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Mental fatigue impairs emotion regulation

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Abstract

As healthy physical and mental functioning depends on the ability to regulate emotions, it is important to identify moderators of such regulations. Whether mental fatigue, subsequent to the depletion of cognitive resources, impairs explicit emotion regulation to negative stimuli is currently unknown. This study explored this possibility. In a within-subject design over two separate sessions, healthy individuals performed easy (control session) or difficult (depletion session) cognitive tasks. Subsequently, they were presented neutral and negative pictures, with the instructions to either maintain or regulate (i.e., reduce) the emotions evoked by the pictures. Emotional reactivity was probed with the startle reflex. The negative pictures evoked a similar aversive state in the control and depletion sessions as measured by startle potentiation. However, subjects were able to down-regulate their aversive state only in the control session, but not in the depletion session. These results indicate that mental fatigue following performance of cognitive tasks impairs emotion regulation without affecting emotion reactivity. These findings suggest that mental fatigue needs to be incorporated into models of emotion regulation.

Keywords

emotion regulation; mental fatigue; ego depletion; startle

Introduction

Emotion regulation, defined as the processes by which individuals influence their emotions (Rottenberg and Gross, 2003), is adaptive and a part of everyday life (Gross et al., 2006). The ability to regulate emotion is essential for healthy physical and mental functioning (Fernandez and Turk, 1989; Gross and Munoz, 1995). Conversely, most psychiatric problems manifest perturbations in emotion regulation, which can result in excessive emotional arousal, and intrusive thoughts and urges (Amstadter, 2008; Gross and Munoz, 1995). Mechanisms behind such perturbations are not well understood, but have been linked to executive control mechanisms (Hofmann et al., 2012). Moreover, emotion regulation is effortful and drains cognitive resources (Schmeichel, 2007). The present study explored the

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untested hypothesis that mental fatigue diminishes subsequent ability to explicitly regulate emotion.

Executive control mechanisms are a constellation of cognitive operations required to execute goal-directed behaviors (Miyake et al., 2000). They are used to regulate automatic thoughts and actions (Hofmann et al., 2012), as well as emotion (Opitz et al., 2012; Schmeichel, 2007). These control mechanisms are effortful (Opitz et al., 2012) and utilize resources, which are overall limited (Baumeister et al., 1998; Hagger et al., 2010). Like a muscle that has been used extensively and become fatigued, executive control operations can deplete resources following sustained engagement, undermining their subsequent use for cognitive performance (Baumeister et al., 1998; Hagger et al., 2010). Indeed, performance of difficult cognitive tasks has been shown to impair the ability to perform well on subsequent cognitive tasks (Schmeichel, 2007). Because emotion regulation requires effortful cognitive control to override inappropriate innate or habitual responses to affective stimuli (Hofmann et al., 2012), these results raise the possibility that mental fatigue, subsequent to resource depletion, could also impair emotion regulation. This possibility relies on at least two assumptions. First, executive control mechanisms have to cut across cognitive and emotional domains. While there is evidence for domain-general control mechanisms (Hagger et al., 2010), this view might be challenged by data showing distinct neural substrates underlying cognitive vs. emotional control (i.e., dorsolateral prefrontal cortex vs. orbitofrontal cortex, respectively) (Shimamura, 2000). Second, depletion needs to outlast the initial resource-consuming task and persist during the subsequent attempt at emotion regulation (Baumeister and Heatherton, 1996).

Regarding the resources devoted to cognitive vs. emotion control, evidence shows that they share the same limited capacity, suggesting that depletion in one domain can affect performance in the other domain. For example, controlling one's emotions can impair performance on subsequent cognitive tests: individuals asked to inhibit their emotion (e.g., while watching aversive clips) showed subsequent performance impairment on various cognitive tasks (Baumeister et al., 1998). However, *critically*, whether the converse is true, i.e., whether cognitive depletion impairs emotion regulation, remains to be determined as research on this topic is scarce with unclear results (e.g., Wagner & Heatherton, 2013). One issue is that of the heterogeneity of emotion regulation. Emotion regulation can rely on behavioral (e.g., suppression of facial expression) or cognitive (e.g., reappraisal) strategies (Gross and Thompson, 2007). One study found that resources depletion via working memory reduced facial expression of emotion, but without affecting self-reports of emotional feelings (Schmeichel, 2007). Another study reported a decrease in amygdala response to negative emotional pictures after cognitive depletion via an inhibition task, but without explicit instructions to down-regulate emotion (Wagner and Heatherton, 2013). Decreased amygdala activation was interpreted to reflect emotion down-regulation. However, there was no objective (physiological) or subjective (ratings) measure of emotion, which prevents any clear functional interpretation of the results as reduced amygdala activation does not provide evidence of emotional down-regulation (see problem of reverse inference (Poldrack, 2006)). In addition, this study did not investigate explicit emotion regulation (e.g., reappraisal), which may require more control and, thus, may be more vulnerable to the effect of resource depletion.

Taken together, the literature on the influence of resource depletion by cognitive tasks on emotion processing and regulation is in its infancy, albeit with encouraging but inconclusive results. To date, whether cognitive depletion affects explicit emotion regulation based on cognitive strategy is not known. The present study was designed to address this question using state-of-the-art methodologies, one for emotion induction, exposure to the International Affective Picture System (IAPS) (Lang et al., 1994), and the other for emotion measurement, the startle reflex (Lang et al., 1990). The startle reflex is a reliable measure of aversive states (Grillon and Baas, 2003; Lang et al., 1994). It is potentiated by threat cues and negative stimuli, and can be modulated by regulation strategies (Jackson et al., 2000; Lissek et al., 2007). We hypothesized that resource depletion would weaken emotion regulation. Hence, we predicted that startle would be potentiated by the negative pictures compared to the neutral pictures in the non-regulated condition and that this startle potentiation would be reduced by emotion regulation. The specific hypothesis was that the ability to reduce startle potentiation during emotion regulation would be diminished by resource depletion.

Materials and Methods

Sample

Thirty four healthy volunteers participated in the study, which consisted of two experimental sessions on separate days. Four participants did not return to the second session. The data of two additional participants were not included in the final analysis because of small or no startle responses. The data analysis was conducted on 28 subjects (mean age 27.2 (SD 6.2); N=14 female). Inclusion criteria were: no past or current psychiatric disorders according to the Structured Clinical Interview for DSM-V (SCID-I/P) (First et al., 2002), no medical conditions that interfered with the objectives of the study as established by a physician, and no use of illicit drugs or psychoactive medications according to history and confirmed by a negative urine screen. All participants gave written informed consent approved by the National Institute of Mental Health (NIMH) Human Investigation Review Board.

Procedure

The study consisted of two experimental sessions, a depletion session and a control session, separated by 1-3 weeks. For half the participants, the depletion and control sessions took place on the first and second visit, respectively. For the other half participants, this order was reversed.

The two sessions were similar except for the depletion tasks (see below). Shortly after their arrival in the laboratory, subjects were asked to complete a mood questionnaire. The eyeblink electrodes were then attached under one eye, after which nine startle stimuli were delivered, one every 18–25 s, to habituate the startle response. Next, subjects performed the cognitive depletion or control tasks. This was followed by an assessment of emotional reactivity and emotional regulation to IAPS pictures using the affective modulation of startle methodology (Lang et al., 1990).

Resource depletion tasks

Two tasks were selected because they are frequently employed in depletion studies and require significant effort to maintain a high level of executive functioning (Hagger et al., 2010). Both tasks used paper and pencil. The first, derived from (Schmeichel, 2007), lasted 6 min. In the depletion session, participants were asked to copy a text omitting the letters ‘a,’ ‘e,’ and ‘i.’ Given that many words contain these three letters, this task requires substantial control. In the control session, the task was simply to copy the text. The second task lasted 4 min and consisted of a series of mental calculations (additions, subtractions, multiplications, and divisions). The calculations consisted of 1- to 3-digit numbers and up to three levels of calculation (e.g., 345 – 127 × 6) in the resource depletion session, and 1- and 2-digit numbers and two levels of calculations (e.g., 12 + 7) in the control session. This task was also selected because of its reliance on working memory, which taxes cognitive control, and is necessary for emotion regulation (Andreotti et al., 2013; Hofmann et al., 2012; Pe et al., 2013). Task duration was selected to be consistent with prior depletion studies (Hagger et al., 2010). Most resource-depletion tasks are relatively short (3-20 min), and although task duration affects depletion, it accounts for very little of the variance in the degree of depletion (Hagger et al., 2010). The subjects were alone in the room when performing the cognitive and emotion regulation tasks but were observed via a video camera.

IAPS pictures

Eighteen neutral (# 6150, 7000, 7004, 7006, 7009, 7010, 7025, 7030, 7050, 7090, 7100, 7140, 7150, 7175, 7211, 7190, 7560, 7235) and sixteen negative (1019, 1050, 1120, 1300, 3030, 3071, 3100, 3181, 3530, 3550, 6230, 6250, 8230, 9181, 9570, 9561) pictures were selected from the IAPS (Lang et al., 1994). The negative pictures included dangerous (e.g., snakes) or dead animals, guns, and bloody scenes. They were used in both sessions. The normative valence and arousal ratings were 4.9 and 2.9 for the neutral pictures, and 2.6 and 6.2 for the negative pictures, respectively (9-point scale; lower scores indicate increased negative valence and lower arousal ratings).

Affective modulation of startle

The affective modulation of startle test consisted of two blocks with each block containing the 34 pictures each shown for 7 sec. Each block started with two neutral pictures not included in the analysis. Next, the pictures were presented pseudo-randomly every 23 to 29 sec. Half the pictures of a valence category were associated with the instructions to maintain emotion and the other half with the instructions to reduce emotion. Pictures that were associated with one type of instructions (e.g., maintain) in one block were associated with the alternative instructions in the other block (e.g., decrease). In each block, no more than two pictures of the same valence or instructions (maintain, decrease; see below) were presented in succession. In addition, each group of 8 successive pictures contained the same number of neutral and negative pictures. The order of stimulus presentation in the second block was the reverse of the first block presentation.

Emotion regulation instructions

The words “maintain” or “decrease” were presented for 3 sec just prior to the presentation of each picture. Subjects were told that, during the maintain regulation condition, they had to respond naturally to the pictures and that, during the decrease regulation condition, they had to reduce whatever emotional response was evoked by the pictures using a regulation strategy they thought was most effective (Dillon and LaBar, 2005). They were given an example of regulation strategy, reappraisal, in which they could imagine that the pictures were a part of a movie. Subjects were also told that they should not look away from the pictures or close their eyes.

Startle stimulation and startle recording

Startle stimulation and recording were controlled by a commercial system (Contact Precision Instruments, UK). The acoustic startle stimulus was a 40ms duration 103-dB (A) burst of white noise presented through headphones. The eyeblink reflex was recorded with electrodes placed under the left eye. The electromyographic (EMG) signal was amplified with bandwidth set to 30–500 Hz and digitized at a rate of 1000 Hz. The signal was rectified and smoothed offline by using a 10-point moving average.

Nine startle stimuli were delivered before resource depletion to acquaint subjects with the startle sound. Each affective modulation block started with four startle stimuli to further habituate initial startle reactivity. Startle stimuli were then delivered during presentation of each picture either 4 sec or 6 sec after picture onset, with order counterbalanced across picture valence and instructions.

Questionnaires

Subjects completed questionnaires assessing their negative mood (Positive and Negative Affect Scale; PANAS (Watson et al., 1988)) shortly after their arrival, after the cognitive tasks, and after each IAPS block (for a total of four ratings). Subjects were asked to rate how difficult and exhausting they found the cognitive tasks on an analog scale ranging from 1 (not at all) to 7 (very).

Data reduction and statistical analysis

Following rectification and smoothing of the electromyographic signal, peak startle/eyeblink magnitude was determined in the 20–100-ms timeframe following stimulus onset relative to a 50-ms pre-stimulus baseline. Trials were discarded when baseline electromyographic activity exceeded two standard deviations of the mean activity of the subject’ trials. Less than 2% of the trials were discarded based on this criterion. The startle magnitude scores were standardized in t-score and then averaged within sessions (depletion, control), IAPS valence (neutral, negative), instructions (maintain, decrease), and across blocks. Data were analyzed with repeated measures analyses of variance (rANOVAs) and t-tests. Greenhouse–Geisser (GGε) correction was used where appropriate. The *a priori* hypothesis was that mental fatigue would diminish subjects’ ability to reduce their emotional reactivity to the negative pictures. We predicted that emotion down-regulation (decrease regulation condition) would reduce startle potentiation to the negative pictures in the control session and that this down-regulation would be reduced in the depletion session.

Results

Self-reports and manipulation check

Positive and negative mood were analyzed separately using a session (control, depletion) x time (baseline, post-cognitive tasks, post-IAPS blocks 1 and 2) rANOVA. Positive mood decreased over time (time: $F(3,81)=20.1$, $p<.0009$, GGε = .66, $\eta^2=.42$; time linear trend; ($F(1,27)=32.5$, $p<.0009$), with no difference between session (session x time: $F(3,81)=.6$, ns, $\eta^2=.02$). Negative mood increased over time (time: $F(3,81)=6.4$, $p<.002$, GGε = .78, $\eta^2=.19$; time linear trend; ($F(1,27)=6.8$, $p<.0009$). The changes in negative mood differed between the two sessions (session x time: $F(3,81)=2.9$, $p<.05$, $\eta^2=.09$; session x time linear trend: $F(1,27)=5.9$, $p<.02$) due to a slight but significant higher negative mood in the depletion session compared to the control session at baseline 11.3 (sd = 2.5) and 10.6 (sd = 1.2), respectively; $F(1,27)=4.8$, $p<.04$, $\eta^2=.14$), but not subsequently.

Compared to the control tasks, the depletion tasks were rated as more difficult ($t(27)=8.0$, $p<.0009$; 4.3 (sd = 1.7) and 1.7 (sd = .8), respectively) and leading to greater exhaustion ($t(28)=4.1$, $p<.0009$, $\eta^2=.44$; 3.1 (sd = 1.6) and 1.8 (sd = .8), respectively). Thus, the resource depletion manipulation was successful.

Startle Reactivity

Table 1 presents startle magnitudes during the viewing of the pictures. The results were analyzed using a session (control, depletion) x valence (neutral, negative) x regulation (maintain, decrease) x order (depletion 1st session, depletion 2nd session) rANOVA. As expected, there was a valence main effect ($F(1,26)=11.4$, $p<.002$, $\eta^2=.30$) due to an overall startle potentiation by the negative pictures compared to the neutral pictures. The valence x regulation was significant ($F(1,26)=23.8$, $p=.0009$, $\eta^2=.47$) as was the session x valence x regulation interaction ($F(1,26)=4.4$, $p<.05$, $\eta^2=.14$). This 3-way interaction was consistent with our three predictions (see end of Introduction). The first prediction (manipulation check) was that startle would be potentiated by the negative pictures compared to the neutral pictures in the maintain regulation condition in both the control and depletion sessions. Paired t-tests confirmed that during the maintain regulation condition, startle magnitude was potentiated during the negative pictures compared to the neutral pictures in the control session ($t(27)=5.6$, $p<.0009$, $\eta^2=.54$) and in the depletion session ($t(27)=2.6$, $p=.01$, $\eta^2=.20$). Comparison of startle potentiation to the negative pictures (relative to neutral pictures) in the control and depletion condition showed no significant differences ($F(1,27)=1.8$, ns, $\eta^2=.06$).

To address the second prediction – that startle potentiation during the negative pictures would be reduced in the decrease regulation condition in the control session – and, more importantly (main hypothesis) – that the ability to down-regulate would be impaired (reduced) in the depletion session - we calculated startle potentiation scores - startle magnitudes during negative pictures minus startle magnitude during neutral pictures – for each condition. We entered these startle potentiation scores into a session (control, depletion) x regulation (maintain, decrease) rANOVA. The results showed a significant session x regulation interaction ($F(1,27)=4.6$, $p=.04$, $\eta^2=.17$), which was due to greater down-regulation in the control session compared to the depletion session (Fig. 1). In fact, the maintain/decrease comparison (down-regulation) was highly significant in the control session ($t(27)=4.2$, $p<.0009$, $\eta^2=.39$), but missed significance for the depletion session ($t(27)=1.9$, $p=.07$, $\eta^2=.11$). These results confirmed that down-regulation to the negative pictures was less efficient in the depletion compared to the control condition.

A post-hoc finding was that startle to the neutral pictures was significantly *increased* by regulation in both the control and depletion sessions ($F(1,27)=7.0$, $p=.01$, $\eta^2=.20$) without regulation difference between sessions ($F(1,27)=.00009$, ns, $\eta^2=.000006$. Finally, the order in which the depletion session was conducted (1^{st} or 2^{nd} session) did not influence the regulation effect. Specifically, the session x valence x regulation x order interaction was not significant ($F(1,26)=.004$, ns, $\eta^2=.009$).

Discussion

Adaptive behavior requires emotion regulation. Failure to regulate emotion can have dire consequences for mental and physical health (Fernandez and Turk, 1989; Gross and Munoz, 1995). It is therefore crucial to identify moderating factors of regulation. The present results support the hypothesis that because emotion regulation requires cognitive resources (Ochsner et al., 2012), prior consumption of such resources impairs later regulation. Draining cognitive resources weakened emotion regulation (during the “decrease” condition) without affecting emotion reactivity (during the “maintain” condition); the depletion and control sessions were associated with similar increase in startle potentiation to the negative pictures, suggesting that depletion did not affect emotional reactivity. However, this startle potentiation was reduced during regulation in the control session but not in the depletion session. These findings indicate that mental fatigue needs to be included in models of emotion regulation.

As expected, startle magnitude was increased during the viewing of negative pictures compared to neutral pictures, reflecting the facilitation of defensive reflexes due to activation of aversive states (Lang et al., 1990). This effect was obtained in both the control and depletion sessions without significant difference between the two sessions. As expected (Jackson et al., 2000), startle potentiation to the negative pictures was reduced during emotion regulation in the control session. Such a down-regulation was not found in the depletion session. These results are consistent with the view that increased engagement of cognitive resources during difficult tasks carries over and impairs regulatory processes via exhaustion of these resources (Baumeister and Vohs, 2007). The deficits in emotion regulation in the depletion session, compared to the control session, cohere with the perception that the depletion tasks were more difficult and required greater effort, leading to higher exhaustion. A recent meta-analysis concluded that resource depletion is robust and has similar effects across different types of cognitive tasks (Hagger et al., 2010), probably because depletion acts on a common pool of resources used by these tasks (Lorist et al., 2000; van der Linden et al., 2003). A prior study reported that depletion weakened the ability to regulate facial expression of emotion (Schmeichel, 2007). The novel finding reported here is that cognitive depletion can disrupt subsequent emotion regulation of an aversive state. Cognitive emotion regulation requires overriding the innate and dominant tendency to generate emotions to affective stimuli. Such a process necessitates the expenditure of effortful control mechanisms, which, as the present study indicates, are weakened by prior cognitive performance.

Emotion regulation was disrupted by depletion, but this disruption did not extend to emotion reactivity. Implicit and explicit self-regulation mechanisms are believed to operate whenever emotion is generated (Davidson, 1998). According to this view, one may expect that mental fatigue would increase emotion generation because of poor self-regulation. This would be consistent with the claim of increased amygdala reactivity to negative pictures after mental fatigue without explicit instructions to regulate emotion (Wagner and Heatherton, 2013). However, we did not observe any significant difference in startle potentiation to the negative pictures in the maintain condition of the depletion session compared to the control session. Self-regulation without instructions to regulate emotion may be more resistant to mental fatigue than instructed regulation.

Two main alternative psychological explanations for the depletion effect have been proposed. First, difficult tasks can lead to frustration and anger, which may evoke a negative mood that could interfere with subsequent performance. Such a negative mood has been noted in a few studies (Ciarocco et al., 2001), but not in most (Baumeister et al., 1998; Bruyneel et al., 2009). This explanation does not seem to apply. Self-reports of positive mood decreased and negative mood increased with time, but these two measures did not differ between the two control and depletion sessions. Second, mental fatigue could lead to decreased motivation to perform well (Muraven and Slessareva, 2003), raising the possibility that a lack of motivation caused poor emotional regulation in the depletion session. However, it has been argued that a motivational account of depletion-induced performance impairment is consistent with a mental fatigue interpretation of the results. Accordingly, motivation and fatigue are inter-dependent (Muraven and Baumeister, 2000). Subjects may lose their motivation because the cost of performing the task may devaluate the importance of the task. Future studies should investigate whether poor emotion regulation following mental depletion is caused by a lack of motivation, for example, by providing various degrees of incentives for task performance (e.g., by stressing the benefit of the task (Muraven and Slessareva, 2003), or by providing monetary incentives).

We unexpectedly found that the startle to the neutral figure was increased during the decreased regulation condition. Other studies did not find such an effect (e.g., (Dillon and LaBar, 2005; Ray et al., 2010) or did not use instructions to decrease emotion with the neutral pictures (Jackson et al, 2000). Our objective was to assess any potential nonspecific effect of emotion regulation on startle. However, one may wonder what subjects were doing to decrease presumably a non-existing emotion. A tentative explanation to explain this finding is that reappraising has potentially two effects. First, it increases arousal because the subjects becomes more cognitively active and, second, it affects valence according to the instructions (reduce or increase). In the context of neutral pictures, only arousal is at play, which results in a slight increase in startle. In the context of negative pictures, the reduction in startle potentiation overwhelms the slight potentiation due to arousal, resulting in a net decrease in startle potentiation.

The present results contribute importantly in identifying a factor – mental fatigue - that plays a key role in emotion regulation, but they also raise important questions. The study focused on down-regulation of negative emotion because pro-hedonic regulatory goals (e.g., “decrease negative”) is clinically relevant (Fernandez and Turk, 1989; Gross and Munoz, 1995). However, one may wonder whether depletion also affects up-regulation of emotion and whether the results extend to positive emotion. Because contra-hedonic regulatory goals (e.g., “increase negative”) are more difficult to achieve than pro-hedonic regulatory goals (Riediger et al., 2011), it is possible that the former goals are more likely to be disrupted by depletion than the latter goals. Regarding the valence of emotion, we do not make any claim as to the specificity of the depletion effect to regulation of negative affect. It is likely that depletion also disrupts regulation of positive emotion, given that such regulation also relies on control resources (Hofmann et al., 2012). Because poor control of positive emotion can lead to debilitating impulses and urges (e.g., drug addiction, risk-taking behaviors, depressive symptoms (Baumeister and Vonasch; Fussner et al., 2014)), understanding the effect of depletion on positive emotions and reward processing will be an important question for future studies.

The strengths and limitations of the study should be discussed. Among the strengths, robust and well-established methodologies were used, including the affective modulation of the startle, an objective physiological measure of emotion. The study showed clear and unambiguous evidence that emotion was expressed and regulated. Among the limitations is the fact that subjects were not instructed to use a specific regulation strategy. It is therefore unclear which regulation strategies are vulnerable to depletion. Exit interviews suggested that the two most common strategies used were thinking about something else, and reappraisal. These regulation strategies may involve distinct neural networks that could be differently impacted by resource depletion (Hartley and Phelps, 2010; McRae et al., 2009). However, in this initial study we thought it was preferable for each subject to select their own strategy to ensure robust regulation. To conclude, this study found that mental fatigue weakened emotion regulation. This finding has important theoretical and mental health implications; this result is consistent with the view that higher levels of cognitive resources are required for successful emotion regulation (Opitz et al., 2012) and that depletion of such resources can impair healthy emotion functioning. They indicate that individuals’ ability to regulate emotion is not constant but vary with prior mental effort. Hence, successful emotion regulation depends not only on individual differences in executive capacity but also on the extent to which these resources get exhausted and recover overtime. It will be important to identify factors that lead to or protect against the negative impact of depletion on emotion. Periods of rest (Tyler and Burns, 2008) and taking fuel (e.g., glucose) (Gailliot et al., 2009) are associated with less disruptive effects of depletion on subsequent cognitive performance. Similar approaches may also prevent poor emotion regulation. Furthermore, it is important to identify other affective or cognitive processes vulnerable to depletion. Healthy functioning requires coping with stress and the ability to alter behavioral tendencies and urges (e.g. to refrain from smoking). These control mechanisms of behaviors require mental efforts and may also be impaired by depletion.

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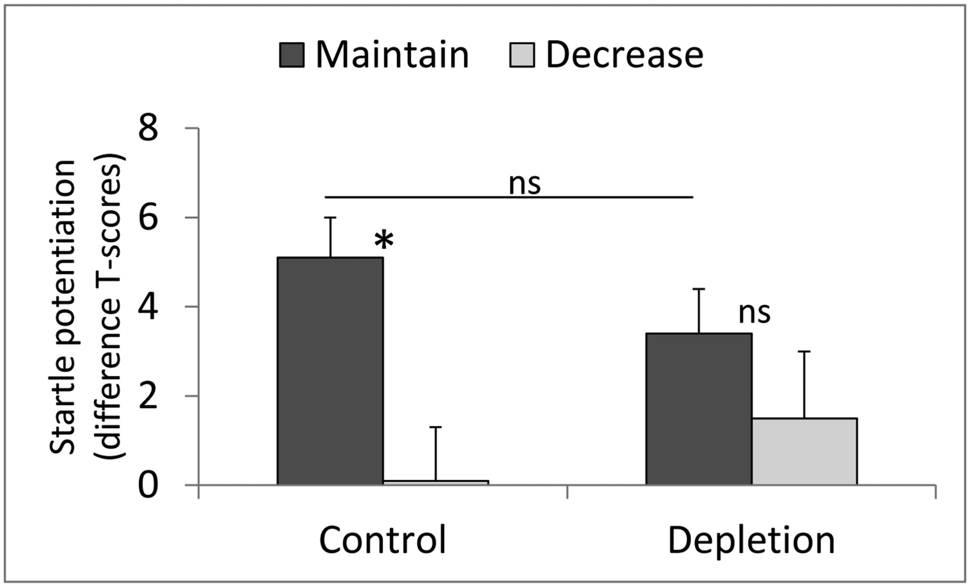

Figure 1.
Startle potentiation (difference startle magnitude scores negative minus neutral) in the *maintain* and *decrease* conditions in the depletion and control sessions. The error bars are standard errors of the mean. * for significant difference at p<.01; ns for non-significant.

Table 1

Startle (eyeblink) magnitude (mean (SEM) T-scores) during the viewing of neutral and negative pictures in the *maintain* and *decrease* conditions of the depletion and control sessions.

	Control		Depletion	
	Maintain	**Decrease**	**Maintain**	**Decrease**
Neutral pictures	46.8 (0.7)	48.3 (1.0)	45.0 (1.0)	46.8 (0.8)
Negative pictures	51.9 (1.2)	48.4 (1.0)	48.4 (1.1)	48.3 (1.0)