methods

A Battery of Cognitive Tasks for the Assessment of Non-Affective and Affective Executive Functioning

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Abstract. Executive functions (EF) are a set of higher order cognitive processes that are engaged in a goal directed behaviour. It has been suggested that these functions work differently depending on the type of stimuli (non-affective or affective). Although there are many studies where EF measures have been used for affective or non-affective stimuli, the obtained results do not provide the opportunity to directly compare the data from both measures. To address the problem, the present study aimed at presenting a new battery of cognitive tasks working with non-affective and affective stimuli. Thus, the *n*-back, Stroop and letter-number tasks were used to assess three core EF, namely updating, inhibition and shifting. New affective versions of the classical *n*-back, Stroop and letter-number tasks were created as well. Eighty-four participants completed a neutral version followed by the affective version of each task. The results showed a significant positive correlation between the neutral and affective versions in updating and shifting, but not inhibition. There were no significant differences in performance on the neutral and affective versions of updating, cost of inhibition and shift cost. More experiments should be conducted to further broaden the applicability of this novel approach in the assessment of EF in emotion-cognition interactions.

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Keywords: executive functions, affective information, updating, shifting, inhibition, *n*-back task, Stroop task, letter-number task

Acknowledgements. I thank Dmitry Lyusin for his advice and Ekaterina Uetova for her assistance with the data collection.

Received July 12, 2019, accepted September 28, 2019.

Introduction

Executive functions (EF) refer to a set of higher order cognitive processes that are involved in the control of behaviour (Jurado & Rosselli, 2007; Schmeichel & Tang, 2015). They are controlled rather than automatic processes, and play a significant role in individual differences in cognitive performance (D'Esposito et al., 1995; Kane & Engle, 2003).

EF is one of the research directions in the field of cognition and emotion. There has been a growing interest in the relationship between EF and emotion. For instance, research has focused on how emotion influences EF and how EF also relate to emotional responses and processes. Studies on the influence of emotion on EF have mainly focused on the effect of mood on various cognitive abilities such as working memory updating (Joormann & Gotlib, 2008; Segal et al., 2015), inhibition (Martin & Kerns, 2011; Schuch & Koch, 2015), and shifting (Phillips et al., 2002; Yang & Yang, 2014). On the other hand, EF are believed to influence emotional responses and processes such as emotion regulation (Gyurak et al., 2012; Hendricks & Buchanan, 2016) and emotion recognition (Lee et al., 2009).

In the literature on cognition and emotion, EF have largely been measured using two types of stimuli: affective or neutral. Affective information implies that emotional content (could be words, pictures or a combination of both) was adopted as the stimuli for the assessment of EF, while neutral refers to stimuli that are affectively neutral (could be alphabets, numbers, shapes or any combination of these). Experiments on the role of EF in emotional processing have

Table 1. A Summary of Popular Tasks Used to Investigate Updating, Inhibition and Shifting

The Three EF	Tasks	Number of Papers on PubMed from 2009 to 2019 Referring to Each Task
Updating	The *n*-back task (Kirchner, 1958)	1889
	The keep track task (Yntema, 1963)	86
	The running memory span (Pollack, Johnson, & Knaff, 1959)	36
Inhibition	The Stroop task (Stroop, 1935)	2903
	The Flanker task (Eriksen & Eriksen, 1974)	856
	The Simon task (Hommel, 2011)	844
Shifting	The trail making test (Reitan, 1955)	4699
	The local-global task (Navon, 1977)	1431
	The letter-number task (Rogers & Monsell, 1995)	387
	The plus-minus task (Jersild, 1927)	35

often produced inconsistent findings (Aker & Landrø 2014; Gyurak et al., 2012; Hendricks & Buchanan, 2016; Marceau et al., 2018; McRae et al., 2012). This has partly been attributed to the type of stimuli used in the EF tasks. However, there is a limitation in the attempt to compare non-affective and affective EF tasks in the reviewed studies because they are not identical in procedure and implementation. It has been shown that individuals generally react differently when presented with affective and neutral stimuli (Aker & Landrø, 2014; McRae et al., 2012). The aim of the current study is to introduce a new battery of cognitive tasks for the assessment of non-affective and affective EF. The procedure and implementation of the non-affective and affective tasks would be matched as closely as possible. The new tasks would allow us to directly compare EF working with neutral and affective stimuli.

Although the list of EF is not exhaustive, Miyake et al. (2000) attempted to summarize them into three categories using the unity-diversity framework. These categories included updating, inhibition and shifting, which together make up the complex EF while they are also diverse at the component level. That is, of all the many EF, they are each related to at least one of the summarized three functions. These specific EF were selected based on the empirical support received by the unity-diversity model as being representative of cognitive control (Friedman & Miyake, 2017).

As a term, updating refers to the process where we encode, manipulate and retrieve information in the short-term memory (Baddeley, 2003). This involves replacing existing information in the memory with an updated version and being able to suppress the old information with the updated version when it is demanded in a given task. In everyday activities, we are constantly engaged in the updating of our existing knowledge in one way or another. Inhibition, sometimes referred to as inhibitory control, is the ability to deliberately obstruct a prepotent, dominant or automatic response when required (Miyake et al., 2000). In the absence of inhibitory control, we would usually follow our impulses, instincts or thought patterns. Shifting, also referred to as set-shifting, involves the ability to shift from one task to another in a multiple task condition (Aker & Landrø, 2014). In other words, the goal of shifting is to successfully execute multiple tasks at the same time where you would have to continuously monitor each task, executing what is expected of you.

Assessment of Updating, Inhibition and Shifting

Although the tasks developed to assess each of these EF (i.e., updating, inhibition and shifting) are numerous, the popular ones are presented in Table 1[1]. Several versions of the tasks measuring the three EF (from Table 1) have been created and used in testing cognitive processing and their interactions with affective context, mainly by utilizing either affective or neutral stimuli. Affective EF tasks compared to neutral tasks are important in the study of the interaction between cognition and emotion for many reasons. In the past, experiments on cognition and emotions often involved asking participants to complete the classical (neutral) tasks and then emotion measures were assessed separately (Hendricks & Buchanan, 2016; Schmeichel, Volokhov, & Demaree, 2008). However, according to the dual competition framework model (Pessoa, 2009), EF are influenced by the affective content in the task. This supports the view that studies on the emotion-cognition interaction in assessing cognition should consider both neutral and affective versions of the EF task.

It has been suggested that the affective content of a task produces different impacts on EF, with little or no effect on updating but a substantial effect on inhibition. For working memory updating, previous studies (e.g., Schweizer et al., 2019) have shown that, with healthy participants, there is little or negligible difference in updating using both neutral and affective stimuli at the behavioural level. Affective content does have a greater impact at the neural level and in patients with affective disorders. Similarly, a number of studies on inhibition have implemented an inhibition task which makes use of either neutral or affective stimuli (Goeleven, Raedt, Baert, & Koster, 2006; Joormann, 2004). However, some studies (e.g., Veroude, Jolles, Croiset, & Krabbendam, 2013; Winter et al., 2015) did implement both the

[1] The popularity of these tasks were determined by computing the number of times these tasks appeared in papers listed on PubMed between 2009 and 2019.

neutral and affective versions of a task in the same experiment. In previous research (Veroude et al., 2013), it has been demonstrated that there is a stronger affective interference as evidenced by longer response times (RT) in incongruent and negative trials as compared to the neutral version with healthy participants. Participants with affective disorders have been shown to commit more errors or spend more time on incongruent affective stimuli after performing an affective go/no go task and an affective Stroop task (Chechko et al., 2009; Harfmann, Rhyner, & Ingram, 2019).

Similar to the other EF tasks, separate studies have been conducted on shifting where neutral or affective stimuli have been used in their assessment. In the case of affective stimuli, affective words (Deveney & Deldin, 2006) and pictures (De Lissnyder, Koster, Derakshan, & de Raedt, 2010) have been used. In most cases, these studies only focused on the link between mood-related disorders and biases in affective shifting. Inconsistent findings related to the link between shifting and emotion could be traced to the kind of stimuli used in the shifting task. For instance, the use of the standard (neutral) letter-number task showed no link between the switch-cost and emotion regulation (Hendricks & Buchanan, 2016) just as with the standard trail making test (Sperduti et al., 2017). However, a positive correlation between shift cost using the standard global-local task and emotion regulation has been observed in another study (McRae et al., 2012). The only available study on neutral and affective shifting tasks (Aker & Landrø, 2014) involved an attempt to examine the relationship between the standard WCST and an affective picture sorting task. The results showed that participants generally performed worse in the affective picture sorting task on areas such as the total errors, categories completed, perseveration over response and errors as well as failure to maintain set (Aker & Landrø, 2014).

To sum up, the previous studies on EF working with affective and neutral information were mostly conducted using either affective or neutral tasks separately. However, there is no battery of EF-tasks which utilizes these three EF and at the same time takes into consideration both affective and neutral stimuli. This is needed to help us directly compare EF measures working with affective and neutral stimuli.

The Present Study

The current study aimed at presenting a battery of EF measures which takes into account both neutral and affective stimuli. The idea is to use the new battery in future research to observe how emotional factors (i.e., mood, emotion regulation or affective disorders) would relate to the neutral and affective versions of a task in the same way or differently. A low to medium positive correlation between the neutral and affective EF measures would suggest the need to use both measures in the assessment of EF in cognition and emotion interactions. To develop the battery, the *n*-back, Stroop and letter-number tasks were specifically chosen to assess updating, inhibition and shifting respectively. These tasks were chosen for a number of reasons. First, these specific tasks (especially the *n*-back and Stroop tasks) have been used more frequently in the study of cognition and emotion as evidenced in the literature (Gyurak et al., 2012; Schweizer et al., 2019). Second, since this study relied on Miyake's model, the Stroop and letter-number tasks were selected as used in that model (Miyake et al., 2000). Each of these tasks in the current study had the classical (neutral) stimuli in one block and emotional faces in the other (affective) block. The affective tasks of these EF measures were designed to employ the same procedure that included the same number of trials, stimulus presentation time and inter-trial interval. A low to medium positive correlation was expected between the neutral and affective versions of each task.

Method

Participants

The study was approved by the Institutional Review Board of the Higher School of Economics. Eighty-four Russian speaking students from the Higher School of Economics, Moscow volunteered to take part in the experiment in exchange for course credit. Participants received a brief overview of all the tasks after signing the informed consent. Incomplete data from two participants were expunged, reducing the final sample size to 82 (51% female). The mean age was 19.3 years ($SD = 2.1$).

Stimuli

Pictures from the EU-Emotion stimulus dataset (O'Reilly et al., 2012; O'Reilly et al., 2015) were used in the affective versions of the three tasks. These pictures consisted of faces of actors (both male and female) that expressed various positive and negative emotions such as sadness, anger, happiness and disgust. Sample pictures can be seen in Figure 1.

Task Design[2]

***n*-back task (2-back)**. The *n*-back paradigm (with $n = 2$) was used to measure updating. This factor ($n = 2$) has been shown to be difficult enough to demonstrate individual differences in updating (see Gajewski, Hanisch, Falkenstein, Thönes, & Wascher, 2018). Here, a series of stimuli appeared at the centre of the screen for 2500 ms with an intertrial interval of 500 ms. As each stimulus appeared on the screen, the participant was expected to compare the present stimulus with the stimulus that appeared two steps back. If they were the same, key "1" was pressed; if different, the "0" key was pressed. In the neutral version, letters from the Russian alphabets were used. The participant had to detect whether the letters were vowels or consonants. They were considered the same when both were vowels or consonants; otherwise, they were different. In the affective version, participants saw affective faces and were expected to decide whether the affective expressions were the same (both positive or both negative) or different (one was positive and the other was negative). This is represented in Figure 1. Eighty-one trials in quasi-random order were used for the neutral and the affective versions which were preceded by 16 practice trials each. This was the same for all participants. Mean accuracy and RT were recorded.

Stroop task. The onscreen classical Stroop task was adapted and used for the neutral version of the task. Participants were presented with names of colours that were

[2] The various tasks used in the present study have been deposited online. See Supplementary Online Materials for an up-to-date link.

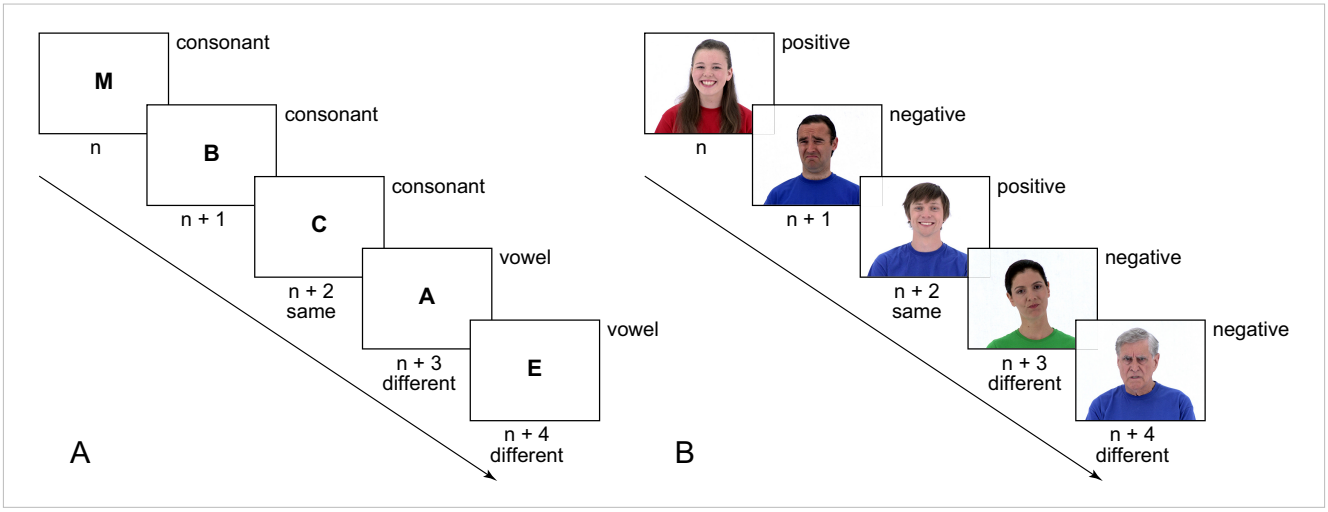

Figure 1. The design of the 2-back task (A for neutral and B for affective stimuli).

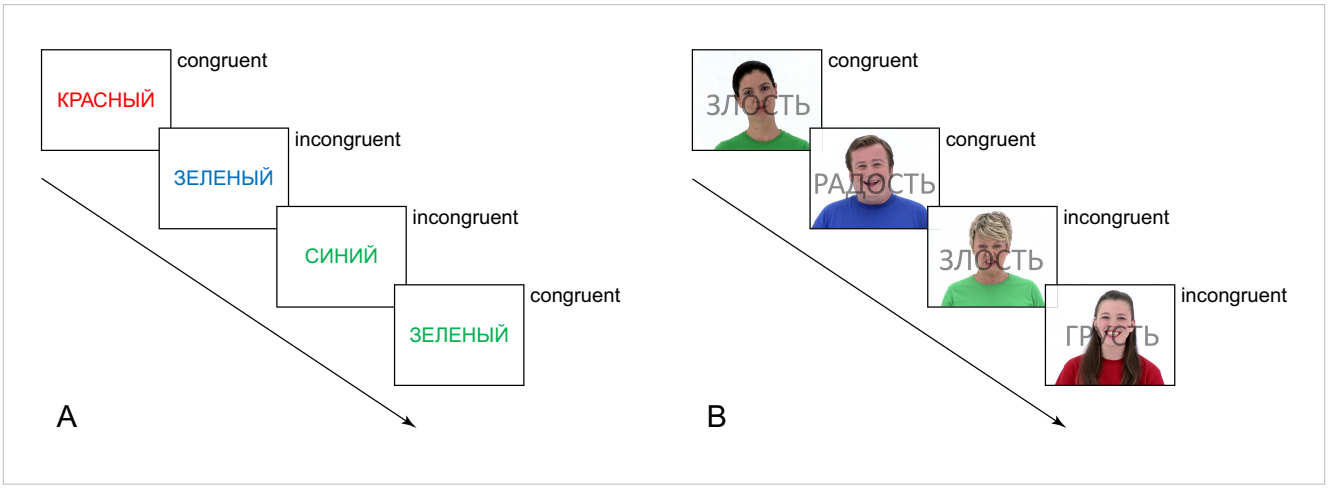

Figure 2. The design of the Stroop task (A for neutral and B for affective stimuli). Words in Russian: red, green, blue, green (A); anger, happiness, anger, sadness (B).

printed in the same colour as the word (congruent) or in a different colour (incongruent). Red, green and blue were the colours used for the experiment with their corresponding coloured stickers attached to the "V", "B" and "N" keys on the keyboard. Sixty quasi-randomized stimuli were completed in this session, with an equal number of trials per colour. Each colour name had 10 congruent trials and 10 incongruent trials (5 each for the remaining 2 colours). In the affective version, sadness, anger and happiness were the background facial expressions used. These were specifically chosen because of how salient they are to detect. Sadness, anger and happiness were also printed across each face in a translucent form. Similar to what existed in the colour naming version, congruent trials had the affective expression on the face (e.g., anger) being the same as the affective word printed on the face. Incongruent trials had the affective expression on the face being different from the printed word across the face (e.g., angry face with either 'sad' or 'happy' written across the face). The affective version also had 60 trials made up of 20 blocks of 3 affective expressions presented in a quasi-random order. The same principle as in the colour naming was applied here regarding congruent and incongruent blocks. This is demonstrated in Figure 2. Mean accuracy and RT were recorded.

Letter-number task. In the letter-number task, a pair consisting of a letter and a number (e.g., A5, M2) appeared in any of the quadrants displayed on the screen. A set of eight letters (A, И, M, O, P, C, T, У) and numbers (2, 3, 4, 5, 6, 7, 8, 9) were used in this task. The pairing was done in quasi-random order. If the letter-number pair appeared in an upper quadrant (could be left or right), a participant had to focus on the letter and report if the letter was a vowel or consonant. If the letter-number appeared in a bottom quadrant (could also be left or right), a participant focused on the number by reporting if the number was odd or even. There were three blocks in all. In the first block the letter-number pair appeared at the top, and in the second block it appeared at the bottom. In the final and most important block, the letter-number pair appeared in any of the quadrants in a clockwise direction. The participant pressed the white labelled key (on "Q") when the number was even and when the letter was a vowel, whereas the yellow labelled key (on "P") was pressed when the number was odd and when the letter was a consonant. The first two blocks had 32 trials each, while the third block had 128 trials. In the affective version, affective faces were used instead. When the face appeared in an upper quadrant, the participant reported the sex of the actor; the participant reported on the valence of the affective expression if it appeared in a bottom quadrant. Similar to the neutral version, 32 trials were presented in the first two blocks whereas 128 trials were used in the third block. This task is demonstrated in Figure 3.

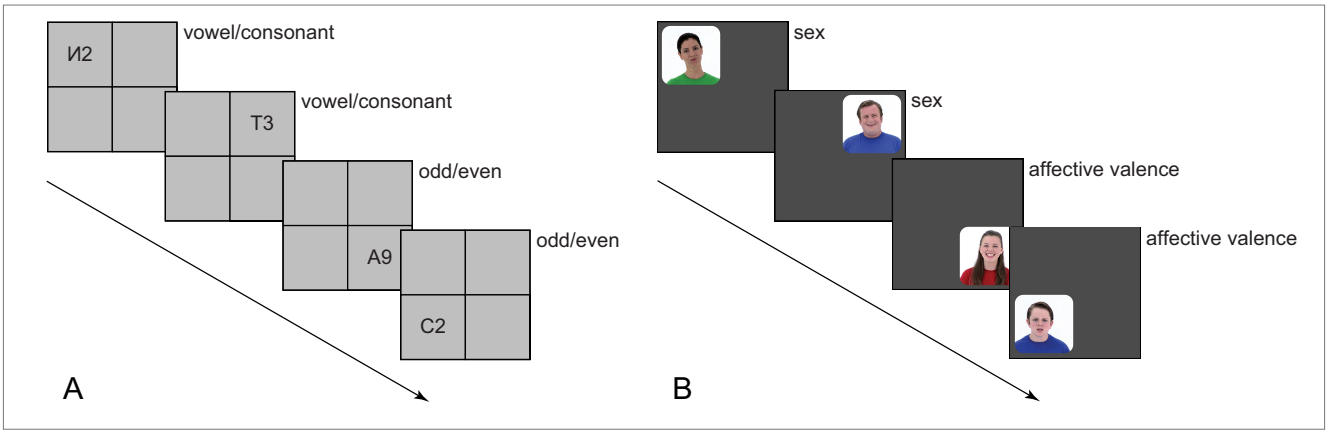

Figure 3. The design of the letter-number task (A for neutral and B for affective stimuli).

Table 2. Summary of Mean Accuracy Rates and RTs for the Neutral and Affective Versions of the Three EF Tasks (*N*=82)

Variable	Minimum	Maximum	Mean	Std. Deviation
Updating ACC	.30	.96	.69	.16
Affective updating ACC	.41	.94	.69	.15
Updating RT	.66	1.67	1.17	.20
Affective updating RT	.46	1.80	1.21	.23
Inhibition ACC	.90	1.00	.99	.02
Affective Inhibition ACC	.83	1.00	.96	.04
Inhibition RT: Congruent trials	.49	1.05	.70	.12
Affective Inhibition RT: Congruent trials	.66	1.50	.98	.19
Inhibition RT: Incongruent trials	.51	1.42	.80	.15
Affective Inhibition RT: Incongruent trials	.72	1.58	1.07	.19
Shifting ACC	.52	.89	.81	.08
Affective Shifting: ACC	.68	1.00	.94	.06
Shifting RT: No-shift trials	.44	1.18	.75	.15
Affective shifting RT: No-shift trials	.58	1.58	.86	.17
Shifting RT: Shift trials	.29	1.99	1.16	.31
Affective shifting RT: Shift trials	.78	2.03	1.28	.26

Note: ACC = Accuracy, RT = Response time.

Procedure

All tasks were carried out on a computer screen in the laboratory using the PsychoPy software (Pierce et al., 2019). In each task, participants began with a practice session before proceeding to the main session. They began with the *n*-back task, followed by the letter-number task and the Stroop task. This sequence was adopted based on the level of difficulty. Thus, they started with the most difficult one and ended with the least difficult task. In each task, all participants first completed the neutral tasks followed by the affective versions. The average time spent in completing the tasks was 40 minutes. Summary statistics for all of the tasks are shown in Table 2.

Data Preparation

Mean accuracy rates and RT were obtained for all tasks. Whereas accuracy rates and RT were used as indices of updating, only RT was used for inhibition and shifting. RT was used for inhibition and shifting because the costs associated with these abilities are more prominent with time. Moreover, the Stroop and letter-number tasks usually have almost perfect scores, and hence are weaker in showing individual differences in performance. In order to obtain the Stroop effect, the mean score was calculated for congruent and incongruent trials. Several methods have been used to calculate inhibition (Jensen & Rohwer, 1966). In this case, standardized residuals were obtained by pre-

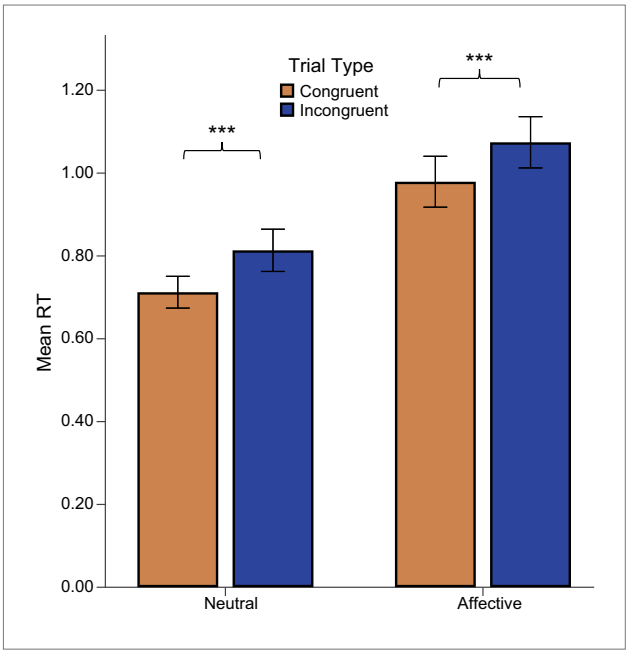

Figure 4. Summary of mean RTs based on trial type in the Stroop task. The error bars display 95 % confidence intervals. *** — $p < .001$.

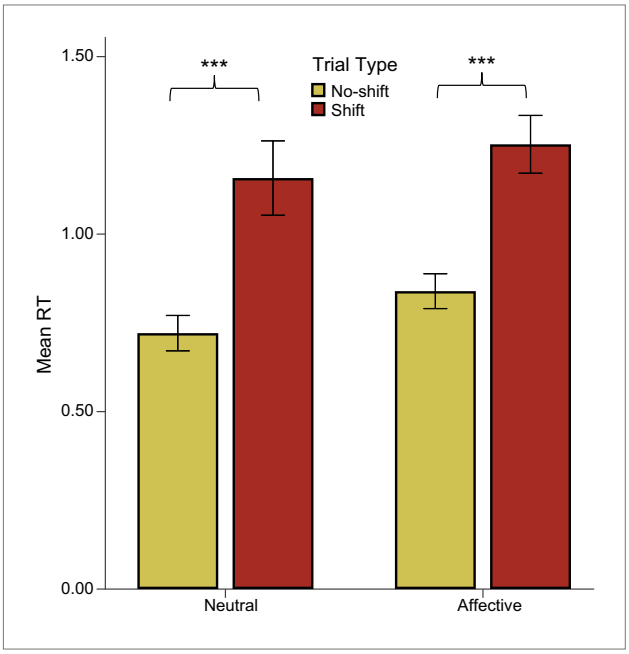

Figure 5. Summary of mean RTs based on trial type in the shifting task. The error bars display 95 % confidence intervals. *** — $p < .001$

dicting incongruent trials from congruent trials. This preferred method results in indices that best meet the normality assumption. In shifting, the mean RTs for the first block, second block and the trials that required the same task in the third block were computed as no-shift trials, whereas the RT of trials in the third block that required shifting were computed as shift trials. Here again, the standardized residuals were calculated by predicting the mean RT of shift trials from the mean RT of no-shift trials. Finally, the raw data were inspected and tested for normality. Though the results of the test showed deviation from normality, parametric tests were used for the analyses as it has been suggested that parametric tests could still be used if the data have been collected from a group with more than 50 participants (Ghasemi & Zahediasl, 2012).

To test the mean difference between the neutral and affective versions of the 2-back, letter-number and Stroop tasks, paired *t*-test analyses were conducted. Testing the cost of inhibition required that congruent and incongruent RTs were compared. To this end, congruent and incongruent RTs were compared separately for neutral and affective Stroop tasks using the paired *t*-test. The analyses of shift cost followed the same procedure as with cost of inhibition. Thus, RTs of no-shift and shift trials were compared using the paired *t*-test. No-shift RT and shift RT were tested for mean differences separately for the neutral and affective tasks. Finally, the Pearson correlation was used to test the relationships among all EF measures with the *p*-values adjusted ($p < .05$) using the false discovery rate (FDR: Benjamini & Hochberg, 1995).

Results

There was no significant mean difference between the neutral and affective 2-back for accuracy rate ($t(78) = .07$, $p = .95$, $d = .01$) and RT ($t(78) = 1.71$, $p = .09$, $d = .19$). For the relationship between the neutral and affective 2-back tasks, the results showed a significant positive correlation between the neutral and affective 2-back task using accuracy rate ($r(79) = .65$, $p < .001$) and RT ($r(79) = .55$, $p < .001$). Thus, participants who performed higher in the neutral task also performed higher in the affective task.

Regarding inhibition, a significant mean difference was obtained between congruent RT and incongruent RT in the neutral task ($t(79) = 11.54$, $p < .001$, $d = 1.28$) and the affective task ($t(79) = 8.1$, $p < .001$, $d = .90$), suggesting the existence of inhibition costs. This is further illustrated in Figure 4. In addition, there was a significant mean difference in congruent trials of the neutral and affective Stroop tasks on the one hand ($t(79) = 15.60$, $p < .001$, $d = 1.74$), and incongruent trials of the neutral and affective Stroop tasks on the other hand ($t(79) = 14.37$, $p < .001$, $d = 1.46$). Furthermore, the results of the comparison between the cost of inhibition for neutral and affective tasks showed no significant mean difference ($t(79) = .99$, $p = .33$, $d = .11$), suggesting no mean difference in the inhibition cost obtained with neutral and affective stimuli. Finally, the results of the relationship between neutral and affective inhibition costs showed no significant correlation ($r(80) = .13$, $p = .19$).

As for shift cost, there was a significant mean difference between no-shift and shift RTs in both the neutral ($t(78) = 12.03$, $p < .001$, $d = 1.35$) and affective tasks ($t(78) = 18.42$, $p < .001$, $d = 2.07$). This is further illustrated in Figure 5. Furthermore, the results showed that the mean difference between the no-shift RT of the neutral and affective tasks on the one hand ($t(78) = 5.64$, $p < .001$, $d = .46$) and that of the shift RT ($t(78) = 3.84$, $p < .001$, $d = .43$) on the other hand were statistically significant. However, there was no significant mean difference between the neutral and affective shift costs ($t(78) = .28$, $p = .78$, $d = .03$). Moreover, there was a significant positive correlation between the neutral and affective shift costs ($r(79) = .38$, $p < .001$). This shows that the higher the shift cost in the neutral task, the higher the shift cost in the affective task as well.

In summary, the results of the present study showed no significant mean difference between the neutral and affec-

Table 3. Summary of Correlation Coefficients Between the Neutral and Affective Versions of the Three EF Tasks

Variable	1	2	3	4	5	6	7	8
1. Updating ACC	—							
2. Affective updating ACC	.65**c	—						
3. Updating RT	−.06	−.23*	—					
4. Affective updating RT	−.04	−.17	.55**c	—				
5. Inhibition	−.01	−.05	.02	.02	—			
6. Affective inhibition	−.14	−.19	.01	.04	.15	—		
7. Shifting	−.08	−.15	.03	−.18	.23*	.03	—	
8. Affective shifting	−.08	−.16	.05	−.05	.13	−.04	.38**c	—

Note: * $p < .05$
** $p < .01$
c p is significant after FDR adjustment.

tive versions of the three EF tasks. However, there was a significant positive correlation between the neutral and affective versions of the updating and the shifting tasks, but not inhibition. Table 3 provides further results of the multiple correlations conducted on the three EF tasks. Hence, apart from the neutral and affective versions of updating and shifting, no other significant correlations were observed.

Discussion

The study aimed at presenting a new battery of EF tasks using both non-affective and affective stimuli. Updating, inhibition and shifting were chosen as representative of EF and were assessed with the *n*-back, Stroop and letter-number tasks respectively. The results showed that the accuracy rates and RTs of the neutral and affective versions of the *n*-back task were significantly positively correlated, as shown in Table 3. This pattern was similar for the letter-number task. The finding on updating is consistent with previous studies (Schweizer et al., 2019) where it was reported that no significant mean difference existed at the behavioural level. The longer RTs observed in the affective Stroop and letter-number tasks were consistent with the findings of previous studies (Aker & Landrø, 2014; Veroude et al., 2013), although there was no significant correlation between the neutral and affective Stroop costs. Moreover, previous studies failed to directly compare the costs associated with inhibition and shifting except to focus on incongruent trials (Aker & Landrø, 2014; Veroude et al., 2013; Whalen et al., 1998).

It is important to note that since the principle behind these tasks stood the same both in the neutral and affective versions, it was expected that participants should approach the tasks in a similar way, thus producing these results. The processing of affective information requires more resources than neutral information due to the additional requirement of identifying the emotion by looking at all possible cues from the face. This is not the case in neutral tasks. Taking the *n*-back task as an example, since it was only letters that appeared on the screen, it was easier to just identify a letter and proceed. In the case of the affective pictures, after the picture is displayed, one still has to identify the emotion before associating it with the right valence. The increased RTs in the affective versions reinforces the need to consider working with neutral and affective versions of EF measures when studying the link between EF and emotion. Moreover, the low to medium positive correlations obtained in the neutral and affective versions of the *n*-back and letter-number tasks suggests that both versions can be used in the assessment of EF. The differences in RT of the neutral and affective versions provide further insight on how stimuli type could affect the performance of participants.

Though many measures of EF can be found in the literature, there is no existing battery of cognitive tasks that measures the three EF components using both neutral and affective stimuli. It is important to highlight some limitations associated with the current EF battery. The present study used only letters and numbers for the neutral updating and shifting tasks and colours for the Stroop task. The affective tasks had faces and affective words (for the affective Stroop task). Since the processing of faces requires more resources compared to letter processing, this could affect the pattern of the obtained results. The present study was carried out using younger adults (mean age of 19.3 years) without a history of affective disorders. The present findings cannot be generalized to other age groups and individuals suffering from affective disorders.

The new EF battery is useful in directly comparing performances when using neutral and affective stimuli. More experiments must be conducted to further broaden the applicability of this novel approach in the assessment of EF in emotion-cognition interactions. Future experiments should consider exploring how participants in an emotional state or with affective disorders will perform when presented with the current battery of EF tasks.

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методы

Батарея когнитивных задач с эмоционально окрашенными и нейтральными стимулами для измерения управляющих функций

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Аннотация. Управляющими функциями (УФ) являются когнитивные процессы относительно высокого уровня, задействованные в целенаправленном поведении. Предполагается, что эти функции работают по-разному в зависимости от типа стимулов (неаффективные или аффективные). Хотя существует много исследований, использующих методики на УФ с аффективными и неаффективными стимулами, их результаты не позволяют прямо сравнить данные, полученные с помощью методик этих двух типов. В настоящем исследовании для решения этой проблемы представляется новая батарея когнитивных задач, использующих неаффективные и аффективные стимулы. Для измерения трех основных УФ — обновления, торможения и переключения — использовались задача «n шагов назад», задача Струпа и задача «буква-цифра». Также были разработаны новые, аффективные, версии этих классических задач. Восемьдесят четыре испытуемых выполняли сначала нейтральную, а потом аффективную версию каждой задачи. Получены значимые положительные корреляции между нейтральной и аффективной версиями задач на обновление и переключение, но не между нейтральной и аффективной версиями задачи на торможение. Не выявлено значимых различий в показателях обновления, цены торможения и цены переключения в нейтральной и аффективной версиях. Необходимы дальнейшие исследования, чтобы расширить применимость предложенного нового подхода к измерению УФ в контексте взаимодействия между эмоциональными и познавательными процессами.

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Ключевые слова: управляющие функции, аффективная информация, обновление, переключение, торможение, задача «n шагов назад», задача Струпа, задача «буква-цифра»

Благодарности. Выражаю благодарность Дмитрию Люсину за консультации и Екатерине Уэтовой за помощь в сборе данных.

Статья поступила в редакцию 12 июля 2019 г. Принята в печать 28 сентября 2019 г.

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