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## Emotional activation measured using the emotional Stroop task in early Hungarian–Serbian bilinguals from Serbia

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3 **Abstract:** The primary goal of this research was to examine the processing of emotionally valenced  
4 and neutral words in the context of bilingualism. The objective was to find out, using an experimental  
5 measure of automatic emotional activation, if there were differences in response time in the first and the  
6 second language, Hungarian and Serbian respectively. The sample consisted of early Hungarian–Serbian  
7 bilinguals, assimilated into the Serbian majority culture.

8 The emotional Stroop task is an experimental paradigm, which has been adapted to measure  
9 bilingual population in the past few years. The emotional Stroop interference could be counted from  
10 response time latencies, which is usually an effect showing longer responses to negative vs. neutral  
11 information.

12 Hungarian and Serbian negatively, positively and neutrally valenced words were used in the re-  
13 search. Our hypothesis was that there would be a similar emotional activation in the first and the second  
14 language and that negative words would be processed the longest.

15 The result of the research was a significant main effect of word type, where the negative infor-  
16 mation captured the attention for a longer period of time than the neutral one. A similar pattern of word  
17 processing showed in both languages and there were no significant differences between Hungarian and  
18 Serbian reaction times and the interaction between word type and language was not significant. The  
19 results suggested that early Hungarian–Serbian bilinguals were equally effective and fast in monitoring  
20 emotional information in both of their languages, giving emphasis through more elaborative processing  
21 to the threatening stimuli.

22 **Keywords:** emotional Stroop task; negative words; positive words; neutral words; bilingualism; Hun-  
23 garian; Serbian

## 1. Introduction

25 In the last decade, scientists have shown a growing interest in the emo-  
26 tional content expressed in language: emotion and emotion-laden words,  
27 metaphors, and language emotionality have recently become very popu-  
28 lar topics in psychology and linguistics (Pavlenko 2006; Wierzbicka 2008;  
29 Kövecses 1990).

30 The relations and interplay between language and emotions have been  
31 assessed employing various methods: rating procedures (Altarriba 2006),  
32 experimental designs (Sutton et al. 2007; Eilola et al. 2007; Eilola & Ha-  
33 velka 2010b; Winskel 2013), and physiological measures (Harris et al. 2006;  
34 Eilola & Havelka 2010b).

35 Researchers have so far revealed different potential factors that can  
36 affect the expression and subjective experience of emotional content in the  
37 first- and the second language: age of language acquisition, frequency of  
38 language use, language dominance, proficiency and context of use are just  
39 some of them, and they seem to also have a joint effect.

40 Emotional processing and production through language can be an-  
41 alyzed on different levels of complexity: memories, stories, sentences or  
42 words. The results of these studies are not equivocal, some point to differ-  
43 ences, whereas others to similarities in bilinguals' affective displays seen  
44 through language.

45 Complex structures like language-specific emotional utterances and  
46 stories were analyzed by Koven (2006), who worked with a Portuguese-  
47 French bilingual, who used French – the L2 – for public and private inter-  
48 actions, but also Portuguese at home and with her boyfriend. The task was  
49 to articulate emotionally charged experiences in each of the two languages.  
50 Generally, the results showed that the subject was calmer and more neutral  
51 in Portuguese and more “emotionally intense” in French. The conclusion  
52 reached was that the same person can be a “different kind of social actor”  
53 depending on the language used (*ibid.*, 107).

54 Kövecses (1990) adopted a different approach by working with com-  
55 plex linguistic stimuli in the form of sentences. Among other linguistic ex-  
56 pressions, metaphors and metonyms were used to analyze emotional mean-  
57 ing. Conceptual metaphors can be related/derived from several different  
58 metaphors/metonyms and they are the root of many emotional expres-  
59 sions. The author succeeded in connecting basic conceptual metaphors to  
60 expressions related to several positive and negative emotions. In Kövecses's  
61 opinion, emotion concepts are a valid aspect of reality and a valuable tool  
62 for studying the human affective world. Kövecses (2003) also made cross-

63 linguistic comparisons: among other things, he found that metaphorical  
64 expressions about love in Hungarian and English with a similar superficial  
65 meaning could also have different ideological and cultural implications,  
66 presumably mirroring different attitudes towards life in the two cultures.

67 Psycholinguistic research often used single words as stimuli. A very  
68 important step in this line of inquiries was the question about the status  
69 of emotion words in the mental lexicon. Altarriba et al. (1999) conducted  
70 a normative study about the nature of emotion words. They used a word  
71 rating task and found that emotion words were between abstract and con-  
72 crete words regarding imageability and the lowest of the three categories on  
73 concreteness and context availability measures. This meant that emotion  
74 words could be accounted for as a different class of words in the mental lex-  
75 icon. In practice, this would mean that emotion words should be treated,  
76 used and analyzed separately in experiments and research.

77 In this field of study difficulties occurred because there were no con-  
78 ventional and widely accepted criteria for the categorization and the selec-  
79 tion of emotion words/affectively charged words. A taxonomy of 500 emo-  
80 tion words was construed by Ortony et al. (1987), which was an important  
81 step towards systematization of verbal emotional expressions. Since then  
82 Bradley and Lang (1999) have provided affective ratings for 1034 English  
83 words on the affective dimensions of pleasure, arousal and dominance,  
84 and similar databases have been made based on their work in Spanish  
85 (Redondo et al. 2007), German (Schmidtke et al. 2014) and European  
86 Portuguese (Soares et al. 2012). Word ratings can be also found for 4300  
87 Dutch (Moors et al. 2013), 210 British English and Finnish nouns (Eilola  
88 & Havelka 2010a) and 1482 Serbian words (Janković 2000a;b), but these  
89 studies used different methodologies, had various aims and differing the-  
90 oretical grounds, although all of them investigated qualitative aspects of  
91 words or underlying higher order dimensions of words. It should be pointed  
92 out that the affective lexicon has been studied extensively in the English  
93 language but unfortunately there are many other languages in which sim-  
94 ilar categorizations and taxonomies have not yet been made.

95 The topics of language emotionality had been extended to bilingual  
96 population. Pavlenko (2006) was the first who raised questions about bilin-  
97 gual and multilingual people's first, second, etc. language emotionality  
98 through a fusion of linguistics and the affective sciences. Since then, many  
99 researchers have designed studies asking whether and when the first, native  
100 language is emotionally more intensive compared to the second one and  
101 vice versa. The debate is ongoing: some researchers think that the first,  
102 native language has more intensive emotional tone (Deweale 2004), and

103 that it is presumably contextually more grounded than the second lan-  
104 guage (Altarriba 2006), whereas others state that research on bilingualism  
105 does not unequivocally support the notion that “the first language is the  
106 language of the heart” (Eilola et al. 2007). Javier’s (2007, 76) opinion is  
107 that an additional feature of affective and abstract information might be  
108 that they are “more accessible in relation to the language more closely  
109 associated with the development of this specific emotional and abstract  
110 information”, than concrete words/topics.

111 In recent times, an experimental design, the emotional Stroop task,  
112 has been adapted to measure bilingual populations (Sutton et al. 2007;  
113 Eilola et al. 2007; Eilola & Havelka 2010b; Winskel 2013). The task can  
114 show interference due to emotional content. A typical result is that neg-  
115 ative emotional information causes a slowdown in reaction time relative  
116 to the neutral one (Chajut et al. 2010). The method instructs subjects to  
117 ignore the threatening, negative and neutral meaning of the words pre-  
118 sented, asking just to name or identify them. It can show if the presence of  
119 negative information induces some kind of inhibition or freezing effect vis-  
120 ible through longer reaction times to negative stimuli (Algom et al. 2004).  
121 The slower responses mean that subjects, who are explicitly instructed to  
122 ignore the content of the words, are nevertheless unable to exclude pro-  
123 cessing of the semantic information of the words seen (Wilson et al. 2007).

124 Sutton et al. (2007) think that this task is a measure of automatic  
125 access of emotion and selective attention to emotional information. The  
126 reaction times are something “like skin conductance responses to emotion  
127 words” (Sutton et al. 2007, 1080), although there is still an ongoing polemic  
128 about the underlying mechanism of the elongation (Algom et al. 2004).

129 Recently, Ben-David et al. (2012) made an attempt to unravel the  
130 processes that lie behind the emotional Stroop effect. In presenting these  
131 ideas we must emphasize that they still need testing and additional ex-  
132 perimental support. Using a smart experimental design, which was based  
133 on accuracy measures, the authors compared two views, the attention and  
134 the threat account of the emotional Stroop effect. The first one argues  
135 that threatening information captures attention, whereas the latter one  
136 presupposes “a temporary freeze on all ongoing activity” in the face of  
137 threat (*ibid.*, 537). The Signal Detection Theory was used as a theoretical  
138 framework: in a preliminary hypothesis perceptual sensitivity was linked to  
139 the threat theory and response bias to the attention account. In practice,  
140 this would mean that if the threat account is correct, the “psychological  
141 distance” between the colors would become smaller. When subjects were  
142 confronted with threatening information, the perceptual ability of detect-

143 ing the differences between the colors would be weakened, resulting in  
144 “poorer discrimination” (*ibid.*, 540). Additionally, in the second, attention  
145 account, the readiness to respond in one or an alternative way was changed:  
146 e.g., “favoring one stimulus over the other in responding” (*ibid.*, 537). The  
147 authors’ results showed that sensitivity to the same ink color was reduced  
148 when dealing with emotional words in contrast to neutral ones. Addition-  
149 ally, the response criterion was not significantly altered throughout the  
150 negative and neutral blocks. The authors have concluded that these re-  
151 sults support the threat account and they also suggest that the emotional  
152 Stroop effect is the result of an “instinctive perceptual-motor reaction to  
153 threat” (*ibid.*, 540).

154 The emotional Stroop task has been used with the bilingual popu-  
155 lation, who had English as one of their languages. There are four stud-  
156 ies showing somewhat different results: emotional interference is always  
157 present in both or just one language, but speed and accuracy in the first  
158 and the second language seems to depend on the type of bilingualism. The  
159 results might be also different because these studies used different kinds  
160 of words with varying group sizes and disparate experimental designs.

161 The first research using the emotional Stroop in a bilingual sample was  
162 designed by Sutton et al. (2007): they used sixteen negative and sixteen  
163 neutral words in an early Spanish–English bilingual, English dominant  
164 group. Each subject saw half of the emotion words in Spanish, the other  
165 half in English and again half of the neutral words in Spanish, half in  
166 English. Their results showed the main effect of word type and language.  
167 Emotional interference was present in the expected form: negative words  
168 took longer to name. In English language the answers were faster than  
169 in native Spanish, so the authors presume that this effect emerged from  
170 frequent everyday L2 use and immersion into a second language linguistic  
171 community.

172 The second research conducted by Eilola et al. (2007) started with  
173 a hypothesis that late, Finnish dominant bilinguals, who are proficient in  
174 English, should show a smaller interference effect in the second language,  
175 due to its reduced emotionality. An additional aim was to test if there was  
176 a taboo Stroop effect using taboo words, which were assumed to be inten-  
177 sively arousing and connected to physiological changes (Jay et al. 2008).  
178 A significant emotional interference was found between negative and neu-  
179 tral and taboo and neutral words. Positive words did not differ from any  
180 other group and there were no language effects. Regarding errors there was  
181 a significant difference between taboo and neutral words: subjects made  
182 more mistakes when they saw taboo words. The authors’ main conclusion

183 was that the impact of the age of language acquisition was not as impor-  
184 tant as the proficiency level of a later acquired language for the emotional  
185 salience of a language.

186 Eilola and Havelka (2010b) have continued their work in this field; in  
187 a new research they compared English native speakers with Greek–English  
188 late, Greek dominant bilinguals. The difference was that only English was  
189 tested: in one group as a native and in the other group as a second lan-  
190 guage. Skin conductance responses were also measured with the aim to  
191 compare behavioral measures with physiological ones. The English stim-  
192 ulti were taken over from the experimental design of 2007. The results  
193 showed a word type effect, with no language differences or interaction ef-  
194 fects: again, negative and taboo words took longer to name than neutral  
195 and positive words. Furthermore, native English subjects were more error  
196 prone than the other group. On skin conductance measures a different pic-  
197 ture has emerged: there was a significant main effect of word type and the  
198 interaction between language background and word type was marginally  
199 significant ( $p = 0.085$ ). The analyses of word type differences in the two  
200 groups showed that there were higher levels of skin conductance for nega-  
201 tive and taboo words than the other word categories in the native speaker  
202 group only, but we should mention that taboo words also showed a trend  
203 to be significant in the non-native subjects. The interpretation of the ob-  
204 tained results was that in the second language, unbalanced bilinguals are  
205 successful in working with the denotative meaning but they do not show  
206 an access or activation of the connotative meaning of emotionally charged  
207 words in the way as they show in the first language. In conclusion, it seems  
208 that the changes in physiological (re)activity are not always mirrored in  
209 subjective experience.

210 Winskel (2013) investigated the effects of language proficiency on emo-  
211 tional interference. Twenty negative and twenty neutral emotion and emo-  
212 tional words were used to compare a native English group from Australia  
213 with Thai–English bilinguals from Thailand. Although some of the subjects  
214 started to learn the second language early (the age range was between four  
215 and ten years) they had all learnt it in an educational setting. The results  
216 showed a significant main effect of word type, language and interaction. In  
217 the bilingual group, for Thai there were significantly longer reaction times  
218 to negative than neutral words, but this was not the case for English. In  
219 the English native group, there was also a significant emotional Stroop  
220 effect. Proficiency effects were tested in the bilingual group using corre-  
221 lation between English language proficiency test results and the English  
222 emotional Stroop effect, but no significant results were obtained. Winskel

223 concluded that proficiency acted as an important factor for emotional in-  
224 terference in the first language, but in the case of the second language it  
225 might be that the test used to assess the second language proficiency level  
226 was not adequate and precise enough.

227 The results reviewed above show that the most robust effect in bilin-  
228 gual groups is the effect of word type (or the emotional Stroop effect),  
229 more specifically, the longer reaction times to negative and taboo words  
230 than other categories. The effects of the first- or second language are not  
231 unequivocal, they seem to depend on the first and second language learn-  
232 ing histories and the joint effects of frequency of language use, contexts of  
233 language acquisition/learning and use, age of acquisition, language domi-  
234 nance and language proficiency.

235 The aim of the current research is to compare two distinctive lan-  
236 guages, Hungarian and Serbian using a bilingual sample to see whether  
237 threatening stimuli capture the attention in both languages to the same  
238 extent. Based on previous results, our hypothesis is that we will find a  
239 similar emotional interference in both Hungarian and Serbian because we  
240 study early bilinguals immersed into the majority, Serbian culture. We as-  
241 sume that there will be differences between the reactions to negative and  
242 neutral words, but not between positive and neutral ones.

243 The novel contribution of this research is that it compares two lan-  
244 guages, which have not been studied in the context of language emotional-  
245 ity. We also use a bilingual sample, which is different in language learning  
246 history from the groups compared so far.

## 247 2. Materials and Methods

### 248 2.1. Subjects

249 In the pre-screening procedure we have administered the Hungarian Beck  
250 Depression Inventory Short Form (?<sup>3</sup> translation by Kopp 2007) and the  
251 STAI State-Trait Anxiety Inventory (?<sup>4</sup> translation by Sipos & Sipos 2007),  
252 and a shortened version of the Language History Questionnaire (Li et al.  
253 2006), which was translated into Hungarian for the purposes of this re-  
254 search.

255 Subjects who started learning the second language after the age of  
256 seven, had high depression/anxiety score or did not know more than seven  
257 words were excluded from further analysis.

258 Overall, after the selection, the sample consisted of thirty-nine sub-  
259 jects. There were nineteen females and twenty males, who had normal

▷ A „Beck & Beck 1978” nevű hivatkozásnak nem adta meg az adatait a hátsó hivatkozáslistában. Kérjük, pótolja.

▷ A „Spielberger 1970” nevű hivatkozásnak nem adta meg az adatait a hátsó hivatkozáslistában. Kérjük, pótolja.

260 or corrected-to-normal vision and no known reading disorders. Thirty-six  
 261 of them were pupils of the Svetozar Marković High School or the Mihajlo  
 262 Pupin High School in Novi Sad. They obtained an additional subject credit  
 263 for activity by participating in the research. Additional three subjects were  
 264 acquaintances of the researcher, coming from various faculty departments  
 265 in Novi Sad.

266 The age range fluctuated between fifteen to thirty years ( $M = 17.717$ ,  
 267  $SD = 3.516$ ). The wider social and linguistic environment of the subjects  
 268 was Serbian, which is also the majority language. The subjects were mem-  
 269 bers of a Hungarian minority group or came from linguistically mixed  
 270 marriages, meaning that they mostly spoke Hungarian or both languages  
 271 in the family settings. Some acquired both languages since birth. In most  
 272 cases, the broader social environment and family members were an in-  
 273 tensive motivational force for learning the second language, being an im-  
 274 portant means of getting along successfully later in life and professional  
 275 development.

276 The Language History Questionnaire showed that all subjects had  
 277 started to learn Serbian as their second language before the age of seven  
 278 ( $M = 2.846$ ,  $SD = 2.621$ ). The age of seven was used as a critical point,  
 279 because this was the time when subjects enrolled in the primary school  
 280 and started learning the second language in educational settings. Harris  
 281 et al. (2006) used similar criteria in a comparative research measuring skin  
 282 conductance responses of early and late bilinguals.

283 On a seven point self-rating scale of the Language History Question-  
 284 naire, the following skills were tested: reading-, writing-, speaking ability  
 285 and comprehension in both languages (see tables 1 and 2).

**Table 1:** Hungarian language skills

	Hungarian reading skill	Hungarian writing skill	Hungarian speaking skill	Hungarian comprehension
Mean	6.87	6.62	6.77	6.87
Standard deviation	0.339	0.633	0.427	0.339

286 We compared the two languages using a composite language proficiency  
 287 score: the mean of reading, writing, speaking and comprehension rat-  
 288 ings. The difference between the two languages was significant ( $t(38) =$   
 289  $4.299$ ,  $p = 0.000$ ), the mean for Hungarian was  $M = 6.782$ ,  $SD = 0.363$ ,  
 290 the mean for Serbian was  $M = 6.089$ ,  $SD = 0.932$ . As shown, the most



**Table 2:** Serbian language skills

	Serbian reading skill	Serbian writing skill	Serbian speaking skill	Serbian comprehension
Mean	6.13	6.05	5.79	6.38
Standard deviation	1.005	1.075	1.218	0.935

291 important part of language production, speaking was rated the lowest in  
 292 the second language. Additionally, it must be pointed out that in both  
 293 languages the means were around 6 (“very good”) and that even the  
 294 mother tongue abilities did not yield the maximum value 7 (“native like  
 295 level”). Eight subjects indicated that both Hungarian and Serbian were  
 296 their mother tongues and one subject that Serbian was his native lan-  
 297 guage.

298 Frequency of language use was also checked: the subjects reported  
 299 speaking Hungarian between 75–100% of the day, with one subject using  
 300 it 50% of the day, while Serbian was used daily 100% by 12, 75% by 13,  
 301 50% by 6, 25% by 5 and less than 25% by 3 speakers. Important to our  
 302 research is that all but three subjects indicated using Serbian in their  
 303 family setting.

304 Based on these findings, we can conclude that the bilingual group  
 305 consisted of early Hungarian–Serbian bilinguals, with Hungarian as their  
 306 dominant means of expression and understanding, who are highly pro-  
 307 ficient in Serbian. Additionally, the subjects were currently living in an  
 308 environment where the second language, Serbian was the socially domi-  
 309 nant language, and they were using it on everyday basis in formal and  
 310 informal setting as well.

## 311 2.2. Method

### 312 2.2.1. Materials

313 In this research, three different word types were used to create the emo-  
 314 tional Stroop task: negative, positive and neutral. In the first step, the  
 315 *Connotative Dictionary* was used (Janković 2000a;b) to find words which  
 316 would belong to the three predefined categories by valence. Initially, forty-  
 317 one Serbian words were selected, which then were sent to Belgrade in order  
 318 to obtain their frequencies from Kostić (1999). The Hungarian database,

319 Szószablya<sup>1</sup> was used to find the frequencies of matching Hungarian words.  
 320 The process resulted in eighteen words in the negative list, eighteen in the  
 321 positive and eighteen in the neutral list.

322 Word frequency was matched for Hungarian using the Szószablya  
 323 database, and for Serbian using Kostić (1999). The frequency measures  
 324 were log-transformed because they were not normally distributed: Hun-  
 325 garian negative ( $M = -12.275$ ,  $SD = 1.517$ ), Hungarian positive ( $M =$   
 326  $-12.788$ ,  $SD = 1.861$ ) and Hungarian neutral ( $M = -11.342$ ,  $SD =$   
 327  $1.655$ ) words yielded in  $F(2, 51) = 3.421$ ,  $p = 0.041$ , where there was  
 328 a significant difference between the neutral and positive words  $p = 0.039$ .  
 329 The Serbian negative ( $M = -10.857$ ,  $SD = 1.516$ ), Serbian positive ( $M =$   
 330  $-11.565$ ,  $SD = 1.817$ ) and Serbian neutral words ( $M = -10.421$ ,  $SD =$   
 331  $1.949$ ) yielded in  $F(2, 51) = 1.917$ ,  $p = 0.157$ . Word length measured by  
 332 the number of syllables was also matched between word groups. Compar-  
 333 ing the length of Hungarian negative ( $M = 3.333$ ,  $SD = 1.084$ ), Hun-  
 334 garian positive ( $M = 3.111$ ,  $SD = 0.758$ ), Hungarian neutral ( $M =$   
 335  $2.777$ ,  $SD = 1.165$ ), Serbian negative ( $M = 2.833$ ,  $SD = 0.985$ ), Ser-  
 336 bian positive ( $M = 3.388$ ,  $SD = 0.777$ ) and Serbian neutral words  
 337 ( $M = 2.666$ ,  $SD = 1.137$ ) for language the test resulted in  $F(1, 102) =$   
 338  $0.334$ ,  $p = 0.564$ , for valence category in  $F(2, 102) = 2.629$ ,  $p = 0.077$   
 339 and interaction  $F(2, 102) = 1.366$ ,  $p = 0.260$ . The arousal and valence  
 340 dimensions were available just for Serbian words (Janković 2000a;b). On  
 341 the arousal dimension the Serbian negative ( $M = 1.242$ ,  $SD = 0.200$ ),  
 342 positive ( $M = 1.737$ ,  $SD = 0.386$ ) and neutral ( $M = 1.419$ ,  $SD = 0.205$ )  
 343 words resulted in an  $F(2, 51) = 14.669$ ,  $p = 0.000$ , and the post hoc analy-  
 344 sis showed that negative and positive ( $p = 0.000$ ) and positive and neutral  
 345 words ( $p = 0.004$ ) differed significantly from each other, positive words  
 346 being more arousing.

347 On the valence dimension the Serbian negative ( $M = -2.461$ ,  $SD =$   
 348  $0.188$ ), positive ( $M = 2.435$ ,  $SD = 0.225$ ), neutral ( $M = 0.275$ ,  $SD =$   
 349  $0.214$ ) words resulted in an  $F(2, 51) = 2457.694$ ,  $p = 0.000$ , and a post hoc  
 350 analysis showed that each category differed significantly from the other on  
 351 the level  $p = 0.000$ .

352 The emotion-laden words used in the experiment were the follow-  
 353 ing (in Hungarian, Serbian and their English glosses). In the negative  
 354 group: *erőszak-agreszija* ‘aggression’, *adósság-dug* ‘debt’, *veszteség-gubitak*  
 355 ‘loss’, *árulás-izdaja* ‘treason’, *kínzás-mučenje* ‘torture’, *tiszteletlenség-*  
 356 *nepoštovanje* ‘disrespect’, *igazságtalanság-nepravda* ‘injustice’, *idegesség-*

<sup>1</sup> <http://szotar.mokk.bme.hu/szoszablya/searchq.php>

357 *nervoza* ‘nervousness’, *baleset–nesreća* ‘accident’, *sikertelenség–neuspeh*  
 358 ‘failure’, *veszély–opasnost* ‘danger’, *sérülés–povreda* ‘injury’, *megcsalás–*  
 359 *preljuba* ‘cheat on somebody’, *szakítás–raskid* ‘split up’, *háború–rat* ‘war’,  
 360 *szegénység–siromaštvo* ‘poverty’, *pofon–šamar* ‘slap’, *verekedés–tuča* ‘fight’.

361 The positive list consisted of *gondtalanság–bezbriznost* ‘ease’, *jólét–*  
 362 *blagostanje* ‘well-being’, *tisztaság–čistota* ‘purity’, *jólelkűség–dobrodušnost*  
 363 ‘charity’, *kedvesség–ljubaznost* ‘kindness’, *önzetlenség–nesebičnost* ‘self-  
 364 lessness’, *gyengédség–nežnost* ‘tenderness’, *ünnep–praznik* ‘celebration’,  
 365 *tökély–savršenstvo* ‘perfection’, *biztonság–sigurnost* ‘safety’, *megkönnyeb-  
 366 bülés–olakšanje* ‘relief’, *szabadság–sloboda* ‘freedom’, *megértés–razumevan-  
 367 je* ‘understanding’, *melegség–toplina* ‘warmth’, *nyugalom–smirenost* ‘calm-  
 368 ness’, *kényelem–udobnost* ‘comfort’, *édesség–umiljatost* ‘sweetness’, *élvezet–*  
 369 *uživanje* ‘pleasure’.

370 The list of the neutral words was as follows: *gyorsaság–brzina* ‘fastness’,  
 371 *bizonyíték–dokaz* ‘proof’, *kivétel–izuzetak* ‘exception’, *kard–mač* ‘sword’,  
 372 *szokás–navika* ‘habit’, *kötelezettség–obaveza* ‘commitment’, *osztályzat–oce-  
 373 na* ‘grade’, *fennmaradás–opstanak* ‘survival’, *ellenállás–otpor* ‘resistance’,  
 374 *javítás–popravljanje* ‘reparation’, *kamaszkor–pubertet* ‘puberty’, *áram–stru-  
 375 ja* ‘current’, *bíró–sudija* ‘judge’, *ellenkezés–suprotstavljanje* ‘opposition’,  
 376 *hír–vest* ‘news’, *hatalom–vlast* ‘power’, *törvény–zakon* ‘law’, *tél–zima* ‘win-  
 377 ter’.

### 378 2.2.2. Procedure

379 The testing was done individually. All subjects filled in the questionnaires  
 380 about their language proficiency, the Beck Depression Inventory Short  
 381 Form and the STAI State-Trait Anxiety Inventory.

382 The experimental part was done on a Samsung Ativ Book 6 670 lap-  
 383 top with a custom made experimental program (this was supported by a  
 384 project of the Ministry of Serbia, number III47013). The procedure resem-  
 385 bled the one used by Sutton et al. (2007) with elements of the one used  
 386 by Eilola et al. (2007). Words were shown on a white background, the font  
 387 size was 100 points with a 72-dpi resolution, type Times New Roman. Four  
 388 colors were used: red, blue, green and yellow.

389 The words were blocked, organized into categories by valence: there  
 390 were separate blocks with positive, blocks with negative and separate  
 391 blocks with neutral words. The tasks had two parallel versions, one in  
 392 Hungarian and one in Serbian, so language was also blocked: some of the  
 393 subjects saw the Hungarian task first, and then the Serbian, while the  
 394 others did it the other way around.

395 The order of the tasks was counterbalanced and the words and colors  
396 were randomized. Each word was presented only once. The instructions  
397 were the following: You will see different words in different colors. Your  
398 task is to choose and press the button on the keyboard, which has the  
399 same color label as the color of the word seen. The aim is to respond as  
400 fast and as accurate as you can by pressing the matching button (green,  
401 blue, red or yellow), while ignoring the meaning of the word.

402 The explanation was afterwards repeated orally and subjects were  
403 told that they would see words both in Hungarian and Serbian. When the  
404 subjects felt that they were ready to start the experiment, they completed  
405 six practice trials in both languages with words that were not used later  
406 in the procedure. Afterwards, there was a little pause to discuss whether  
407 everything was clear and if the real experiment could start. In the exper-  
408 imental part, the fixation cross, in the form of a + sign appeared on the  
409 screen for 300 ms before the stimulus word. Then the colored words were  
410 shown until the subjects responded. In the following section, a fixation  
411 cross again signalized the next target word. Subjects used the “V” key  
412 with a yellow, the “B” key with red, the “N” key with blue and the “M”  
413 key with green labels for providing the answers. If the word presented was  
414 blue, subjects had to push the blue button and if it was green, the green  
415 button, etc. If the subjects made a mistake, the “Wrong answer!” sentence  
416 appeared and if the answer was the right one, then the “Right answer”  
417 message was shown. They were also told to try to answer accurately, but  
418 also as fast as they can. After the experiment, the subjects were given a  
419 list containing all of the words, where they could indicate if they had prob-  
420 lems with comprehension. As a final step words were rated for emotional  
421 valence, but due to space limits, we will not report these results here.

### 422 3. Results

#### 423 3.1. Analysis of errors

424 The erroneous answers, which accounted for 2.7% of all results, were anal-  
425 ysed separately. The average error rate was  $M = 0.027$ ,  $SE = 0.005$ . A  
426 two-way within-subjects ANOVA was conducted with two factors: Word  
427 Type (negative, positive, neutral) and Language (Hungarian, Serbian).  
428 The main effect of language was  $F(1, 38) = 0.276$ ,  $p = 0.602$ , the main  
429 effect of word type  $F(2, 76) = 2.277$ ,  $p = 0.110$  and the interaction  
430  $F(2, 76) = 0.288$ ,  $p = 0.706$  (in the case of interaction, a Greenhouse-  
431 Geisser correction was used, because sphericity was violated). There were

432 no significant differences between word categories, nor between languages  
433 regarding errors and mistakes in the answers.

### 434 3.2. Analysis of response latencies

435 Only the correct answers were included in the analysis of response laten-  
436 cies. The reaction times included in this further analysis were not smaller  
437 than 300 ms or greater than 1500 ms. The analysis was conducted on  
438 negative Hungarian, positive Hungarian, neutral Hungarian and negative  
439 Serbian, positive Serbian, neutral Serbian mean reaction times for each  
440 subject. A two-way within-subjects ANOVA with two factors: Word Type  
441 (negative, positive, neutral) and Language (Hungarian, Serbian) was used.

442 There was a significant main effect of Word Type:  $F(2, 76) = 4.236$ ,  
443  $p = 0.018$ , partial  $\eta^2 = 0.100$ . The mean reaction time for negative words  
444 was  $M = 719.631$ ,  $SE = 13.270$ , for positive words  $M = 716.475$ ,  $SE =$   
445  $13.646$  and for neutral words  $M = 701.310$ ,  $SE = 14.012$  (see figure 1,  
446 where the difference between the dark gray bars is a significant difference).  
447 The pair-wise comparisons showed that there is a significant difference be-  
448 tween negative and neutral words  $p = 0.007$ , whereas there are no sig-  
449 nificant differences between negative and positive words  $p = 1.000$  and  
450 positive and neutral words  $p = 0.120$ .

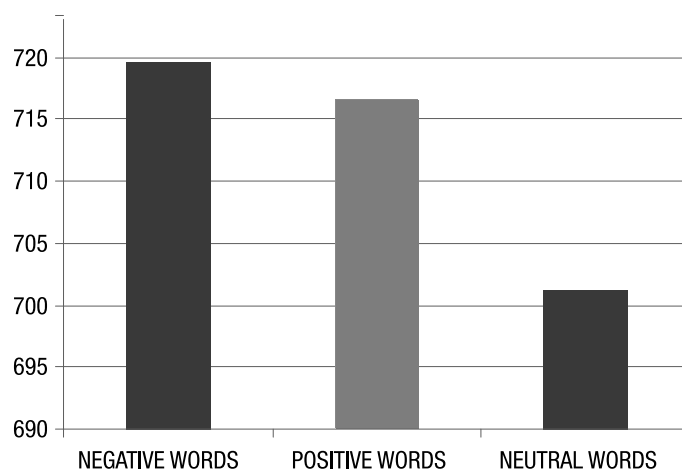


Figure 1: Mean reaction times (ms) for negative, positive and neutral words

451 The Language factor as a main effect was not significant,  $F(1, 38) =$   
452  $0.023$ ,  $p = 0.879$ , partial  $\eta^2 = 0.001$ . The interaction between Word Type  
453 and Language did not yield a significant result,  $F(2, 76) = 0.456$ ,  $p =$   
454  $0.636$ , partial  $\eta^2 = 0.012$ .

455

#### 4. Discussion

456 In the emotional Stroop task meaning is processed automatically and fast  
457 (Eilola et al. 2007), and it has been proposed that in word processing we  
458 can distinguish between physiological, “somatovisceral responses” or “af-  
459 fective processing” and processing of the “affective valence” or “semantic  
460 processing” of words (Pavlenko 2012, 416, 423) and the emotional Stroop  
461 task seems to tap valence effects only.

462 The aim of this research was to compare early Hungarian–Serbian  
463 bilinguals in the automatic processing of emotionally valenced and neutral  
464 words in their two languages.

465 The research revealed a significant difference in responding to nega-  
466 tive and neutral words, meaning that there is an emotional Stroop effect:  
467 negative information captured the attention and had a greater impact on  
468 the subjects than seeing neutral stimuli. Also, the effect seems to be inde-  
469 pendent of the language used by early bilinguals: between-language analy-  
470 sis of response latencies did not show a significant difference. We can thus  
471 conclude that the word processing and the pattern of interference were  
472 similar in the two languages and that there was no prioritized language  
473 for working with emotion-laden words.

474 Comparing the sample used in this research with the ones used in  
475 the prior four studies using the bilingual emotional Stroop task we can  
476 say that our group showed resemblance to the one used by Sutton et al.  
477 (2007) based on the language history measures. The similarities were that  
478 they investigated early bilinguals, highly proficient in both of their lan-  
479 guages, but a difference was that their subjects had their second language  
480 as the dominant one. In this research the subjects were highly proficient in  
481 their second language, they were living in an L2 environment, the acqui-  
482 sition/learning of the language also had an early start and subjects were  
483 dominant in their native language. Sutton et al. (2007) obtained signifi-  
484 cant emotional Stroop effect and language differences as well. The effect  
485 was smaller in the first, non-dominant language and faster reaction times  
486 were found in the dominant, but second language. Important to note is  
487 that in the research by Sutton et al. (2007) the second language was the  
488 language of the environment and subjects used it 81% of the day. They in-

489 terpreted their results in the context of frequency of L2 use and proficiency  
490 level and they believe that these factors contribute the most to language  
491 emotionality and interference size. The results of our research are in line  
492 with the opinion of Sutton and colleagues, because in this sample the  
493 bilinguals included used their second language on a daily basis, some of  
494 them interchangeably during the day, and also, they were immersed into  
495 a majority, second-language speaking environment.

496 The other three studies that measured the emotional effects worked  
497 with late bilinguals, who started to learn the second language at the age  
498 of 6–7 or later (Eilola et al. 2007; Eilola & Havelka 2010b) and in formal,  
499 educational settings (Winskel 2013). Eilola et al. (2007) and Eilola and  
500 Havelka (2010b) have found mutually concurring results: a significant ef-  
501 fect of word type, and non-significant effects of language and interaction.  
502 This means that in both cases the subjects showed a “negativity/threat”  
503 bias, or emotional Stroop effect, but also that they were not affected by  
504 first- or second language activation in responding to the colors. Returning  
505 to early bilinguals, Harris et al. (2006) think that in early bilingual groups  
506 the emotional activation of the languages can be of the same size: if profi-  
507 ciency is at similar levels or the first learned language is actually less profi-  
508 cient. In their research, they measured skin conductance responses during  
509 a pleasantness rating task using neutral, aversive and positive words, en-  
510 dearments, insults, reprimands and taboo words, and found no differences  
511 between the L1 and L2 words in early L2-dominant bilinguals. It must  
512 be added that late bilinguals also showed differential processing only in  
513 the case of childhood reprimands. Harris et al. (2006) believe that the  
514 highly emotional context of language learning is the determining and cru-  
515 cial factor of language emotionality. If the emotional transactions are a  
516 natural part of childhood language use, these languages become associ-  
517 ated with emotional valence. Moreover, Harris et al. (2006) believe that  
518 language emotionality is not an exclusive characteristic of childhood lan-  
519 guage learning and acquisition; it can be also reshaped later in life through  
520 intimate relationships and emotional interactions and verbal exchange.

521 Based on these opinions, the early bilingual sample of this research  
522 might have developed a similar emotionality on the level of semantics in the  
523 first and second language as well, due to interpersonally and emotionally  
524 salient contexts of childhood language learning through frequent commu-  
525 nications with family and friends. The context-of-learning theory proposed  
526 by Harris and her colleagues is consistent with the pattern found because  
527 natural contexts of learning led to similar activation of both languages.

528 A popular model of bilingual language processing is the Revised Hi-  
529 erarchical Model, which was proposed by ?<sup>4</sup>. The model assumes that there  
530 are independent representations for the L1 and L2 words with a shared  
531 conceptual store, that the L1 is more strongly linked to the conceptual  
532 store than the L2 and that on the lexical level L2 would activate more  
533 easily the L1 words than vice versa (Schwartz & Kroll 2006). The model  
534 has been criticized since because converging empirical data have supported  
535 language nonselectivity contrary to the hypothesized existence of two dis-  
536 tinct lexicons formulated by the model. This question is still open, and  
537 Kroll et al. (2010) argue that bilinguals might have separate lexicons with  
538 paralell access to content. The model is developmental and suggests that  
539 growing proficiency changes the functioning of the two languages. Profi-  
540 cient bilinguals do not use translation equivalents from the L1 to work  
541 with L2 words (Kroll et al. 2010). Kroll and Sunderman (2003) believe  
542 that proficiency is the key factor, which can lead to concept mediation in  
543 the second language and that this factor also ensures that the L2 links to  
544 concepts become more similar as in L1 (Schwartz & Kroll 2006).

545 Eilola et al. (2007) pointed out that, based on the Revised Hierarchical  
546 Model, the L1 should produce a bigger emotional Stroop effect than the  
547 L2 due to stronger links with the conceptual system, faster activation of  
548 meaning and also less interference in the L2 in late bilinguals. Nevertheless,  
549 their results did not support this theoretical assumption showing the same  
550 effect in both languages, which was explained by high levels of proficiency  
551 in both languages.

552 Our subjects were early bilinguals, who used their languages on a  
553 daily basis. They did not show differences in the first and second language  
554 processing speed, thus words were accessed equally fast, independent of the  
555 activated language and valence was also processed in both languages. We  
556 assume that our data support the proposal that there are similar L2 links  
557 to concepts as in L1 in early bilinguals. This further confirms proficiency  
558 effects and the effect of frequent language use on language emotionality.

559 The value of this research lies in the fact that it extends the results  
560 regarding bilingual emotional activation. We have used specific languages,  
561 Hungarian and Serbian, using the emotional Stroop task, which were not  
562 directly compared until now. Also, we used a special type of subjects: an  
563 early, Hungarian-dominant sample currently immersed into the linguistic  
564 and cultural environment of their second language.

565 In the future, the authors plan to conduct a similar research with late  
566 Hungarian–Serbian bilinguals and to use the Stroop task as well, to see



567 whether there are differences in executive functioning of various types of  
568 Hungarian–Serbian bilinguals.

569

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