



Better regulatory performance without greater cognitive resource expenditure: The effect of motivational states on self-regulation



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ABSTRACT

Although studies have shown better self-regulation for participants in promotion versus prevention-focused states, there remains debate as to whether better regulatory performance requires more cognitive resources. In this study, participants performed a colour-word Stroop task in different motivational states and reported their cognitive effort in Experiment 1, and engaged in a subsequent spatial-word Stroop task to measure their ego depletion in Experiment 2. Results showed that participants in promotion focus neither reported more cognitive effort in Experiment 1 nor suffered worse ego depletion in Experiment 2 than participants in prevention focus. Additionally, the two experiments consistently showed better self-regulation in promotion than prevention focus with no difference in interference effects. This study suggested that self-regulation execution was more effective in promotion than prevention-focused states without greater cognitive resource expenditure, and that increased capacity for conflict identification rather than conflict resolution could account for our findings.

1. Introduction

Self-regulation is the self's capacity to adaptively change and adjust thoughts, emotions, and behaviours for goal attainment (Baumeister, 2014; Baumeister & Vohs, 2007; Hofmann, Schmeichel, & Baddeley, 2012). People higher in self-regulation are more likely to aim at desirable goals and avoid undesirable consequences, present better adaptability in general life domains (Tangney, Baumeister, & Boone, 2004), and experience more affective well-being (Hofmann, Luhmann, Fisher, Vohs, & Baumeister, 2014). A meta-analysis of 102 studies (de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012) showed that self-regulation was related to a wide range of behaviours, including but not limited to school and work performance, eating and weight-related issues, sexual behaviour, addiction, interpersonal functioning, affect regulation, well-being and adjustment, deviant behaviour, and planning and decision-making. As the resource model posits, self-regulation depends on limited cognitive resources (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Muraven & Baumeister, 2000) and is determined by the amount of allocated cognitive resources (Beedie & Lane, 2012). Motivation is a key factor affecting cognitive resource allocation in exerting self-regulation (Baumeister & Vohs, 2007; Hofmann

& Kotabe, 2012; Muraven, Shmueli, & Burkley, 2006). Researchers have proposed that insufficient or reduced task motivation often results in failure in regulatory tasks, even if people have sufficient cognitive resources (Inzlicht, Schmeiche, & Macrae, 2014; Inzlicht & Schmeichel, 2012), and that increased task motivation could improve self-regulation to a certain extent (Muraven & Slessareva, 2003; Vohs, Baumeister, & Schmeichel, 2012).

However, there are two motivational states leading people to exert self-regulation: promotion focus and prevention focus. Higgins (1997) proposed that nurturance needs, strong ideals, and situations involving gain–nongain would induce promotion focus, and that security needs, strong responsibility, and situations involving nonloss–loss would induce prevention focus. People in a promotion focus are concerned with the regulation of desired outcomes; therefore, they prefer to improve the status quo through eagerness strategies and approach-related behaviours. In contrast, people in prevention focus are concerned with the regulation of aversive end states; therefore, they prefer to maintain the status quo through vigilance strategies and avoidance-related behaviours to avoid negative outcomes (Crowe & Higgins, 1997).

Some studies have shown better self-regulation in promotion than prevention-focused states. For example, Crowe and Higgins (1997)

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found that participants who performed regulatory tasks to perform a liked task (promotion-focused state) both had better regulatory performance after experiencing failure and persisted longer in difficult tasks, unlike participants who performed regulatory tasks to avoid a disliked task (prevention focused state). Similarly, Dholakia, Gopinath, Bagozzi, and Nataraajan (2006) found that dieting undergraduates primed in promotion focus were better able to refrain from high-calorie tasty food than those primed in prevention focus, while Newheiser, Barreto, Ellemers, Derks, and Scheepers (2015) found that stigmatized participants in the promotion-focused group (who were instructed to promote a positive impression by concealing their identity) performed much better in hiding a stigmatized identity in social interactions than those in the prevention-focused group (who were instructed to prevent a negative impression by concealing their identity).

Why do people have better self-regulation in promotion than prevention-focused states? More cognitive resource investment in promotion-focused states is a common intuitive explanation under the accounts of the self-regulation resource model (Beedie & Lane, 2012) and the effort-based decision-making model (Kool & Botvinick, 2014). As cognitive effort is fundamentally implicated in the decision to invest cognitive resources by mediating the behavioural or physiological consequences of motivation (Westbrook & Braver, 2015), people are inclined to allocate more cognitive effort to items of higher value (Shenhav et al., 2017). Brodscholl, Kober, and Higgins (2007) found that participants in a promotion-focused state valued the outcome of an attainment task more than participants in a prevention-focused state; some researchers also found a more positive goal pursuit experience in a promotion than a prevention-focused state even if the end consequences were the same (Idson, Liberman, & Higgins, 2000; Ouyang, Zhu, Fan, Tan, & Zhong, 2015), indicating higher intrinsic value. Based on this evidence, people in a promotion-focused state may be more willing to expend cognitive effort in exerting self-regulation.

However, some research suggests that better self-regulation does not require more cognitive resources. First, some regulatory strategies or methods were more effective than others without greater cognitive resources expenditure. For example, Magena, Kimb, Dweckb, Grossb, and McClure (2014) found that people would increase rational choices in inter-temporal decision-making without additional willpower expenditure when the choice presentation is changed from a traditional hidden-zero format to an explicit-zero format. Some studies also found that the regulatory strategies of avoiding conflicts were more effective than those of resolving conflicts without requiring greater cognitive effort (Gillebaart & Ridder, 2015). It is likely that the regulatory strategies or methods in promotion-focused states are more effective than those in prevention-focused states. Additionally, Trawalter and Richeson (2006) found that participants who were told to seek a positive interracial exchange (promotion-focused group) suffered less ego depletion in refraining from bias in interracial interactions than those told to avoid prejudice (prevention-focused group); researchers also found that people pursuing avoidance often presented a self-regulatory vulnerability over time (Oertig et al., 2013), and that they were more cognitively depleted after exerting cognitive effort than those with approach goals (Roskes, Elliot, Nijstad, & De Dreu, 2013). Together, this indicates that the cognitive resource consumption in exerting self-regulation is not greater in a promotion than a prevention-focused state.

This study consisted of two experiments designed to further explore whether better performance in a promotion-focused state costs more cognitive resources. In Experiment 1, all participants completed a colour-word Stroop task in three randomly arranged motivational states of promotion focus, prevention focus, or a neutral state, and reported their respective cognitive efforts. We assumed that if greater cognitive resource allocation was the reason for better self-regulation, then participants in the promotion-focused state should pay more cognitive effort. In Experiment 2, two groups of participants performed a colour-word Stroop task in a promotion or prevention-focused state and then completed a spatial-word Stroop task without motivational operation.

The phenomenon of ego depletion shows that if greater cognitive resources are expended in a regulatory task, then there would be worse task performance in a subsequent unrelated regulatory task due to decreased cognitive resources (Baumeister et al., 1998; Muraven & Baumeister, 2000) or shifted task motivation (Inzlicht et al., 2014; Inzlicht & Schmeichel, 2012). Thus, we assumed that if participants in a promotion-focused state allocated more cognitive resources to the target task, then they would perform worse on subsequent tasks.

2. Experiment 1

2.1. Methods

2.1.1. Participants and procedures

A total of 42 undergraduates (18 male; mean age = 20.62 years, $SD = 1.60$) participated in the experiment. The experiment had a 3 (motivational states: promotion focus, prevention focus, and neutral state) \times 3 (stimulus types: consistent word response, inconsistent word response, and inconsistent colour response) within-subjects design. All participants had to complete a colour-word Stroop task with three types of randomly arranged stimuli in three randomly arranged blocks, where each block presented one motivational state. Participants were informed that they could earn 10 RMB in addition to their 10 RMB show-up fee if their total scores were no < 100 points. After 24 practice trials, participants proceeded to the formal task and reported their cognitive effort after each block. Finally, participants completed a questionnaire on their demographic information.

2.1.2. Measures

2.1.2.1. Colour-word Stroop task. We adopted a modified colour-word Stroop task, in which a colour word, 'red' or 'blue', was printed in red or blue and encircled by either a full or dotted black circular ring. The ring acted as a cue for responding to the meaning or colour of the word. Specifically, for the full ring, participants responded to the meaning by pressing 'F' or 'J' key for 'red' or 'blue', respectively, while for the dotted ring, they responded to the colour by pressing 'F' or 'J' key for the red or blue colour, respectively. The task contained three random blocks, each with 120 randomly arranged stimuli: 40 meaning-colour-consistent words with a full circle (consistent word response), 40 meaning-colour-inconsistent words with a full line (inconsistent word response), and 40 meaning-colour-inconsistent words with a dotted line (inconsistent colour response). There was a one-minute between-block interval. In each trial, a fixation cross (+) appeared for 500 ms at the centre of the computer screen, followed by a 100-ms blank screen, and then a 1000-ms target stimulus. Participants were required to respond as accurately as possible within 1500 ms. Finally, feedback was displayed for 1000 ms, followed by a 200-ms blank screen as an interval.

Consistent with previous studies, motivational states were manipulated through the scoring rule, which was reflected in the feedback display (Ouyang et al., 2015). In promotion focus, participants either gained one point (+1) for a correct response or gained nothing (+0) for an incorrect response. In prevention focus, participants either lost nothing (-0) for a correct response or lost one point (-1) for an incorrect response. In the neutral state, participants neither gained nor lost any points. The feedback displayed the score in the current trial as well as the accumulated scores under the promotion and prevention foci and displayed the number of correct or incorrect trials in the neutral state. The total score was calculated by subtracting the lost score from the gained score.

2.1.2.2. Cognitive effort. At the end of each block, participants rated the following two items on a scale from 0 (*none*) to 10 (*very much*): (1) 'How much did you concentrate on this task?' (2) 'How much effort did you put into this task?' Higher scores denoted greater cognitive effort in self-regulation. The coefficients of internal consistency in promotion

Table 1
Means and standard deviations of error rates (ERs: %) in Experiment 1.

Motivational states	CWR		IWR		ICR	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Promotion focus	4.00	5.46	10.45	9.19	21.74	15.03
Prevention focus	8.12	8.11	14.57	12.84	25.26	16.27
Neutral state	7.10	8.35	15.05	11.45	26.33	17.52

Note: CWR = Consistent word response, IWR = Inconsistent word response; ICR = Inconsistent colour response.

focus ($\alpha = 0.73$), prevention focus ($\alpha = 0.84$), and neutral state ($\alpha = 0.75$) were all adequate.

2.2. Results

The error rates (ER) in stimuli responses are displayed by motivational state in Table 1. Repeated-measures ANOVAs were performed to check the effects below.

2.2.1. The effects of stimulus type and motivational state on ER

The main effect of stimulus types on ER was significant, $F(2, 82) = 83.37, p < .01, \eta_p^2 = 0.67$. A post-hoc test (LSD) showed that the ERs of IWR ($M = 13.36\%$, $SD = 8.77\%$) and ICR ($M = 24.44\%$, $SD = 13.36\%$) were both significantly higher than the ER of CWR ($M = 6.41\%$, $SD = 5.29\%$), $ps < .01$, and Cohen's $d = 0.96$ and 1.74 , respectively, indicating that the properties of meaning and colour interfered with each other in inconsistent stimuli.

The main effect of motivational states on ER was significant, $F(2, 82) = 4.66, p < .05, \eta_p^2 = 0.10$. A post-hoc test (LSD) showed that participants had lower ER in promotion focus ($M = 12.06\%$, $SD = 8.35\%$) than in prevention focus ($M = 15.98\%$, $SD = 10.84\%$) and neutral state ($M = 16.16\%$, $SD = 10.89\%$), $ps < .01$, Cohen's $d = 0.41$ and 0.42 , respectively, indicating better self-regulation in promotion than prevention focus. Specifically, for consistent stimulus types, the main effect of motivational states on ER of CWR was significant, $F(2, 82) = 4.74, p < .05, \eta_p^2 = 0.10$. Specifically, the ER of CWR was lower in promotion focus than in prevention focus ($p < .01$, Cohen's $d = 0.60$) and neutral state ($p < .05$, Cohen's $d = 0.44$). For inconsistent stimulus types, interference effects, shown by a deviation of ER between inconsistent stimulus and consistent stimulus, was analysed. A repeated-measures 2 (inconsistent stimuli: IWR and ICR) \times 3 (motivational states: promotion focus, prevention focus and neutral state) ANOVA found neither a significant main effect of motivational state on interference effect, $F(2, 82) = 0.83, p = .44$, nor a significant interactive effect of motivational state and inconsistent stimuli on interference effect, $F(2, 82) = 0.04, p = .96$.

2.2.2. The effect of motivational state on cognitive effort

The main effect of motivational state on cognitive effort was significant, $F(2, 82) = 10.68, p < .001, \eta_p^2 = 0.21$. Specifically, a post-hoc test (LSD) showed that the reported levels of cognitive effort in promotion focus ($M = 8.00$, $SD = 1.58$) and prevention focus ($M = 7.87$, $SD = 1.74$) did not significantly differ, $p = .95$, and were both higher than in neutral state ($M = 7.10$, $SD = 2.00$), $ps < .01$, Cohen's $d = 0.49$ and 0.41 , respectively, indicating that there was no significant difference in the increased cognitive effort between promotion and prevention foci.

2.3. Discussion

Experiment 1 found that participants in a promotion-focused state had better performance on a regulatory task than in a prevention-focused state, but reported the same extent of cognitive effort. As cognitive effort reflected the willingness and action to engage in a

regulatory task (Westbrook & Braver, 2015), the results in Experiment 1 were inconsistent with the first explanation in the Introduction and supported the viewpoint that better self-regulation in promotion focus did not expend more cognitive resources than in prevention focus.

However, there might be three limitations in Experiment 1. First, it is hard to deny that motivational state moderates the perception of cognitive effort, such that the same subjective cognitive effort was reported in the promotion-focused state, even when the regulatory task required more objective cognitive effort. After all, the more positive experience in promotion versus prevention focus (Idson et al., 2000; Ouyang et al., 2015) might have led participants to employ more cognitive effort but underestimate the amount. Additionally, we found that although motivational states affected task performance for all stimulus types, they did not influence the interference effects on inconsistent stimuli. Considering the possibility of a sequence effect due to the within-subject design, this finding needs further verification. Finally, the manipulation of prevention focus in the loss or nonloss framework might be problematic, as the aim was avoiding loss to gain a monetary reward. Based on the above limitations, Experiment 2 was designed.

3. Experiment 2

3.1. Methods

3.1.1. Participants and procedures

A total of 80 undergraduates (31 male, mean age = 19.61 years, $SD = 0.93$) voluntarily participated in this experiment with a between-subjects design. Participants were randomly assigned to either the promotion-focused ($N = 40$) or prevention-focused group ($N = 40$) and performed a colour-word Stroop task in promotion or prevention focus, respectively. They then performed a position-word Stroop task in which they only received feedback in terms of correct or incorrect responses.

3.1.2. Measures

3.1.2.1. Colour-word Stroop task (target task). This task was similar to that used in Experiment 1, with the following difference. In the promotion-focused group, participants whose accumulated gains were above 150 points would gain a reward of 10 RMB alongside their participant fee of 15 RMB; in the prevention-focused group, those whose accumulated losses were above 30 points would see a reduction 10 RMB from their participant fee of 25 RMB.

3.1.2.2. Spatial-word Stroop task (subsequent task). This non-incentivised task was a modified spatial Stroop task (MacLeod & MacDonald, 2000), which was intended to reflect ego depletion caused by the target task. In this task, the two words 'above' and 'below' were coloured either red or blue and presented either above or below a cross ('+'). The colour was the task cue for responding to the meaning or position of the word. Specifically, when the word was printed in red, participants should respond to the meaning of the word (regardless of its relative position); when the word was printed in blue, participants should respond to the position of the word (regardless of its meaning). The response was made with the left or right hand by pressing the 'F' and 'J' buttons, and the stimulus-response mapping was counterbalanced across participants. This control task contained 180 randomly arranged stimuli: 60 meaning-position consistent words printed in red (consistent meaning response), 60 meaning-position inconsistent words printed in red (inconsistent meaning response), and 60 meaning-position inconsistent words printed in blue (inconsistent position response); there was a 1-minute break after 90 trials. In each trial, a fixation cross (+) appeared for 500 ms at the centre of the computer screen, followed by a 100-ms blank screen, and then a 1000-ms target stimulus. Participants were required to respond as quickly and accurately as possible within 1500 ms. Finally, feedback was displayed for 1000 ms, followed by a 200-ms blank screen as an interval.

Table 2
Means and standard deviations of error rates (ERs: %) in Experiment 2.

Tasks	Motivational states	CWR		IWR		ICR or IPR	
		M	SD	M	SD	M	SD
Target task	Promotion focus	9.33	7.72	17.96	12.12	27.29	13.93
	Prevention focus	13.92	11.02	24.75	14.71	31.46	14.84
Subsequent task	Promotion focus	6.04	7.38	11.88	9.52	21.50	11.41
	Prevention focus	11.75	13.65	17.75	15.98	31.04	15.99

Note: CWR = Consistent word response, IWR = Inconsistent word response; ICR = Inconsistent colour response; IPR = Inconsistent position response.

In the two sequential regulatory tasks, self-regulation was measured through the mean ER of all stimuli responses. Lower ER in the target task indicated better self-regulation, and lower ER in the subsequent task indicated less ego depletion.

3.2. Results

The error rate (ER) of responses to the three stimulus types in promotion and prevention foci are presented in Table 2.

3.2.1. Results on the target task

A mixed-design ANOVA was applied to check the effects of stimulus type and motivational state on target task performance ER. The main effect of motivational state was significant, $F(1, 78) = 4.68, p < .05, \eta_p^2 = 0.06$. The promotion-focused group ($M = 18.22\%, SD = 9.33\%$) had lower ER (better self-regulation) than the prevention-focused group ($M = 23.44\%, SD = 11.93\%$). The interaction effect of stimulus type and motivational state on performance ER was not significant, $F(2, 156) = 4.68, p < .05$. These results above indicate that the promotion-focused group performed much better than the prevention-focused group for all three stimulus types, but the two groups showed no difference in interference effect.

3.2.2. Results on the subsequent task

A mixed-design ANOVA was also used to check the effect of stimulus types (CWR, IWR and IPR) and motivational groups on subsequent task performance ER. The main effect of stimulus type was significant, $F(2, 156) = 95.53, p < .01, \eta_p^2 = 0.55$. The ERs for IWR ($M = 14.83\%, SD = 13.40\%$) and IPR ($M = 26.27\%, SD = 14.61\%$) were both higher than that for CWR ($M = 8.91\%, SD = 11.28\%$), $ps < .01$, Cohen's $d = 0.49$ and 1.33 , respectively, indicating that the properties of meaning and position interfered with each other for inconsistent stimuli. The main effect of motivational groups was significant, $F(1, 78) = 8.37, p < .01, \eta_p^2 = 0.10$. The promotion-focused group ($M = 13.12\%, SD = 8.10\%$) had lower ERs than the prevention-focused group ($M = 19.18\%, SD = 13.09\%$), indicating better regulatory performance and less ego depletion in the subsequent regulatory task. The interaction effects of stimulus type and motivational state on the subsequent task performance ER was not significant, $F(2, 156) = 1.44, p = .24$, indicating that the two groups showed no difference in interference effect.

3.3. Discussion

Experiment 2 manipulated the prevention-focused state in a loss or nonloss framework involving avoidance of participant fee loss, and we still found that promotion-focused participants had better performance than prevention-focused participants for all stimulus types but no difference in interference effect. This result was consistent with the findings in Experiment 1.

Additionally, we found that the promotion-focused group showed better performance in accuracy rate in the subsequent regulatory task. This result supported the findings that participants in the promotion (versus prevention)-focused state did not suffer more ego depletion (Oertig et al., 2013; Trawalter & Richeson, 2006) and then denied more cognitive resource allocation in the colour-word Stroop task.

4. General discussion

The two experiments consistently showed that better regulatory performance in the promotion versus prevention-focused state did not cost more cognitive resources. Experiment 1 showed that participants in the promotion and prevention-focused states reported subjectively increased cognitive effort to the same extent, so we propose that the variation of affective experience (Idson et al., 2000; Ouyang et al., 2015) in the two motivational states did not influence the cognitive effort and cognitive resource allocation. Experiment 2 further showed that participants in the promotion-focused state did not objectively allocate more cognitive resources and suffered no worse ego depletion. This finding is consistent with related studies. For example, Roskes, Elliot, and De Dreu (2014) found that approach goals had overwhelming superiority over avoidance goals in task performance but involved less resource depletion. Werner and Milyavskaya (2019) proposed that want-to (vs. have-to) motivation was associated with better goal attainment and less cognitive effort. Thus, we concluded that motivational states also affected self-regulation and resulted in better regulatory performance in the promotion-focused state without greater cognitive resource expenditure.

The two experiments also consistently showed that participants in the promotion-focused state had better performance on all stimulus types with the same interference effect on the colour-word Stroop task. As proposed by the two-stage model of self-regulation (Myrseth & Fishbach, 2009), the cognitive process of exerting self-regulation involves two stages: conflict identification and conflict resolution. For a stimulus for which no conflict is identified, the cognitive process ends and a response is made, but if a conflict is identified, then the cognitive process advances to the subsequent stage of conflict resolution before response. Based on whether there is a conflict of properties between word and colour in the colour-word Stroop task, we posit that the cognitive process in the case of CWR only involves conflict identification, while for IWR and ICR it involves both conflict identification and conflict resolution. In Experiment 1, we found that the reward in promotion focus increased conflict identification (Wang, Chen, Hu, & Yin, 2019), but avoiding loss in prevention focus did not. We consistently found the capacity of conflict resolution had no difference in promotion and prevention focused state in the two experiments. Given that ego depletion only influenced conflict resolution but not conflict identification (Hedgcock, Vohs, & Rao, 2012), we propose that an increased capacity of conflict identification rather than conflict resolution may be the reason for better self-regulation without greater cognitive resource expenditure in the promotion-focused state.

The findings of this study have positive implications for the domain of effortless self-regulation (Gillebaart & Ridder, 2015). They indicate that self-regulation depends not only on the amount of cognitive resources allocated (Baumeister et al., 1998; Beedie & Lane, 2012; Muraven & Baumeister, 2000), but also on the motivational state to exert self-regulation. Thus, self-regulation could be situationally improved without greater cognitive resource expenditure. For example, people could achieve better task performance in the mindset of doing things right to attain a desired consequence rather than not doing things wrong to avoid an undesired consequence; education and management could enhance performance in a promotion-related cultural environment with an incentive mechanism, intensifying positive behaviours and performances. Additionally, it suggests a potential cognitive mechanism of people with high trait self-regulation. Some research found that people high in trait self-regulation did not have more

cognitive resources available to resolve conflict but instead were more successful in avoiding conflict (Gillebaart & Ridder, 2015; Hofmann, Baumeister, Förster, & Vohs, 2012). We propose that the key to success for people high in trait self-regulation might be that they were more likely to exert self-regulation in a promotion than a prevention-focused mindset in the long term.

The main limitation of this research is that all participants in the two experiments were nondepressed, healthy undergraduates, who might predominantly display promotion-focused traits better suited to a promotion-focused state (Lisjak, Molden, & Lee, 2012). It might be that the regulatory fit (Camacho, Higgins, & Luger, 2003; Cesario, Higgins, & Scholer, 2008) rather than motivational state resulted in better self-regulation in the promotion focus than the prevention focus without greater cognitive effort. Further research could check the findings in this research by taking trait motivational orientations into consideration.

CRedit authorship contribution statement

Yi Ouyang: Conceptualization, Writing - original draft. **Guochun Yang:** Formal analysis, Writing - review & editing. **Yi Zhu:** Investigation, Writing - review & editing. **Qianbao Tan:** Software, Investigation. **Xun Liu:** Supervision, Writing - review & editing.

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