

Martynova E.N.¹, Lyusin D.^{1,2} The influence of happiness and anxiety on emotional Stroop effect

Мартынова Е.Н.¹, Люсин Д.В.^{1,2} Влияние радости и тревоги на эмоциональный эффект Струпа

¹ National Research University Higher School of Economics, Moscow, Russia

² Institute of Psychology, Russian Academy of Sciences, Moscow, Russia

The emotional Stroop effect is defined as a delay in reaction time or an increase in error rate while naming the color of emotional words compared to neutral words. The aim of this study was to examine how happiness and anxiety influence the emotional Stroop effect. According to the principle of emotion congruence, information processing is facilitated when its emotional valence matches the individual's mood. In the context of the emotional Stroop task, this implies that emotionally congruent words should be processed more easily, leading to a reduction or even elimination of the emotional Stroop effect. Conversely, processing incongruent stimuli should be more challenging and the impact of word meaning on color naming should be more pronounced. Based on these considerations, the hypothesis was proposed that emotional Stroop effect would be stronger when using stimuli incongruent with the participant's emotional state. We administered the emotional Stroop task with neutral, happy, and threatening words, music for mood induction, and the EmoS-15 questionnaire to assess mood induction effectiveness. The hypothesis was partially confirmed, as the emotional Stroop effect, assessed by error rates, was greater for stimuli incongruent with the emotional state.

Keywords: emotional Stroop effect, emotion congruence, mood induction, anxiety, happiness

Introduction

This research aims to understand how opposite emotional states with high arousal influence the emotional Stroop effect and whether its size depends on emotion congruence between emotional stimuli and participants' moods. Emotional Stroop effect (ESE) is calculated as a delay in reaction time (RT) while naming the colors of emotional words compared to neutral words [Algom et al., 2004]. ESE can also be estimated as an increase in error rate (ER) while naming the colors of emotional words.

In the classical Stroop task, participants must name the colors in which the words are printed, while the words are the names of colors [Stroop, 1935]. If the meaning of the word and the color in which it is printed are congruent, RT is faster than when they are not congruent. In the emotional Stroop task (EST), another kind of stimuli is used: emotional and neutral words instead of color words.

Although both tasks look similar, the explanations of the classical and emotional Stroop effects differ; some authors believe that they engage substantially different cognitive processes [Algom et al., 2004].

ESE has two main explanations. The first one refers to the mechanisms of attention. Emotional information automatically captures attention [Lang et al., 1990]. Therefore, a participant's attention is attracted to the emotional meaning of the word. This induces interference and distracts a participant from performing the main task – recognizing and naming the color of the word. The time that a participant needs to inhibit the processing of irrelevant information causes a delay in the answer [Sysoeva, 2014]. Algom and co-authors [2004] suggested another account for ESE, Generic Slowdown. The authors claim that ESE does not include the mechanisms of attention. Color and meaning of words cannot be congruent or incongruent dimensions in EST. Therefore, interference does not appear between these two dimensions. According to the Generic Slowdown account, in response to a threatening stimulus, all reactions irrelevant to the threat slow down. This is the reason for the delay in naming the color of a threatening word.

We hold the opinion that ESE requires the work of attention, so it is necessary to describe how happiness and anxiety influence attention. Fredrickson [1998] claimed in her broaden-and-build theory that positive emotions make attention broader, but negative emotions narrowed. This suggestion was partly confirmed by Rowe and colleagues [2007]. According to their results, positive affect expands attentional filters and weakens inhibitory control. Extrapolating this theory on ESE, it can be expected that the broadening of the scope of attention while in a positive mood will result in greater interference from the meaning of the word, thus making ESE greater, regardless of the emotional tone of words. Eysenck and co-authors [2007] suggested the new approach. Attentional control theory claims that anxiety impairs the goal-directed system of attention and that threat-related stimuli grab attention. Therefore, anxious participants should be worse at inhibiting the meaning of threatening words while performing EST, and ESE should be greater.

Considering the question about how moods influence the processing of emotional information, it is necessary to describe the principle of emotion congruence. According to this principle, the processing of stimuli is facilitated if their emotional tone matches a participant's mood or emotional trait [Rusting, 1998]. It is not always clear what facilitation means in EST. On the one hand, this may mean that facilitation leads to faster processing of emotion congruent stimuli meaning and switching attention to color. Then, RT should be lower for emotion congruent stimuli. On the other hand, facilitated processing leads to additional attentional capture by word meaning and distracts from the color. Then, RT should be higher for emotion congruent stimuli. Also, it is important to consider the

principle of counter-regulation in affective attentional biases. According to this principle, attention automatically switches to stimuli that have a different emotional tone with the emotional state [Rothermund et al., 2008]. It provides balanced processing of emotional information. This principle is completely opposite to the principle of emotion congruence but has the same contradictory predictions about ESE. On the one hand, automatic attention switching to emotion incongruent stimuli may lead to faster meaning processing and main task completion. Then RT should be lower for emotion incongruent stimuli. On the other hand, it can lead to attention grabbing by word meaning and slower switching to color naming. Then RT should be higher for emotion incongruent stimuli. All this refers to the mechanisms of ESE and the special feature of attention work, which is still completely unknown.

The large part of the literature that considers interaction between participants' states and types of emotional stimuli in EST is dedicated to affective disorders (see [Williams et al., 1996] for review). For example, ESE in depressed people was shown to be greater for depressive words compared to maniacal words [Gotlib, McCann, 1984]. MacLeod and Rutherford [1992] demonstrated the same pattern for trait anxiety. They tested students with different levels of trait anxiety at the beginning of the semester and before exams. Participants demonstrated similar results when situational anxiety was lower (at the beginning of the semester), but the effect was greater in more anxious students before the exams. These studies show that participants with anxious or depressive disorders or traits demonstrated longer RT for emotion congruent stimuli in EST. This can be observed because words related to affective disorders or traits have a high personal significance for such people [Williams et al., 1996].

Another direction of research focuses on emotion congruence in EST when healthy participants are induced into various emotional states. Gilboa-Schechtman and co-authors [2000] considered three possible factors influencing the size of ESE, namely emotionality, concern relevance, and mood congruence. They found that the mean RT was greater for emotional stimuli congruent with participants' moods. The target mood included sadness and happiness. They can be named as opposite, but they have different levels of arousal: high for happiness and low for sadness. Isaac and colleagues [2011] partly replicated this result for sadness. They showed that participants in a sad emotional state had longer latencies for sad words than in happiness. More recent research [Schwager, Rothermund, 2013] demonstrated results that can be considered opposite. Mean ER for emotional stimuli incongruent with participants' moods was greater than for congruent stimuli. The authors explain this finding by referring to the idea of emotional counter-regulation. However, the authors

used a modified version of EST with emotional pictures and colored frame. This result may not represent and describe mechanisms that are the basis for the word version of ESE and EST because it includes spatial attention, and two dimensions are not located in one stimulus. Also, Schwager and Rothermund used a romantic movie and a movie on the final days of World War II for mood induction and IPANAT for affect measurement. It does not allow us to define precisely which emotional states were induced.

Emotion congruence has two opposite predictions about ESE severity. On the one hand, since the processing of emotionally congruent information is facilitated, this leads to the faster processing of the meaning of emotionally congruent words, which, in turn, allows the participant to name the word color faster, and ESE becomes smaller or even disappears. Conversely, the processing of emotion incongruent stimuli is impaired; so, interference and ESE must be greater compared to emotion congruent stimuli. On the other hand, facilitated processing can lead to additional grabbing of attention by word meaning, then slowdown to emotion congruent stimuli, and ESE will be greater. There were two experiments that partly supported each of these predictions. At the same time, we should also consider the general influences of anxiety and happiness on attention. On the other side, it is still unknown whether the general effects of emotion on attention influence ESE in the same way, or if it has any specific effects. We suggest that ESE should be greater for emotional stimuli incongruent with a participant's mood compared to congruent emotional stimuli.

Method

Participants

Eighty-nine participants aged from 18 to 31 ($M = 20.25$, $SD = 2.69$, 60 females, 29 males) took part in the experiment. Participants gave informed consent; debriefing was carried out after the experiment. Participants were volunteered psychology students.

Emotional Stroop task

The task included 21 neutral, 21 threatening, and 21 happy words. Words were taken from the stimuli base ENRuN [Lyusin, Sysoeva, 2017], which includes affective ratings for Russian nouns. The word lists were balanced in letters and syllable length ($M = 6.14$ and $M = 2.33$ for threatening words; $M = 6.05$ and $M = 2.40$ for neutral words; $M = 5.95$ and $M = 2.43$ for happy words). Threatening words had the highest ratings on the scale "Fear" ($M = 3.43$, $SD = 0.37$), happy words had the highest ratings on the scale "Happiness" ($M = 4.38$, $SD = 0.22$), and neutral words had the lowest ratings on all emotion scales. Used words are given in the Appendix. A fixation cross appeared before each trial

for 400 ms. Then a word was presented until response. The word appeared in the center of the black screen with a letter high of 1.4 cm, printed in one of three colors: blue, green, or yellow. Participants determined the color in which the word was printed using three predetermined keys: “V”, “B”, and “N” on a keyboard. Each key was marked by a blue, green, or yellow sticker. Participants chose fingers and hands for responses by themselves. Words of the same valence were presented in one block; the order of colors within a block was pseudorandom with one restriction: one color could not be repeated more than twice in a row. Each block was presented three times, so that every word appeared in each color. In sum, a participant performed 189 trials arranged in 9 blocks in each part of the experiment. PsychoPy v.2020.2.10 was used for stimuli presentation and response recording (ER and RT) [Peirce et al., 2019].

Mood induction

Two types of music were used for mood induction: “A Man Named Fred Krueger – Steve Jablonsky – A Nightmare on Elm Street – 2010” for anxiety, and the backing track of the song “Safe and Sound – Capital Cities – In a Tidal Wave of Mystery – 2013” for happiness. White noise was used for the neutral state. Participants were listening to the music while performing the EST. We chose music for mood induction because it engages auditory modality that is different with visual modality which is required for task completion. During anxiety induction, the stress level did not exceed the intensity of negative emotions in regular life.

Mood manipulation check

We used the EmoS-15 questionnaire [Lyusin, 2019] to check the effectiveness of the induction of target emotional states. The questionnaire includes three scales: “Positive affect”, “Negative affect”, and “Tension”. The scales “Tension” and “Positive affect” were used for mood manipulation checks.

Procedure

At the beginning of the experiment, participants reported their emotional state using EmoS-15. After that, participants were presented with a practice session to learn the target buttons. The practice session included 33 trials with neutral words that were not used in the main session. At the end of the practice session, they received feedback on the number of correct responses. If this number was greater than 29 (90% of trials), the experiment continued. If not, a participant took the practice session once again. The main session was divided into three parts with the induction of three different moods. In the first part, one of the emotional states, happy or anxious, was induced with the help of relevant music. While listening to the music, a participant performed the EST. After that, a participant filled

out the EmoS-15 questionnaire. A participant performed the same tasks in a neutral state while listening to white noise in the second part. In the third part, another emotional state, anxious or happy, was induced. Every experimental part included nine blocks with 189 trials. Participants filled out EmoS-15 after each part of the experiment. The layout of the procedure is presented in Figure 1.

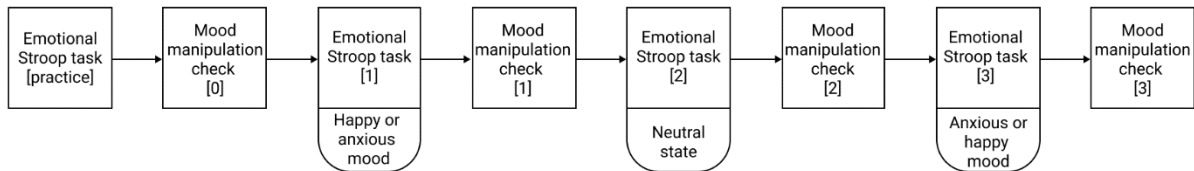


Fig. 1. The Procedure of the Experiment.

Results

Data was processed in R v. 2022.12.0+353 [R Core Team, 2021] and JASP v. 0.17.1 [Apple Silicone; JASP Team, 2023].

Mood manipulation check

We calculated the mean scores on the scales “Positive affect” and “Tension” of the EmoS-15 questionnaire to estimate how effective mood induction was (Table 1).

Table 1

Mean Scores and Standard Deviations of Positive Affect and Tension before and after the Induction of Anxious, Happy, and Neutral States

Emotional state	Scale	
	Positive affect <i>M (SD)</i>	Tension <i>M (SD)</i>
Before	13.86 (4.84)	12.46 (4.56)
Anxious	11.33 (5.03)	13.02 (5.01)
Happy	13.35 (5.21)	10.47 (4.52)
Neutral	11.28 (5.30)	11.57 (4.94)

Repeated Measures ANOVA (4 x 2) was conducted with two factors, *emotional state* (measurement before experiment, anxious, happy, and neutral) and *mood scale* (Positive affect, Tension); the sequence of mood induction (anxiety-happiness or happiness-anxiety) was used as between subject

factor; mean scores were dependent variables. We also checked assumptions for ANOVA using Levene's test showed the homogeneity of variances ($F(7) = 0.63, p = 0.73$), but Shapiro-Wilk test indicated normal distribution only for one variable (Positive affect before induction; $p = .05$). However, some authors [Caldwell et al., 2022] claimed that ANOVA quite stable against violations of the normality assumption. The interaction between the factors *emotional state* and *mood scale* ($F(3, 258) = 27.76, p < .001, \eta_p^2 = .24$) and the factor *emotional state* ($F(3, 258) = 15.46, p < .001, \eta_p^2 = .15$) were statistically significant with higher scores for the scale "Tension" after anxiety induction ($M = 13.02$) and higher scores for the scale "Positive affect" after happiness induction ($M = 13.35$; Figure 2). Pairwise comparisons were implemented using Tukey's HSD method. The mean scores on "Positive affect" in happiness ($M = 13.35$) were greater than in anxiety ($M = 11.33; t(88) = -5.38, p_{Tukey} < .001$) and neutral state ($M = 11.28, t(88) = -5.47, p_{Tukey} < .001$), and the mean scores on "Tension" in anxiety ($M = 13.02$) were greater than in happiness ($M = 10.47; t(88) = -6.78, p_{Tukey} < .001$) and neutral state ($M = 11.57; t(88) = 3.86, p_{Tukey} = .003$). The interaction between factors *emotional state* and *block* ($F(3, 258) = 1.30, p = .28, \eta_p^2 = .02$) and the interaction between factors *emotional state, mood scale* and *block* ($F(3, 258) = 1.31, p = .27, \eta_p^2 = .02$) were not significant. Also, the influence of factor *block* as between subject effect ($F(1,86) < 1$) was not significant either. Therefore, the target moods were induced successfully regardless of the mood inducing sequence.

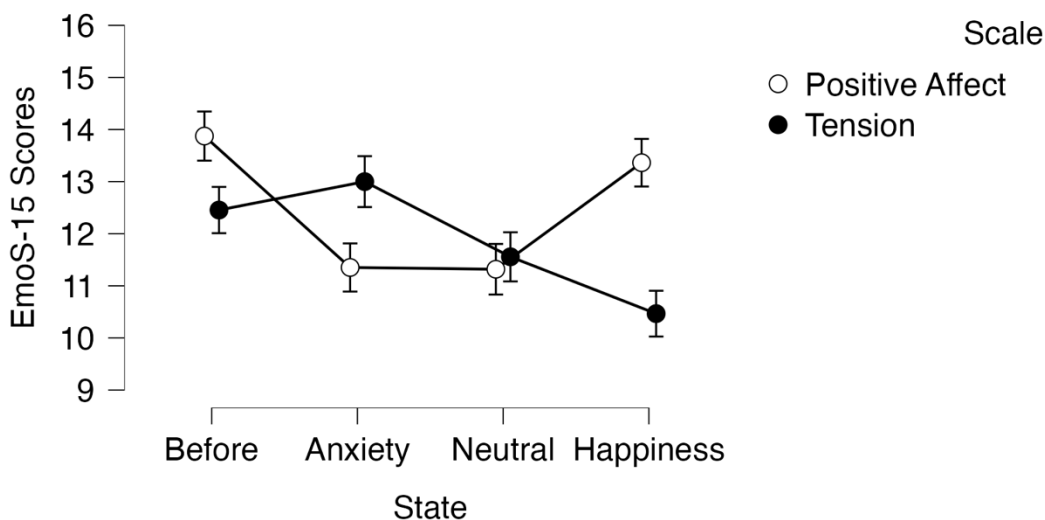


Fig 2. Scores on EmoS-15 Scales "Positive Affect" and "Tension" in Neutral, Anxious, and Happy States

Note. Error bars represent SE.

Emotional Stroop effect

Two indicators, ER and RT, were used for calculating ESE. Trials with incorrect responses (3.70%) and RTs with more than three interquartile ranges above the third quartile or more than three

interquartile ranges below the first quartile of the RT distribution were excluded from the analysis of RT.

The mean RT and ER were calculated for each participant in each emotional state (neutral, anxious, and happy) for all types of stimuli (neutral, threatening, and happy) (Table 2).

Table 2

Means and Standard Deviations (in brackets) for RT (in ms) and ER

Emotional State	Stimuli							
	Neutral		Threatening		Happy		RT	ER
	RT	ER	RT	ER	RT	ER		
Neutral	1373 (100)	2.08 (2.00)	1397 (120)	2.39 (2.04)	1396 (116)	2.27 (2.07)	1389 (112)	2.25 (2.04)
Anxious	1383 (110)	2.20 (2.18)	1418 (138)	2.36 (2.14)	1404 (118)	2.48 (2.07)	1402 (122)	2.35 (2.13)
Happy	1375 (102)	2.43 (2.57)	1410 (125)	2.81 (2.82)	1401 (110)	2.55 (2.32)	1395 (112)	2.59 (2.57)
	1377 (104)	2.24 (2.25)	1408 (128)	2.52 (2.33)	1400 (115)	2.43 (2.15)		

The size of ESE was calculated in two ways: as a difference between mean RT for emotional (threatening and happy) and neutral stimuli and as a difference between mean ER for the same types of stimuli. A paired *t*-test was used to evaluate the significance of ESE (Table 3). The results show that ESE was significant for all experimental conditions when it was calculated as an RT difference but not when it was calculated as an ER difference.

Table 3

Size and Statistical Significance of Emotional Stroop Effect for Mean RT (in ms) and ER

Emotional state	Stimuli					
	Threatening			Happy		
	ESE (sd)	Paired <i>t</i> -test	<i>p</i>	ESE (sd)	Paired <i>t</i> -test	<i>p</i>

Reaction Time						
Neutral	24.60 (56.63)	4.09	< .001	22.80 (50.72)	4.24	< .001
Anxious	33.99 (63.45)	5.05	< .001	20.67 (53.40)	3.60	< .001
Happy	35.84 (53.37)	6.33	< .001	26.05 (49.14)	4.99	< .001
Error Rate						
Neutral	0.33 (1.89)	1.64	.10	0.20 (1.17)	0.88	.38
Anxious	0.16 (2.07)	0.72	.48	0.28 (2.02)	1.31	.19
Happy	0.38 (1.94)	1.86	.07	-0.26 (2.25)	0.53	.60

Testing the hypothesis

Repeated Measures ANOVA (2 x 2) was used with two factors: *emotional state* (anxiety vs. happiness) and *emotional type of stimuli* (threatening vs. happy). The RT for each type of stimuli and the size of ESE as RT were dependent variables. Levene's test indicated the homogeneity of variances for RTs ($F(3) = 0.38, p = .77$) and ESE as RTs ($F(3) = 0.05, p = .98$), but Shapiro-Wilk test indicated non-normal distribution for all variables ($ps < .05$).

The interaction between factors and the effect of *emotional state* were not significant for RT ($F_s < 1$), but the effect of *emotional type of stimuli* was significant ($F(1, 88) = 6.46, p = .01, \eta_p^2 = .07$) with RT greater for threatening stimuli than for happy ones ($t(88) = 2.54, p = .01$).

For ESE, the interaction between the factors and the effect of *emotional state* were not significant ($F_s < 1$). The effect of *emotional type of stimuli* was significant ($F(1, 88) = 6.14, p = .02, \eta_p^2 = .07$) with ESE greater for threatening stimuli compared to happy ones ($t(88) = 2.48, p_{\text{bonf}} = .02$; Figure 3).



Fig. 3. ESE as RT Difference (ms) in Happiness and Anxiety.

Note. Error bars represent SE.

For ER analysis, we used Linear Mixed Models. Analysis was conducted using the lme4 [Bates et al., 2015] and r2glmm [Jaeger, 2016] R packages. ER for each type of stimuli and ESE as ER were dependent variables. *Emotional state* (anxiety and happiness), *emotional type of stimuli* (threatening and happy), and *sequence of mood induction* (anxiety-happiness and happiness-anxiety) were used as fixed effects, a random effect grouping factor was the *id of the participant*. Satterthwaite method was used for model testing. The results are presented in the Table 4. $R^2 = .03$ for the first model; $R^2 = .02$ for the second model.

Table 4

Linear Mixed Models for ER and ESE as ER

Predictors	SE	df	t	R^2	p
ER					
Intercept	0.20	89.00	12.57		.01
State	0.09	106.24	-1.45	.010	.15
Stimuli	0.09	95.47	-0.35	.002	.73
Block	0.20	89.00	-0.51	.023	.61
State*Stimuli	0.07	178.00	1.34	.000	.18
State*Block	0.08	106.24	-2.91	.016	.01
Stimuli*Block	0.08	95.47	-1.54	.007	.13
State*Stimuli*Block	0.08	178.00	-1.26	.003	.21

ESE as ER					
Intercept	0.14	101.77	1.17		.25
State	0.11	105.01	0.67	.004	.51
Stimuli	0.11	87.00	-1.14	.001	.26
Block	0.12	101.77	0.39	.000	.70
State*Stimuli	0.10	173.24	2.01	.001	.04
State*Block	0.11	105.01	0.77	.000	.44
Stimuli*Block	0.11	87.00	-1.14	.006	.26
State*Stimuli*Block	0.10	173.24	-1.00	.002	.32

Note. State – emotional state; Stimuli – type of emotional stimuli; Block – the sequence of mood induction

As can be seen from the table, we found the significant interaction between factors *emotional state* and *emotional type of stimuli* for ESE as ER and between factors *emotional state* and *the sequence of mood induction* for ER. Figure 4 shows ER for all types of stimuli separated by the sequence of mood induction. It is noticeable that there are two different tendencies. When anxiety was the first induced state, participants made more errors in happiness than in anxiety, but when happiness was the first induced state, the number of errors was lower in congruent emotional states (Table 5).



Fig 4. ER for all type of stimuli separated by sequence of mood inducing

Note. AH – anxiety-happiness; HA – happiness-anxiety. Error bars represent 95% CI

Table 5

Means and Standard Deviations (in brackets) for ER separated by sequence of mood inducing

Emotional State	Mood Inducing Sequence					
	Happiness-Anxiety			Anxiety-Happiness		
	Stimuli					
	Happy	Threatening	All	Happy	Threatening	All
Happiness	2.44 (2.35)	2.63 (2.56)	2.54 (2.46)	2.65 (2.30)	2.98 (3.05)	2.82 (2.68)
Anxiety	3.07 (2.10)	2.49 (2.18)	2.78 (2.14)	1.94 (1.90)	2.24 (2.12)	2.09 (2.01)
	2.76 (2.23)	2.56 (2.37)		2.30 (2.10)	2.61 (2.59)	

We conducted the additional analysis to check this observation. There were two analogical Linear Mixed Models with *emotional state* and *type of emotional stimuli* as fixed effects and *participant id* as a random effect for two groups of participants with different sequences of mood induction. As it was predicted, the influence of factor *emotional state* was significant ($t(88,90) = 2.20, p = .03$) for participants with anxiety-happiness sequence, and the interaction between factors *emotional state* and *type of emotional stimuli* was significant ($t(84,00) = 1.95, p = .05$) for participants in the happiness-anxiety group. Moreover, factors *emotional state* ($p = .04$) and *type of emotional stimuli* ($p = .05$) were also significant in this group.

Discussion

Two target emotional states, happiness and anxiety, were successfully induced, which allowed us to test the hypothesis about the effects of emotion congruence on the size of ESE. Two ways of calculating ESE were used, one based on RT and the other on ER. According to the emotion congruence hypothesis, ESE should be greater for stimuli incongruent with participants' moods compared to congruent stimuli. The interaction between the factors *emotional state* and *emotional type of stimuli* was insignificant for RT and ESE assessed by RT. Nevertheless, ESE using threatening stimuli and RT to them were greater than for happy stimuli, so we additionally demonstrated that threatening stimuli capture attention stronger.

When we used ER for testing our hypothesis, and ESE was assessed by ER, the results provided the pattern that corresponded to the predictions of the hypothesis. ESE for happy stimuli was greater in anxiety (0.38) than in happiness (-0.26), whereas ESE for threatening stimuli was greater in happiness (0.20) than in anxiety (0.16), although the size of ESE for ER was not significant. ESE for happy stimuli in happiness is reversed, so participants made more errors with neutral stimuli than with happy ones, while ESE using happy stimuli during anxiety has the greatest size. This serves as a perfect demonstration of emotion congruence: the processing of stimuli with the same emotional tone facilitates, and participants make fewer errors (even fewer than with neutral stimuli). However, we cannot answer the question of whether emotion congruence leads to faster processing of stimuli or additional grabbing of attention, which we raised in the beginning. ER stayed almost the same in anxiety and happiness. It may indicate that threatening stimuli are processed in a special way. The power of their emotionality is probably stronger than the influence of emotional states and emotion congruence. However, this suggestion must be additionally tested, for example, by using another type of stimuli with negative valence and high arousal.

It was also found that the order of mood inducing influenced ER for different types of stimuli, so we conducted two additional analyses for the anxiety-happiness and happiness-anxiety groups. When anxiety was the first induced mood, participants made more errors for non-congruent stimuli. These findings are similar to those obtained by Schwager and Rothermund [2013]. Moreover, participants made more errors with threatening stimuli ($M = 2.61$) than with happy stimuli ($M = 2.30$), and in happiness ($M = 2.82$) than in anxiety ($M = 2.09$; Table 5). When happiness was the first induced mood, participants made more errors in anxiety ($M = 2.78$) than in happiness ($M = 2.54$). The influence of the mood inducing sequence can be explained by the different effectiveness of mood inducing depending on the order. Mean scores for the scale Positive Affect ($M = 13.35$) were greater than for the scale Tension ($M = 10.47$) after the inducing of happiness ($t(88) = 3.60$, $p_{Tukey} = .01$), while the scores of these scales were almost equal ($t(88) = -2.12$, $p_{Tukey} = .11$). So, on average, happiness was induced more successfully than anxiety in the full sample. It leads to the suggestion that happiness remained for a longer time, interfered with anxiety, and suppressed emotion congruence when happiness was the first induced mood. At the same time, we did not find the effect of order in the estimation of mood inducing effectiveness, so this suggestion may not be completely true. Insufficient level of induced anxiety can also explain the weak effect of emotion congruence in anxiety.

The obtained results also allow us to examine the possible effects of mood on the size of ESE. We did not advance any hypotheses of this kind, but a number of theories related to emotional information

processing allow us to suggest that some moods can produce effects on ESE. For example, Fredrickson's broaden-and-build theory [Fredrickson, 1998] claims that positive emotions broaden the scope of attention, thought, and action. On the other hand, attentional control theory [Eysenck et al., 2007] claims that anxiety impedes the work of the goal-directed system of attention and weakens inhibitory control. We found no general effects of mood on the size of ESE, so none of these theoretical ideas received any support.

To sum up, our results suggest that the influence of mood on ESE is specific rather than general; emotional stimuli incongruent with a participant's mood can produce greater ESE. This finding is another demonstration of the role of emotion congruence in the processing of emotional information.

Funding

The study was implemented in the framework of the Basic Research Program at the National Research University Higher School of Economics (HSE University).

References

Algom D., Chajut E., Lev S. A rational look at the emotional Stroop phenomenon: A generic slowdown, not a Stroop effect. *Journal of Experimental Psychology: General*, 2004, 133, 323–338.

Bates D., Mächler M., Bolker B., Walker S. "Fitting Linear Mixed-Effects Models Using lme4." *Journal of Statistical Software*, 2015, 67(1), 1–48.

Caldwell A.R., Lakens D., Parlett-Pelleriti C.M., Prochilo G., Aust F. *Power Analysis with Superpower*. 2022. <https://aaroncaldwell.us/SuperpowerBook/index.html> (10.01.2023)

Eysenck M.W., Derakshan N., Santos R., Calvo M.G. Anxiety and cognitive performance: attentional control theory. *Emotion*, 2007, 7(2), 336–353.

Fredrickson B.L. What good are positive emotions? *Review of General Psychology*, 1998, 2(3), 300–319.

Gilboa-Schechtman E., Revelle W., Gotlib I.H. Stroop interference following mood induction: Emotionality, mood congruence, and concern relevance. *Cognitive Therapy and Research*, 2000, 24(5), 491–502.

Gotlib I.H., McCann C.D. Construct accessibility and depression: An examination of cognitive and affective factors. *Journal of Personality and Social Psychology*, 1984, 47(2), 427–439.

Isaac L., Vrijssen J.N., Eling P., van Oostrom I., Speckens A., Becker E.S. Verbal and facial-emotional Stroop tasks reveal specific attentional interferences in sad mood. *Brain and Behavior*, 2012, 2(1), 74–83.

Jaeger B. r2glmm: Computes R Squared for Mixed (Multilevel) Models. 2016, R package version 0.1.2, <https://cran.r-project.org/web/packages/r2glmm>

JASP Team (2023). JASP (Version 0.17.1) [Computer software].

Lang P.J., Bradley M.M., Cuthbert B.N. Emotion, attention, and the startle reflex. *Psychological Review*, 1990, 97(3), 377–395.

Lyusin D.V. EmoS-15: A self-report measure of core affect. *Psychological journal*, 2019, 40, 97–106.

Lyusin D.V., Sysoeva T.A. Emotional tone of nouns: ENRuN base. *Psychological journal*, 2017, 38, 122–131.

MacLeod C., Rutherford E.M. Anxiety and the selective processing of emotional information: Mediating roles of awareness, trait and state variables, and personality relevance of stimulus materials. *Behaviour Research and Therapy*, 1992, 30, 479–491.

Peirce J.W., Gray J.R., Simpson S., MacAskill M.R., Höchenberger R., Sogo H., Kastman E., Lindeløv J. PsychoPy2: Experiments in behavior made easy. *Behavior Research Methods*, 2019, 51(1), 195–203.

R Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria, 2021. <https://www.R-project.org/>

Rothermund K., Voss A., Wentura D. Counter-regulation in affective attentional biases: A basic mechanism that warrants flexibility in emotion and motivation. *Emotion*, 2008, 8(1), 34–46.

Rusting C.L. Personality, mood, and cognitive processing of emotional information: Three conceptual frameworks. *Psychological Bulletin*, 1998, 124, 165–196.

Schwager S., Rothermund K. Counter-regulation triggered by emotions: Positive/negative affective states elicit opposite valence biases in affective processing. *Cognition & Emotion*, 2013, 27(5), 839–855.

Stroop J.R. Studies of interference in serial verbal reaction. *Journal of Experimental Psychology*, 1935, 18, 643–662.

Sysoeva T.A. Theoretical analysis of the mechanism of occurrence of emotional Stroop effect. *Psychology. Journal of Higher School of Economics*, 2014, 11, 49–65.

Williams J.M.G., Mathews A., MacLeod C. The Emotional Stroop Task and Psychopathology. *Psychological Bulletin*, 1996, 120, 3–24.

Appendix

Words used in the experiment

ДОВОД	ГРОБ	ДОХОД
ПАРОМ	ПАНИКА	ВОСТОРГ
РЕЗЕРВ	ОПАСНОСТЬ	СЧАСТЬЕ
ЗЕРНО	ПОТЕРЯ	ТАЛАНТ
КАПУСТА	ТРЕВОГА	УДАЧА
КВАДРАТ	СТРАХ	ПОЦЕЛУЙ
ШЕРСТЬ	КОШМАР	РАДОСТЬ
ЮРИСТ	ТРУП	ТЕПЛО
КОСМОС	ЖЕРТВА	ЧУДО
СЕКЦИЯ	БОМБА	КОНФЕТА
ДЕЛЕНИЕ	УБИЙСТВО	ВЕЗЕНИЕ
ЖЕЛЕЗО	СМЕРТЬ	ДОБРОТА
ПОЛЮС	ПЫТКА	ШУТКА
ПАРКЕТ	ГИБЕЛЬ	НАГРАДА
ЛОГИКА	ВОЙНА	ТРИУМФ
МОНИТОР	УГРОЗА	КОМЕДИЯ

ПРОБА	УЖАС	УСПЕХ
ФАБРИКА	УБИЙЦА	ЮМОР
ОБЛОЖКА	АВАРИЯ	СМЕХ
СЛОВАРЬ	КАТАСТРОФА	ВЕСЕЛЬЕ
ОЧЕРК	ТЕРРОРИЗМ	МЕДАЛЬ

Поступила в редакцию: 1 сентября 2023 г. Дата публикации: 27 февраля 2024 г.

Information about the authors

Martynova Ekaterina Nikolaevna. Research Assistant, Laboratory for Cognitive Research, National Research University Higher School of Economics (HSE University), per. Armyansky, 4/2, 101000 Moscow, Russia, ORCID: <https://orcid.org/0000-0002-8295-1111>.

E-mail: enmartynova@outlook.com

Lyusin Dmitry Vladimirovich. PhD in Educational Science, Leading Researcher, Laboratory for Cognitive Research (HSE University), per. Armyansky, 4/2, 101000 Moscow, Russia; Leading Researcher, Laboratory of Psychology and Psychophysiology of Creativity, Institute of Psychology, Russian Academy of Sciences, ul. Yaroslavskaya, 13/1, 129366 Moscow, Russia. ORCID: <https://orcid.org/0000-0002-4429-8086>.

E-mail: ooch@mail.ru

For citation: Martynova E.N., Lyusin D. The influence of happiness and anxiety on emotional Stroop effect. *Psikhologicheskie Issledovaniya*, 2023, Vol. 16, No. 92, p. 3. <https://psystudy.ru>

Article addresses: <https://doi.org/10.54359/ps.v16i92.1491>

Мартынова Е.Н.¹, Люсин Д.В.^{1,2} Влияние радости и тревоги на эмоциональный эффект Струпа

¹Национальный исследовательский университет «Высшая школа экономики», Москва, Россия

²Институт психологии Российской академии наук, Москва, Россия

Эмоциональный эффект Струпа определяется как задержка во времени реакции или увеличение частоты ошибок при назывании цвета эмоциональных слов по сравнению с нейтральными словами.

Целью этого исследования было изучить, как радость и тревога влияют на эмоциональный эффект Струпа. Согласно принципу эмоциональной конгруэнтности, обработка информации облегчается, если ее эмоциональная окраска соответствует настроению человека. С точки зрения выполнения эмоциональной задачи Струпа это означает, что значение эмоционально конгруэнтных слов должно обрабатываться легче, а эмоциональный эффект Струпа при этом должен уменьшиться или даже исчезнуть. И наоборот, обработка неконгруэнтных стимулов должна быть осложнена, а влияние значения слова на называние цвета при этом должно быть больше. Основываясь на вышеуказанных соображениях, была выдвинута гипотеза, что эмоциональный эффект Струпа будет сильнее при использовании стимулов, неконгруэнтных эмоциональному состоянию испытуемого. Мы использовали эмоциональную задачу Струпа с нейтральными, радостными и угрожающими словами, музыку для индукции настроения, а также методику ЭмоС-15 для оценки эффективности индукции настроения. Гипотеза была частично подтверждена. Эмоциональный эффект Струпа, оцененный по частоте ошибок, был больше для стимулов, неконгруэнтных эмоциональному состоянию.

Ключевые слова: эмоциональный эффект Струпа, эмоциональная конгруэнтность, индукция эмоций, радость, тревога

Финансирование

Данное исследование было выполнено в рамках Программы фундаментальных исследований НИУ ВШЭ.

Литература

Люсин Д.В. ЭмоС-15: Самоотчетная методика для измерения ядерного аффекта. Психологический журнал, 2019, 40, 97–106.

Люсин Д.В., Сысоева Т.А. Эмоциональная окраска имен существительных: база ENRuN. Психологический журнал, 2017, 38, 122–131.

Сысоева Т.А. Теоретический анализ механизмов возникновения эмоционального эффекта Струпа. Психология. Журнал Высшей школы экономики, 2014, 11, 49–65.

Algom D., Chajut E., Lev S. A rational look at the emotional Stroop phenomenon: A generic slowdown, not a Stroop effect. Journal of Experimental Psychology: General, 2004, 133, 323–338.

Bates D., Mächler M., Bolker B., Walker S. “Fitting Linear Mixed-Effects Models Using lme4.” *Journal of Statistical Software*, 2015, 67(1), 1–48.

Caldwell A.R., Lakens D., Parlett-Pelleriti C.M., Prochilo G., Aust F. *Power Analysis with Superpower*, 2022. <https://aaroncaldwell.us/SuperpowerBook/index.html> (10.01.2023)

Eysenck M.W., Derakshan N., Santos R., Calvo M.G. Anxiety and cognitive performance: attentional control theory. *Emotion*, 2007, 7(2), 336–353.

Fredrickson B.L. What good are positive emotions? *Review of General Psychology*, 1998, 2(3), 300–319.

Gilboa-Schechtman E., Revelle W., Gotlib I.H. Stroop interference following mood induction: Emotionality, mood congruence, and concern relevance. *Cognitive Therapy and Research*, 2000, 24(5), 491–502.

Gotlib I.H., McCann C.D. Construct accessibility and depression: An examination of cognitive and affective factors. *Journal of Personality and Social Psychology*, 1984, 47(2), 427–439.

Isaac L., Vrijisen J.N., Eling P., van Oostrom I., Speckens A., Becker E.S. Verbal and facial-emotional Stroop tasks reveal specific attentional interferences in sad mood. *Brain and Behavior*, 2012, 2(1), 74–83.

JASP Team (2023). *JASP (Version 0.17.1)* [Computer software].

Jaeger B. *r2glmm: Computes R Squared for Mixed (Multilevel) Models*. 2016, R package version 0.1.2, <https://cran.r-project.org/web/packages/r2glmm>

Lang P.J., Bradley M.M., Cuthbert B.N. Emotion, attention, and the startle reflex. *Psychological Review*, 1990, 97(3), 377–395.

MacLeod C., Rutherford E.M. Anxiety and the selective processing of emotional information: Mediating roles of awareness, trait and state variables, and personality relevance of stimulus materials. *Behaviour Research and Therapy*, 1992, 30, 479–491.

Peirce J.W., Gray J.R., Simpson S., MacAskill M.R., Höchenberger R., Sogo H., Kastman E., Lindeløv J. PsychoPy2: Experiments in behavior made easy. *Behavior Research Methods*, 2019, 51(1), 195–203.

R Core Team R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria, 2021. <https://www.R-project.org/>

Rothermund K., Voss A., Wentura D. Counter-regulation in affective attentional biases: A basic mechanism that warrants flexibility in emotion and motivation. *Emotion*, 2008, 8(1), 34–46.

Rusting C.L. Personality, mood, and cognitive processing of emotional information: Three conceptual frameworks. *Psychological Bulletin*, 1998, 124, 165–196.

Schwager S., Rothermund K. Counter-regulation triggered by emotions: Positive/negative affective states elicit opposite valence biases in affective processing. *Cognition & Emotion*, 2013, 27(5), 839–855.

Stroop J.R. Studies of interference in serial verbal reaction. *Journal of Experimental Psychology*, 1935, 18, 643–662.

Williams J.M.G., Mathews A., MacLeod C. The Emotional Stroop Task and Psychopathology. *Psychological Bulletin*, 1996, 120, 3–24.

Сведения об авторах

Мартынова Екатерина Николаевна. Стажер-исследователь лаборатории когнитивных исследований Национального исследовательского университета «Высшая школа экономики», Армянский переулок, 4/2, 101000 Москва, Российская Федерация, ORCID: <https://orcid.org/0000-0002-8295-1111>.

E-mail: enmartynova@outlook.com

Люсин Дмитрий Владимирович. Кандидат педагогических наук, ведущий научный сотрудник лаборатории когнитивных исследований Национального исследовательского университета «Высшая школа экономики», Армянский переулок, 4/2, 101000 Москва, Российская Федерация; ведущий научный сотрудник лаборатории психологии и психофизиологии
Психологические исследования 2023 Т 16 № 92 <https://psystudy.ru> 20

Martynova E. N., Lyusin D. Mood and emotional Stroop effect

творчества Института психологии РАН, г. Москва, Российская Федерация, ORCID:
<https://orcid.org/0000-0002-4429-8086>.

E-mail: ooch@mail.ru

Ссылка для цитирования

Мартынова Е.Н., Люсин Д.В. Влияние радости и тревоги на эмоциональный эффект Струпа.
Психологические исследования. 2023. Т. 16, № 92. С. 3. URL: <https://psystudy.ru>