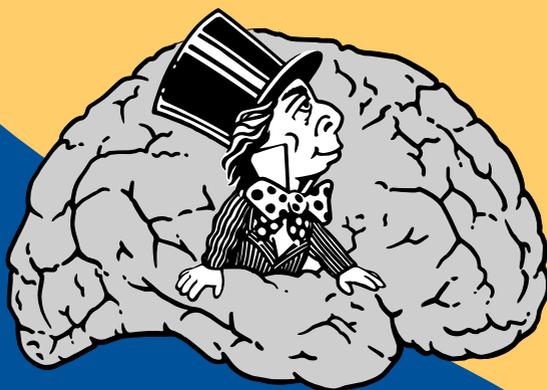


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## THE ROLE OF INDUCED MOOD AND EMOTION REGULATION IN UPDATING OF VALENCED INFORMATION

A.-R. Mohammed

[amohammed@hse.ru](mailto:amohammed@hse.ru)

National Research University Higher School of Economics, Moscow

**Abstract.** Working memory updating is a key feature of executive function. This ability guides us in the execution of goal directed action, including emotion regulation. It has also been suggested that mood plays a role in our updating ability. However, there has not been much empirical evidence to support these propositions. The present study aimed at examining the effect of mood on updating of emotional information, as well as the relationship between emotion regulation and updating. Sixty-three participants randomly assigned to an experimental or a control group took part in the study by performing an emotional 2-back task. Each participant had to compare the valence of the current facial expression with the valence of the facial expression that was presented 2 steps back. On mood induction, the experimental group was presented with disturbing pictures while neutral pictures were presented to the control group. All participants separately filled out emotion regulation and mood state scales. The results showed that neither the suppression and reappraisal strategies of emotion regulation nor emotional updating were significantly correlated. A three-way repeated measures ANOVA also showed that whilst mood had an impact on updating, there was no mood congruence effect on updating.

**Keywords:** updating, emotion regulation, mood, reappraisal, suppression

### Introduction

Updating of valenced information refers to the ability to modify emotional content in our working memory through encoding new information which sometimes demands that we delete the existing information in order to accommodate the new one. Updating is a central feature of executive functions. Many studies have been conducted on this ability and how it predicts cognitive performance. In recent times investigators have shown interest in examining the relationship between executive functions and emotions. Specifically, researchers have studied how mood influences cognitive abilities such as working memory updating. Previous studies have shown that there is a mood congruency effect in updating of emotional content in our working memory (Levens & Gotlib, 2010; Pe et al., 2013). That is whilst individuals in negative mood are better at updating negative information, those in positive mood perform better in updating of positive emotion. However, these studies (e.g. Levens & Gotlib, 2010) mostly focused

on comparing individuals with mood disorders to a control group without mood disorders. Beyond mood and updating, to what extent is this ability related to emotion regulation? Research has shown that individuals with higher capacity in executive functions (such as memory updating, response inhibition, and cognitive flexibility) are better at regulating their emotions (Schmeichel & Tang, 2015). However, not much is known specifically about the relationship between updating and reappraisal strategy of emotion regulation. The present study therefore aimed at examining how mood influences our ability to update emotional content in our working memory and also to what extent it is related to emotion regulation strategies. Three hypotheses were formulated. First, there will be a positive relationship between updating of emotional information and emotion regulation. Second, negative mood will impair updating of emotional information. Third, negative mood will facilitate updating of negative trials and impair updating of positive trials.

## Method

Sixty-three participants took part in the study. Four were excluded for their inability to complete the experimental task thus reducing the final sample size to 59 participants. Each participant was randomly assigned into the experimental or control group. The experimental group was made up of 30 participants (17 female) whilst the control group included 29 participants (19 female). The mean age of the experimental group was 20.8 ( $SD=3.32$ ) and the control group was 21.8 ( $SD=4.65$ ).

After signing the informed consent, there was a training session for the affective 2-back task. Forty positive and negative facial expressions from 6 actors (EU Emotions stimulus set: O'Reilly et al., 2012; O'Reilly et al., 2015) were presented to the participants. A participant was allowed to proceed to the main session after obtaining 60% or above in accuracy. If the participant failed in the first training task, the session was repeated up to 3 times till the cut-off point was met. This was followed by the 1st block of trials of the affective 2-back task. The mood of the participant was then measured with the EmoS-18 questionnaire (Lyusin, 2014). Afterwards, participants were presented with a set of pictures (negative for experimental group and neutral for the control group) for mood induction (IAPS: Lang et al., 1997). They were selected based on the normative ratings contained in the IAPS technical report. Twelve pictures were categorized as neutral whilst another set of 12 pictures included bloody faces and highly disgusting scenes such as 'vomit' and 'dirty toilets'. The specific disgusting pictures as coded in IAPS were '9301', '9322', '3213', '2352.2', '3101', '3150', '3130', '3051', '3060', '3069', '3261' and '3100'; whilst the neutral pictures were '7185', '2840', '7183', '7190', '1670', '7187', '2190', '2850', '7705', '5390', '7186' and '7025'. Each picture was presented for 4000 ms with an inter-trial interval of 4000 ms making a total of 2 minutes. Each participant was required to pay attention to each picture as it appears on the screen. The 2nd block of trials was presented to the participant immediately after the mood induction. After completing Block 2, the participant reported his or her mood experience (with Emos-18) right after the presentation of the pictures. The

experiment ended with the completion of the Emotion Regulation questionnaire (Gross & John, 2003; Pankratova et al., 2017). The participants were subsequently debriefed on the actual aim of the experiment and those in the experimental group were further engaged to ensure that the disturbing pictures they watched did not affect them beyond the experiment. There was no participant who left the experiment in a disturbed mood. The experiment lasted from 30 to 45 minutes.

## Results

The mean score was calculated for each of the three scales measuring mood, namely Positive Mood with High Activation (PM-HA), Negative Mood with Low Activation (NM-LA) and Tension before and after the mood induction. A RM ANOVA (with the three scales serving as within-subject variable and group serving as a between-subject variable) was used to analyze mood changes during the experiment. The interaction between PM-HA and group was significant ( $F(1, 57) = 6.50$ ,  $p = .01$ ,  $\eta_p^2 = .10$ ) meaning that mood manipulation was successful for this variable. This pattern of results was also obtained in NM-LA ( $F(1, 57) = 11.27$ ,  $p = .001$ ,  $\eta_p^2 = .17$ ). On negative mood, the interaction between NM-LA and group was significant ( $F(1, 57) = 11.27$ ,  $p = .001$ ,  $\eta_p^2 = .17$ ). This effect means that NM-LA changed differently for the experimental and the control group after the picture presentation.

Tables 1 and 2 provide the descriptive statistics of emotion regulation measures and emotional updating respectively. To test the first hypothesis, Pearson correlations were calculated between emotion regulation and the indices of emotional updating. A significant correlation was found between reappraisal strategy of emotion regulation and accuracy rates of updating ( $r(59) = .29$ ,  $p = .03$ ). However, after the FDR correction for multiple significance test, we found no significant correlation. Thus, the first hypothesis was not supported.

**Table 1.** Descriptive statistics for the measures of emotion regulation

Variable	All participants (N=59)		Exp. group (N=30)		Control group (N=29)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
ER-reappraisal	28.33	7.66	30.83	8.12	26.76	6.67
ER-suppression	14.02	4.42	14.30	4.55	13.72	4.33

**Accuracy:** To test the second and third hypotheses, a  $2 \times 2 \times 2$  RM ANOVA (with time of measurement and valence of trials as within-subject factors and group as a between-subject factor) was conducted. It was observed that mean accuracy rates of participants were higher after mood induction ( $F(1, 57) = 12.39$ ,  $p < .001$ ,  $\eta_p^2 = .18$ ) likely influenced by practice effect. This means that participants performed better in updating ( $M = 0.85$ ;  $SD = 0.16$ ) after the mood induction than before ( $F(1, 57) = 12.39$ ,  $p < .001$ ,  $\eta_p^2 = .18$ ). It was further found that the mean accuracy rates for positive trials ( $M = 0.85$ ;  $SD = 0.14$ ) were significantly higher ( $F(1, 57) = 13.28$ ,  $p < .001$ ,  $\eta_p^2 = .19$ ) compared to negative trials ( $M = 0.80$ ;  $SD = 0.15$ ) ( $F(1, 57) = 13.28$ ,  $p < .001$ ,  $\eta_p^2 = .19$ ). There was a significant interaction

effect between group and time of measurement ( $F(1, 57) = 4.41, p = .04, \eta_p^2 = .07$ ) which means that mood impacts on updating. That is, though mean accuracy went higher for both groups, the rate of increment was higher for participants in neutral group than negative mood. This finding supports our second hypothesis. However, the results of the overall 3-way interaction showed that there was no significant interaction effect meaning that our third hypothesis was not supported.

**Table 2.** Descriptive statistics for emotional updating

Group	Trial type	Before mood induction				After mood induction			
		Accuracy		RT		Accuracy		RT	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Control	Overall	0.82	0.12	1.17	0.28	0.88	0.09	1.08	0.27
	Positive trials	0.81	0.14	1.14	0.30	0.90	0.09	1.03	0.26
	Negative trials	0.80	0.15	1.22	0.27	0.85	0.13	1.12	0.28
Experimental	Overall	0.80	0.12	1.17	0.19	0.83	0.17	1.09	0.23
	Positive trials	0.81	0.14	1.14	0.20	0.84	0.19	1.07	0.23
	Negative trials	0.78	0.12	1.21	0.19	0.79	0.20	1.11	0.24

**Response Time:** A  $2 \times 2 \times 2$  RM ANOVA (with time of measurement and valence of trials as within-subject factors and group as a between-subject factor) was also conducted on the response time of participants. It was observed that mean RT of participants were lower after mood induction ( $F(1, 57) = 30.62, p < .001, \eta_p^2 = .35$ ) also likely influenced by practice effect. Thus, participants significantly had lower RT after the mood induction ( $M = 1.08; SD = 0.25$ ) than before ( $M = 1.17; SD = 0.24$ ). Moreover, there was a significant difference ( $F(1, 57) = 39.60, p < .001, \eta_p^2 = .41$ ) in the performance of updating of positive trials ( $M = 1.09; SD = 0.25$ ) and negative trials ( $M = 1.16; SD = 0.25$ ). This means that participants spent shorter time in updating of positive trials than negative trials. However, there was no significant interaction effect between group and time of measurement and also, there was no significant 3-way interaction as well. This means that our third hypothesis was not supported.

## Discussion

The results showed that emotional updating was not significantly related to emotion regulation strategies. Thus, our prediction about the existence of positive correlation between emotional updating and emotion regulation was not supported. This finding is inconsistent with previous studies (McRae et al., 2012; Schmeichel et al., 2008) that reported a positive relationship between working memory capacity and emotion regulation. It must be noted that the present study focused on working memory updating and not working memory capacity as the previous studies. These two different constructs measure different aspects of working memory (see Conway et al., 2005).

The study also tested the influence of mood on emotional updating. Here a significant correlation was obtained. That is, negative mood actually impaired updating of emotional information thereby supporting the second hypothesis. This finding is consistent with previous research on mood effects on updating reported by others (Levens & Gotlib, 2010; Pe et al., 2013). In all, the first and the third hypotheses were rejected.

The results provide a foundation for further research to be carried out. Further investigation on the relationship between emotional updating and emotion regulation through the use of other sophisticated approaches will be helpful in finding the relationship. It is recommended that, the use of both classical and emotional versions of the *n*-back task to measure updating will be useful. In the case of emotion regulation, an experimental task to measure emotion regulation should also be adopted. That is, a cognitive task can be manipulated where participants would have to make decisions reflecting an emotion regulation. These recommendations would help in expanding the scope on what is already known about emotional updating and emotion regulation.

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## **РОЛЬ ИНДУЦИРОВАННОГО НАСТРОЕНИЯ И ЭМОЦИОНАЛЬНОЙ РЕГУЛЯЦИИ В ОБНОВЛЕНИИ ЭМОЦИОНАЛЬНОЙ ИНФОРМАЦИИ В РАБОЧЕЙ ПАМЯТИ**

А.-Р. Мохаммед

[arm.raheem@gmail.com](mailto:arm.raheem@gmail.com)

Национальный исследовательский университет «Высшая школа экономики», Москва

**Аннотация.** Обновление информации в рабочей памяти является одной из ключевых управляющих функций. Оно обеспечивает осуществление целенаправленных действий и, в частности, эмоциональную саморегуляцию. Кроме этого, высказывается предположение, что настроение влияет на способность к обновлению информации в рабочей памяти. Однако эмпирических доказательств этих предположений немного. Цель исследования – изучить влияние настроения на обновление эмоциональной информации и связь обновления с эмоциональной регуляцией. Шестьдесят три испытуемых, случайно распределенных между контрольной и экспериментальной группами, выполняли эмоциональную версию задачи «n шагов назад». Испытуемый должен был сравнивать валентность предъявляемого выражения лица с валентностью лица, предъявлявшегося два шага назад. Экспериментальной группе показывали шокирующие изображения, а контрольной – нейтральные. Также испытуемые заполняли опросники, измерявшие их эмоциональное состояние и стратегии эмоциональной регуляции. Результаты показывают, что стратегии подавления экспрессии и переоценки не коррелировали с обновлением эмоциональной информации. Трёхфакторный дисперсионный анализ показал, что настроение влияло на обновление, однако это влияние не соответствовало принципу эмоциональной конгруэнтности.

**Ключевые слова:** обновление, эмоциональная регуляция, переоценка, подавление экспрессии