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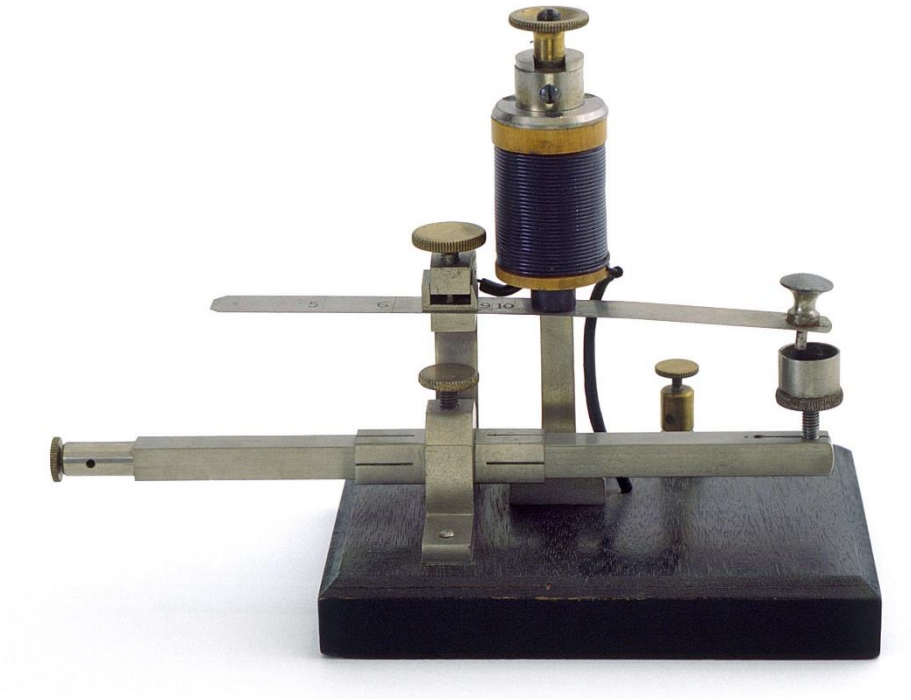

INSTITUTE OF PSYCHOLOGY
LABORATORY FOR EXPERIMENTAL PSYCHOLOGY
FACULTY OF PHILOSOPHY, UNIVERSITY OF BELGRADE

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FACULTY OF PHILOSOPHY, UNIVERSITY OF BELGRADE

Institute of Psychology, Faculty of Philosophy, University of Belgrade

Laboratory for Experimental Psychology, Faculty of Philosophy, University of Belgrade

Belgrade, 2022

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Is there a Difference in the Stroop Effect in Latin and Cyrillic Words?

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Abstract

The main goal of this research was to examine the Stroop effect in Cyrillic and Latin words. The Stroop task enables the examination of the relationship between the perceptual demand of the stimulus and the reading process. The experiment involved 33 subjects who first learned Cyrillic. Two factors were varied: the alphabet (Latin and Cyrillic) and the congruence of the color and color name (congruent and incongruent). Reaction time (RT) was measured as dependent variable. The results show that there is a main effect of the alphabet on RT. Latin words are processed faster than Cyrillic. A statistically significant interaction between varied factors was also found. In Latin words there is a difference in processing stimuli, while in Cyrillic words there is none. The obtained differences in the Stroop effect can be partially explained by the different complexity of the letters and the greater cognitive engagement involved in their processing.

Keywords: Stroop effect, Latin, Cyrillic

Introduction

Language represents a symbolic system composed of signs and rules that enable us to communicate and interpret the world around us. Although those signs and symbols are used for speech or verbal expression, there is another aspect of expression through the writing system. The writing system represents the graphical representation of language in the form of strings or letters. They use visual symbols to represent language. In its outer form, writing appears as strings of characters arranged along lines. In its inner structure it concentrates on representing the words of a language (Kessler & Treiman, 2015). Most often, writing systems are divided based on the symbols they use. Systems that use symbols that stand for morphemes are called logographies. Phonographic systems in which the basic elements represent syllables are syllabaries, and phonographic systems in which the basic elements represent phonemes are alphabets (Kessler & Treiman, 2015; Sampson, 1985;). The Serbian language has an alphabetic writing system. It consists of a set of letters in which each letter usually corresponds to a phoneme or voice of a certain spoken language (Vejnović, 2012). The Serbian language is also characterized by a specific phenomenon of bialphabetism or synchronous digraphy. This is parallel use of two alphabetic systems - Latin and Cyrillic (Ivković, 2013; 2015). Both systems are composed of thirty letters, where each letter is represented by one grapheme, except for the letters “dz”, “lj” and “nj” in the Latin alphabet. Each letter in both alphabets has its own phonemic interpretation, i.e. stands for one phoneme that never changes. Most of the total number of letters (characters) Cyrillic and Latin alphabets are specific only to one or the other alphabet, but there are also a certain number of shared letters. Namely, there are several letters that appear in both alphabets and have the same phonemic interpretation (A, E, J, K, M, O, T), but there is also a smaller number of letters (B, N, P, C) that occur in both alphabets and have a different phonemic interpretation (Lukatela & Turvey, 1998; Lukatela, Savić, Ognjenović, & Turvey, 1978).

Generally speaking, the sequence of cognitive processes during reading is the same (or similar) for all systems. At the first level, visual information is presented in the form of graphemes, and then these input data are compared with knowledge stored in long-term memory (lexical, syntactic, semantic or general knowledge). The final goal is the understanding of words, sentences and text (Li et al., 2022). At that basic, first level, the visual system needs to detect and integrate the visual characteristics of which graphemes are made. If there is a difference in the appearance and visual complexity of individual letters, there will be a difference in the perceptual demands of reading these writing systems.

Verhoeven and Perfetti (2021) investigated the systematic variations of different languages and writing systems and their effects on the reading process. They emphasized the graphic complexity that can be different in different writing systems, but also within a single type. For example, Latin-based alphabets are less complex than other alphabetic writing systems when taking into account the shape and visual appearance of the letters.

The examination of perceptual limitations in reading different writing systems was examined through the Stroop paradigm (Fang, Tzeng, & Alva, 1981; Levitt, Nakakita, & Katz, 2015). The Stroop effect is an interference between reading the words in color and the perception of the color in which the words are written. Reading is an automatic process that is initiated by the presentation of words (Kostić, 2006; Moors & Houwer, 2006) and it is faster than naming word properties (MacLeod, 2015). The visual complexity of letters is negatively correlated with the efficiency of their identification (Pelli, Burns, Farell, & Moore-Page, 2006), so it can affect the reading process.

The main goal of this research was to examine the Stroop effect in Cyrillic and Latin words. Most Cyrillic letters contain junctions that represent connections between letter lines, which makes them visually more complex. Although objective measurements of the visual complexity of letters

have not been done within the Serbian language, there is research that shows that the Russian Cyrillic alphabet has substantially more average complexity than the Latin based alphabets (Verhoeven & Perfetti, 2021). That finding can partially support our assumptions. Given that the visual complexity of letters is related to the speed of their identification, we can assume that graphemically more complex Cyrillic letters will affect the efficiency of their recognition and reading, and thus will model the Stroop effect.

Method

Sample

The sample consisted of 33 students of the University of Banja Luka, aged 19 to 25. All subjects were equal in terms of which letter they learned first (Cyrillic). The second criterion was the absence of a preference for one alphabet in reading and writing. Subjects provided subjective assessments of letter preferences in reading and writing (separately), and we only analyzed data for those who did not have preferences.

We obtained verbal consent for participation in the experiment from all respondents and none of them reported the existence of a color vision deficiency.

Design and Procedure

Two factors were varied: the alphabet (Latin and Cyrillic) and the congruence of the color and color name (congruent and incongruent). In congruent condition word "RED" was printed in red color, while in incongruent condition was printed in blue color. An example of stimuli is shown in Figure 1. The classic Stroop task was used in which the subjects had to choose the color of the stimulus (word) that was shown to them. Five colors were used: red, green, blue, purple, and brown. Participants gave answers by pressing the appropriate key on the keyboard. Each of the five keys used was marked with a sticker of the appropriate color. Each participant had 40 trials with an additional five trials for exercise. The first twenty exposures contained congruent stimuli and the remaining twenty were incongruent ones. Considering that earlier research shows that the magnitude of the Stroop effect increases with the increase in the proportion of congruent items because participants modulate their attention to words (Lowe & Mitterer, 1982), we decided to keep the ratio of congruent and incongruent exposures the same. Even if blocked exposures of congruent and incongruent stimuli would affect selective attention, first exposure of congruent stimuli would not affect cognitive control, because there is no conflict in these conditions (Botvinick et al,. 2001). It is important to note that cognitive control is a broader concept than selective attention in that it refers to the entirety of mechanisms used to control thought and behavior to ensure goal-oriented behavior (e.g., response inhibition) which is crucial for Stroop task (Parri et al., 2022). We combined each color an equal number of times with another color (in incongruence condition) because earlier findings show that both the choice of colors and the frequency of combining pairs affect the strength of the Stroop effect (Jacoby, Lindsay, & Hessels, 2003). Reaction time and response accuracy were monitored. Data analysis was done only for correct answers.

Figure 1. Examples of stimuli in the experiment

Results

The results showed that there is a main effect of the alphabet on RT ($F(1,2642)=7.67$, $p<.01$, $\eta^2=.003$). Latin words were processed faster than Cyrillic. A statistically significant interaction between varied factors ($F(1,2642)=9.33$, $p<.01$, $\eta^2 = .004$) was also found (Figure 2). In Latin words, there was a difference between congruent and incongruent stimuli (57.90ms, (95% CI, -101.56ms to -14.23ms), $p<.01$). But in Cyrillic words, there was no interference, and the reaction time did not differ for congruent and incongruent stimuli (48.79ms, (95% CI, -4.861ms to 102.44ms), $p>.05$).

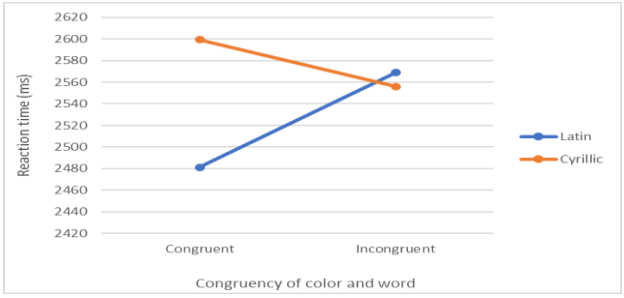

Figure 2: Reaction time in relation to alphabet and congruency in Stroop task

Discussion and Conclusion

The main goal of this research was to examine whether there is a difference in the Stroop effect when words written in different alphabets are used as stimuli. Namely, the Serbian language is characterized by the equal use of two systems, which is called bialphabetism or synchronous digraphy. There are studies that show certain differences in the processing of Latin and Cyrillic words (Vejnović, Jovanović, 2012; Vejnović, Dimitrijević, & Zdravković, 2011). The explanations for these differences were different, from the order of learning and more frequent exposure to one letter, to the visual characteristic of letters. The Stroop task enables the

examination of the relationship between orthographic structure and the reading process, and has also been used to examine the differences between different writing systems based on perceptual characteristics. The Stroop effect implies that words written in an incongruent color are processed more slowly due to the interference of two processes - reading the word and naming the color.

The results of this research show that this effect exists with Latin words. However, no inhibitory effect of incongruence was found for Cyrillic words. The Stroop effect is explained by the automatic reading hypothesis. Reading is a fast, automatic process that requires minimal cognitive engagement. However, if a conflict occurs between the two sources of information, then a greater investment is required to overcome these differences (Moors & Houwer, 2006). Our results are consistent with earlier research showing that one form of the Cyrillic script is more complex in terms of visual features compared to Latin (Verhoeven & Perfetti, 2021) and that a more complex visual identity is negatively correlated with efficient letter identification and therefore reading (Pelli, Burns, Farell, & Moore-Page, 2006). Such findings can explain the results of this research in a way that the complexity of the Cyrillic letters requires a greater engagement of attention, and has a different effect on the interference of reading and color naming. The obtained results should be checked in relation to certain perceptual variations of the letters in the two writing systems, such as letter size or font, as well as in relation to the acquisition order.

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