no feedback. This hypothesis was supported by a regression that predicted self-enhancement bias from WMC (centered), feedback condition (coded 0 = no feedback and 1 = negative feedback), and the WMC X Feedback interaction. The predicted interaction effect was significant, $B = 0.02$, $p = .003$. Neither of the main effects approached significance, ps > .35. Repeating the analysis for accuracy on the OCQ (i.e., hit rate minus false alarm rate) revealed no significant effects, ps > .20, as expected.

To better understand the nature of the significant WMC X Feedback interaction effect on self-enhancing response bias, we repeated our regression analysis on the specific components of the bias score, namely false alarm rate and hit rate. For false alarm rate, the WMC X Feedback interaction was significant, $B = .012$, $p = .02$. Please refer to the top half of Figure 1, which depicts the predicted false alarm rate on the OCQ among participants high ($M + 1$ *SD*) and low ($M - 1$ *SD*) in WMC. Analysis of the simple slopes revealed that, as predicted, individuals with higher WMC exhibited an increase in the endorsement of foils following negative feedback relative to no feedback, $B = .12$, $p < .05$. A trend in the opposite direction emerged among individuals with lower WMC. These participants exhibited a decrease in false alarm rate following negative feedback, although the slope of the regression line fell short of statistical significance, $B = -.09$, $p = .14$.

We also regressed the hit rate on the same predictor variables and found a significant WMC X Feedback interaction, $B = .009$, $p = .002$ (please see the bottom half of Figure 1). Simple slopes analyses indicated that participants with lower WMC claimed familiarity with a lower proportion of actual items following negative feedback relative to no feedback, $B = -.10$, $p = .01$, whereas participants with higher WMC claimed familiarity with a similar proportion of real items in the no feedback and negative feedback conditions, $B = .05$, $p = .18$.

Self-reported affect. We examined participants' self-reported affect at the end of Session 2 as a function of self-reported affect at the beginning of Session 1, WMC, feedback condition, and the WMC X Feedback interaction. Regarding PA, the only significant predictor in the regression model was PA at Session 1, $B = .82$, $p < .001$. Regarding NA, we uncovered two effects: NA at the beginning of Session 1 predicted NA at the end of Session 2, $B = .78$, $p < .001$, and, more notably, the WMC X Feedback interaction approached significance in predicting NA

at the end of Session 2, $B = -.25$, $p = .06$. Simple slopes analyses revealed that participants with lower WMC experienced an increase in NA in the negative feedback condition relative to the no feedback condition, $p = .02$, whereas participants with higher WMC experienced no such increase, $p = .77$. Please see Figure 2, which depicts the residual values in NA at the end of session 2 (i.e., NA following the feedback manipulation controlling for NA at the beginning of Session 1). The pattern indicates that participants with higher WMC prevented an increase in NA following negative feedback.[2]

Discussion

Recent research found that higher WMC predicts better suppression of facial expressions and lower self-reported affect among individuals who were directed by an experimenter to regulate their emotions (Schmeichel et al., 2008). The present study found that the link between WMC and emotion regulation does not simply reflect adherence to instructions among higher WMC individuals. Specifically, following negative feedback about their emotional intelligence, participants with higher WMC spontaneously engaged in self-enhancement by reporting greater familiarity with fictitious information relative to participants with lower WMC. Participants with higher WMC also reported lower levels of negative affect following the negative feedback, suggesting that they successfully—and spontaneously—down-regulated their emotional response to the ego threat.

Given that spontaneous, uninstructed emotion regulation is likely to be more prevalent in daily adult life than emotion regulation attempts that are explicitly instructed by another person (e.g., Egloff et al., 2006; Mauss, Bunge, & Gross, 2007), the current results provide valuable evidence that WMC plays a key role in relatively naturalistic forms of emotion regulation. The current research also highlights the value of applying insights from research on individual

differences in cognitive capacity to the realm of emotional responding. The implication is that people who are relatively more adept at juggling multiple streams of information (i.e., those higher in WMC) are more skilled not only at cognitive tasks but also at managing their emotional responses. Put simply, cognitive capacity is important for success at emotion regulation.

In an influential review article, Baddeley (2003) observed that "the link between working memory and 'conative psychology' presents an important challenge" (p. 835). The present study addresses this challenge by finding that people with higher WMC spontaneously and effectively pursue self-enhancement and emotion regulation goals (see also Hofmann, Gschwendner, Friese, Wiers, & Schmitt, 2008). Although self-enhancement may help sustain psychological well-being and motivation in the face of negative feeback (e.g., Taylor & Brown, 1988), note also that it could prove detrimental. For example, inflated views of self are often unseemly to others and can have negative interpersonal consequences (e.g., Heatherton & Vohs, 2000). Perhaps it is most accurate to say that self-enhancement yields a mixture of personal costs and benefits (e.g., Baumeister, 1989; Robins & Beer, 2001). Further research is needed to ascertain the long-term social and emotional consequences of self-enhancing responses to negative feedback among individuals with higher WMC.

The current work focused on spontaneous emotion regulation in the form of self-enhancing responses to self-relevant negative feedback, but emotion regulation may take myriad forms and may be observed in diverse situations. Future studies should examine the relationship between WMC and other forms of emotion regulation, such as attentional deployment and situation selection (Gross & Thompson, 2007). Moreover, future work should examine emotion regulation in other contexts, such as on the job, in stressful performance environments, and in response to other emotionally-charged personal experiences. Such research will help to clarify

the contours of our knowledge of the contributions of cognitive capacity to the spontaneous self-regulation of emotion.

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Footnotes

[1]We observed identical results when using the more complex formulas for accuracy and bias on the OCQ described in Paulhus et al. (2003) and Paulhus and Harms (2004).

[2]NA at the end of Session 2 was not related to self-enhancing response bias on the OCQ. Thus, response bias could not mediate the effect of the WMC X Feedback interaction on NA.