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# NEGATIVE MOOD IMPAIRS UPDATING OF AFFECTIVE INFORMATION

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# NEGATIVE MOOD IMPAIRS UPDATING OF AFFECTIVE INFORMATION[3]

Updating is an important executive function that is vital for the attainment of goals such as cognitive tasks, daily activities and the regulation of emotion. The ability to update affective content in working memory is said to be influenced by mood. However, little is known regarding influences of mood on the valence of the affective content. We hypothesized that first, negative mood would impair updating of affective information. Second, this impeding impact would be weaker for the updating of negative information due to mood congruence effect. Sixty-three Russian speaking participants were recruited for the experiment. Half of the participants were induced into negative mood by negative pictures; the other half were presented with neutral pictures. All participants performed the affective *2*-back task before and after mood induction. The results showed that negative mood impaired the accuracy rates of updating. However, the mood congruence effect was not observed in the updating of positive and negative materials. We recommend that more experiments be conducted with varied affective stimuli and across different populations.

JEL Classification: Z

Key words: mood, affective updating, mood congruence, mood induction, *n*-back task.

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# Introduction

Updating the content of working memory is a cognitive process vital for the attainment of goals. Updating refers to the process by which relevant information is encoded and manipulated in relation to the task at hand (Baddeley, 2003; Miyake et al., 2000). A deficit in updating is a precursor for psychological maladjustment and deficits in thought and actions (Levens & Gotlib, 2010). To update information in working memory involves three activities, *encoding* new information, *manipulating* existing information through modification and *retrieving* information when needed.

It has been suggested that mood may have an impact on working memory. Mood here is defined as an emotional state characterized by less intensity, lasting for minutes or hours and involved in the control of expressions and observable behavior (Alpert & Rosen, 1990; Russell, 2003). In the past decade, there has been a growing amount of research on the relationship between mood and updating of information in working memory. For instance, the influence of mood in working memory capacity and updating functions have been investigated (Habel et al., 2007; Osaka et al., 2013). While working memory capacity is said to be enhanced by positive mood, negative mood is said to hinder effective performance in working memory using non-affective stimuli (Curci, Lanciano, Soleti, & Rimé, 2013; Storbeck & Maswood, 2016; Yang et al., 2013). Deficits in updating the content of working memory result in emotional dysregulation and emotional maladjustment (Joormann, Yoon, & Zetsche, 2007). However, there are limited studies investigating the role of mood in updating specific types of information such as affective information. In other words, little is known about how a specific mood influences our ability to update negative stimuli or positive stimuli.

Mood congruence effect, a phenomenon which suggests that mood facilitates the processing of affective information that is consistent with an individual's mood. According to Bower and Forgas (2000), individuals spend longer encoding mood-congruent information and integrating it into a network of primed associations which results in better recall of such information. Mood congruence in attention and memory has been reported where individuals are said to retrieve memories that correspond to their mood (Miranda & Kihlstrom, 2005). It is thought that this phenomenon exists in updating of affective information, although there is inadequate research to support the claim. Few studies have attempted to examine the role of

mood in updating of affective information, and they mostly focused on patients with affective disorders. For instance, it has been found that depressed patients compared to healthy participants were faster at updating negative facial expressions (Bistricky et al., 2014; Levens & Gotlib, 2010). Similarly, subjective well-being and positive mood have also been reported to be related to updating of positive information (Pe et al., 2013). However, a more recent study, after inducing negative and positive moods in participants, found no association with updating of specific emotional content (Rączy & Orzechowski, 2019). These studies do not provide clarity on the effect of mood on updating of affective materials and whether a negative or positive mood would facilitate or inhibit updating of affective materials in working memory.

The present study examines the influence of negative mood on updating of affective materials. To achieve this objective, participants, divided into the experimental and control groups, were presented with a *2*-back task made up of faces expressing an emotion. After Block 1 of the *2*-back task, the experimental group was induced into a negative mood, then Block 2 of the *2*-back task was administered to both groups.

To induce mood, participants in the experimental group were presented with highly arousing negative pictures while those in the control group were presented with affectively neutral pictures. Based on the mood congruence effect, we hypothesized that (1) negative mood would impair affective updating and (2) this impeding impact would be weaker for updating of negative information due to the mood congruence effect. Negative mood often hinders cognitive functioning, including working memory (Curci, Lanciano, Soleti, & Rimé, 2013), which can be explained by the consumption of internal resources that are directed to greater introspection and reduce information processing capacity (Ellis & Ashbrook, 1988; Jackson & Arlegui-Prieto, 2016). Nevertheless, this reduction of processing capacity can be mitigated by mood congruence effect. This is a phenomenon where the current mood of an individual facilitates the processing of emotional information consistent with his or her mood. This allows us to expect that the detriment in updating while in a negative mood will be less for negative stimuli.

# Method

## Participants

Sixty-three healthy participants, mostly undergraduate students, participated in the experiment[4]. Incomplete data from four participants were excluded, leaving a final sample of 59. Each participant was randomly assigned to the experimental or control group. The experimental group was made up of 30 participants (17 female) while the control group was made up of 29 participants (19 female). Their ages ranged from 17 to 34 years. The mean age was 20.8 (*SD* = 3.32) in the experimental group and 21.8 (*SD* = 4.65) in the control group. All participants were Russian speaking.

## Materials

### *2-back task*

The *n*-back task with a load factor of two was used to assess updating (Jaeggi et al., 2010; Kirchner, 1958). Pictures from the EU-Emotion Stimulus Set (O'Reilly et al., 2012; O'Reilly et al., 2015) were used for the affective *2*-back task. The stimulus set is made up of still images of both male and female actors ranging from children to adults. The actors displayed various emotions and mental states. For our study, 6 images expressing 'excitement' and 'happiness' and another 6 images expressing 'anger' and 'disgust' were selected. Thus, the *2*-back task had positive and negative facial expressions as stimuli. All selected images had an equal number of males and females in each category.

Each image was displayed on the screen for 2000ms followed by an intertrial interval of 2000ms using the PsychoPy software (Peirce et al., 2019). The participant pressed the letter "P" if the present image was of the same valence with the image presented two steps back, or the letter "Q" if it was different. The key pressed and the response time (RT) were recorded for each trial. All participants began with a practice session made up of 16 trials. To ensure that participants understood the task, participants who scored 60% or higher accuracy proceeded to the main task. In the case the participant failed, the practice session was repeated three times before they proceed to the main task.

[4] The research was approved by the Institutional Review Board of the National Research University Higher School of Economics.

The main task was divided into two blocks. Each block included 41 faces; the responses to 39 of them were analyzed. The sequence of the images presented were quasi-randomized. Block one consisted of 20 positive and 21 negative faces. Block two contained 21 positive and 20 negative faces. The order of the presentation of the blocks was randomized across participants.

Two types of trials were essential for further analysis, positive and negative. In the positive trials, the current stimulus presented on the screen was positive while the stimulus presented two steps back could be positive or negative. In negative trials, the current stimulus was negative. The task design and trial types are demonstrated in Figure 1.

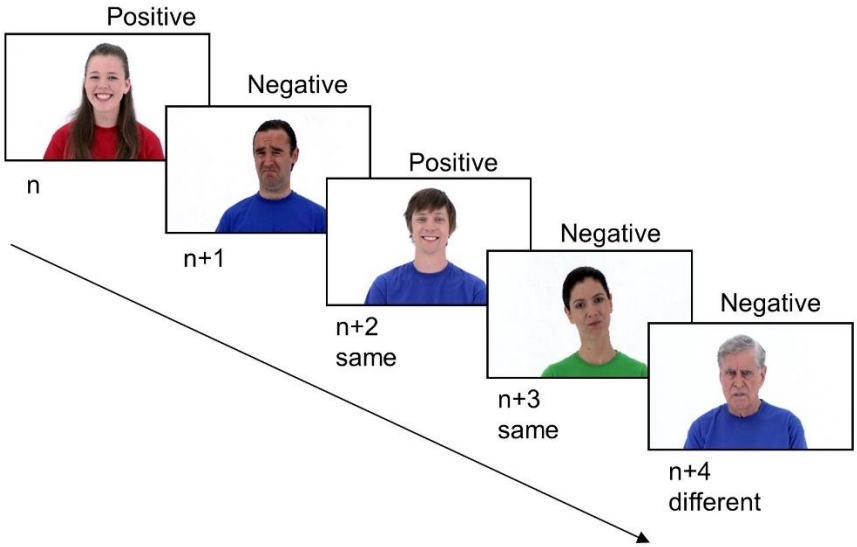



Figure 1. The affective *2*-back task design with pictures from the EU-Emotion Stimulus Set.

## Neutral and Negative Pictures

To manipulate mood, neutral and negative pictures were presented to the control and experimental groups, respectively. Twenty-four pictures were chosen from the International Affective Picture System (IAPS: Lang, Bradley, & Cuthbert, 1997). They were selected based on the normative ratings contained in the IAPS technical report. Twelve pictures were neutral while another set of 12 pictures included bloody faces and disgusting scenes such as “vomit” and “dirty

toilets"[5]. Apart from the normative ratings contained in the IAPS technical report, a pilot experiment was also conducted, corroborating the negative effect of these pictures on participants' emotional states. Although there are several methods to induce negative mood, we opted for pictures due to their relative effectiveness at inducing negative mood (Siedlecka & Denson, 2019).

## Mood Measure

The mood questionnaire EmoS-15 (Lyusin, 2019) was used to assess the participants' moods. This questionnaire consists of 15 Russian nouns which represent various emotional states. Participants are required to rate their mood on the Likert scale from one to four using these words. The EmoS-15 questionnaire has three scales: Positive Affect, Negative Affect, and Tension with corresponding Cronbach's alphas of .86, .87, and .85.

## Data preparation

First, we analyzed how picture presentation influenced mood in the experimental and control groups. Then we compared various indices of affective updating before and after the picture presentation in the experimental and control groups to test the hypotheses.

The analysis started with a mood manipulation check. The mean score was calculated for each of the three scales of the EmoS-15, namely Positive Affect (PA), Negative Affect with Low Arousal (NA), and Tension before and after mood induction. RM ANOVA with two within-subject factors, *before-after* (mood measurement before or after picture presentation) and *group* (control or experimental), was run for each of the three scales as dependent variables (Fig.2).

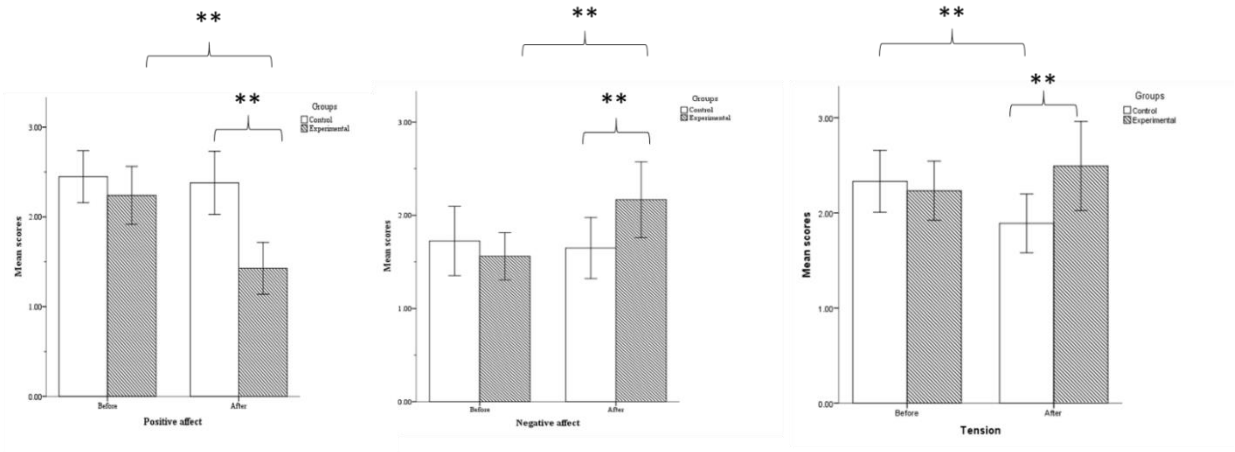
Mean accuracy rates and mean RTs of correct responses to the trials of the affective *2*-back task were used as indices of affective updating. To test Hypothesis 1 about the impeding impact of negative mood on affective updating, the performance of the *2*-back task in the control

[5] The IAPS codes of the negative pictures were 9301, 9322, 3213, 2352, 3101, 3150, 3130, 3051, 3060, 3069, 3261, and 3100; the neutral pictures were 7185, 2840, 7183, 7190, 1670, 7187, 2190, 2850, 7705, 5390, 7186, and 7025.

and experimental groups were analyzed. The mean accuracy rates and RTs of affective updating were calculated for each participant for all trials and separately for positive and negative trials before and after picture presentation. The summary of the descriptive statistics is presented in Table 2.

## Results

For the PA scale, the interaction between *before-after* and *group* factors was significant ($F(1, 57) = 10.70$, $p = .002$, $\eta_p^2 = .16$) meaning that mood manipulation was successful for this variable. Paired-sample t-tests showed that PA scores decreased significantly in the experimental group ($t(29) = 4.50$, $p < .001$) but did not change in the control group ($t(28) = .43$, $p = .67$). For the NA scale, the interaction between *before-after* and *group* factors was also significant ($F(1, 57) = 8.46$, $p = .005$, $\eta_p^2 = .13$). Paired-sample t-tests showed that the NA scores significantly increased in the experimental group ($t(29) = 3.48$, $p = .002$) and did not change in the control group ($t(28) = .483$, $p = .63$). For the Tension scale, the interaction between *before-after* and *group* factors was also significant ($F(1, 57) = 5.95$, $p = .02$, $\eta_p^2 = .10$). Paired-sample t-tests showed no significant difference between the mean scores before and after the picture presentation in the experimental group ($t(29) = 1.11$, $p = .28$), and a significant reduction of the mean score in the control group ($t(28) = 2.68$, $p = .01$).




** p < .01

*Figure 2*. Scores of the EmoS-15 scales before and after the picture presentation in the experimental and control groups. Error bars display 95% CI.

Overall, the induction of negative mood was successful since participants' moods became more negative and less positive after viewing the negative pictures. This did not change substantially after viewing the neutral pictures, except for slightly lower tension in the control group which can be explained by the relaxing impact of the neutral pictures.

Table 2. Performance of the affective *2*-back task

| **Time of measurement and trial type** | **Group** | **ACC rate** | | **95% CI** | | **RT** | | **95% CI** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Mean** | **SD** | **Lower** | **Upper** | **Mean** | **SD** | **Lower** | **Upper** |
| *Before* | | | | | | | | | |
| Positive | Experimental | .81 | .14 | .76 | .87 | 1.14 | .20 | 1.06 | 1.21 |
| | Control | .81 | .14 | .76 | .86 | 1.14 | .30 | 1.02 | 1.25 |
| Negative | Experimental | .78 | .12 | .73 | .82 | 1.21 | .19 | 1.13 | 1.28 |
| | Control | .80 | .15 | .74 | .86 | 1.22 | .27 | 1.11 | 1.32 |
| *After* | | | | | | | | | |
| Positive | Experimental | .84 | .19 | .76 | .91 | 1.07 | .23 | .98 | 1.16 |
| | Control | .90 | .09 | .86 | .93 | 1.03 | .26 | .93 | 1.13 |
| Negative | Experimental | .79 | .20 | .71 | .86 | 1.11 | .24 | 1.02 | 1.20 |
| | Control | .85 | .13 | .80 | .90 | 1.12 | .28 | 1.01 | 1.23 |

A three-way RM ANOVA was conducted for each trial type with *group*, *before-after*, and *trial type* (positive or negative) as factors (Table 3). There was a significant main effect of the *before-after* factor: accuracy was higher ($F(1,57) = 12.39$, $p < .001$, $\eta_p^2 = .18$) and RT was lower ($F(1,57) = 30.62$, $p < .001$, $\eta_p^2 = .35$) after the picture presentation. This improvement of performance in both groups can be explained by the practice effect. The *trial type* factor also showed significant main effect both on accuracy ($F(1,57) = 13.28$, $p < .001$, $\eta_p^2 = .19$) and RT ($F(1,57) = 39.6$, $p < .001$, $\eta_p^2 = .41$), implying that positive trials were more effectively updated compared to negative trials.

Table 3. Summary of RM ANOVA with *group*, *before-after*, and *trial type* (positive or negative) as factors.

| | Accuracy rates | | | Response time | | |
|---|---|---|---|---|---|---|
| **Factors** | **F** | **p** | $\eta_p^2$ | **F** | **p** | $\eta_p^2$ |
| Group | 1.06 | .31 | .02 | 0 | .95 | 0 |
| Before-after | 12.39 | < .001 | .18 | 30.62 | < .001 | .35 |
| Before-after × Group | 4.41 | .04 | .07 | .36 | .55 | .01 |
| Trial type | 13.28 | < .001 | .19 | 39.6 | < .001 | .41 |
| Trial type × Group | .48 | .49 | .01 | 1.56 | .22 | .03 |
| Before-after × Trial type | 3.39 | .07 | .06 | .18 | .67 | 0 |
| Before-after × Trial type × Group | .96 | .33 | .02 | .97 | .33 | .02 |

Importantly, there was a significant interaction for accuracy between the *before-after* and *group* factors ($F(1,57) = 4.41$, $p = .04$, $\eta_p^2 = .07$). Accuracy improved less in the experimental compared to the control group (Fig.3). This result means that the practice effect was significantly smaller in the experimental group. No significant second-order interaction among the three factors was found.

To sum up, negative mood impaired affective updating in accordance with the first prediction of Hypothesis 1. However, there was no difference in the influence of negative mood on updating of positive and negative stimuli. Thus, Hypothesis 2 was not supported.

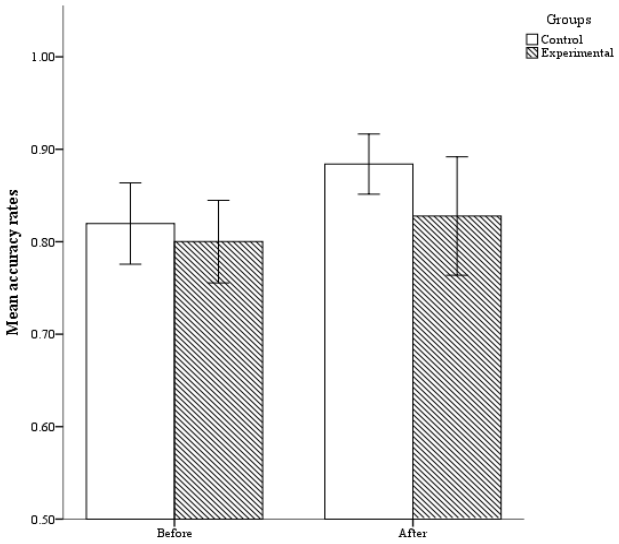



*Figure 3.* Accuracy of updating before and after picture presentation in the control and experimental groups

## Discussion

This study tested two hypotheses: first, that negative mood impairs updating affective materials and, second, that this impairment would be milder for updating negative materials based on the mood congruence effect. The results showed that while negative mood impaired updating, we did not observe that the impairment was milder for negative stimuli. Thus, our first hypothesis was supported while the second was not.

On mood effects on updating, prior research has reported this effect across memory updating tasks using either affective or non-affective materials. However, those studies (e.g., Levens & Gotlib, 2010) largely used participants with affective disorders leaving a gap regarding healthy participants' mood and affective updating. The present study therefore filled this gap by providing data which suggests that mood effects on updating go beyond affective disorders. Consistent with previous findings, our study showed that negative mood impairs updating affective information.

The ability to update affective materials in working memory is important for subjective well-being. Identifying impediments to successful updating is an important step towards improving the ability to update information in working memory. Our findings extend findings of previous research (Bistricky et al., 2014; Levens & Gotlib, 2010) regarding the impeding role of a negative emotional state in updating ability. Thus, it is not only individuals with affective disorders who have impediments in updating emotional content, but healthy individuals in a negative mood as well.

Although our study could not extend the mood congruence effect in updating affective materials, a previous study also found no mood congruence effect (Rączy & Orzechowski, 2019). It appears that the mood congruence effect is more prominent with affective disorders, but this may not be the case with the healthy population (Fredrickson & Branigan, 2005; Segal et al., 2015). In the present study, it is possible that the impeding effect of the induced negative mood was strong enough to generally disrupt the updating function irrespective of the content.

There are some limitations which must be highlighted. The duration of induced mood in a laboratory setting has long been debated (Westermann et al., 1996). Mood induction could vary from person to person. Thus, it is possible that the induced mood might not last longer than expected with some participants. We induced negative mood and compared with the control group (presented with neutral pictures), however, it would have been useful to include positive

mood induction on another group. We also acknowledge that some other affective stimuli could be used for the updating task instead of facial expressions. Hence it would be interesting to examine how mood impacts updating of highly arousing affective materials.

In conclusion, our study showed that an induced negative mood impairs updating of affective materials in working memory. Contrary to our expectation, mood congruence effect was not manifested in updating affective materials. We recommend that future experiments should consider focusing on how specific mood states (i.e., anger, disgust, happiness) impact updating of mood-congruent information in working memory. This should also be examined across different age groups.

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