Reading sentences in Serbian: 
Effects of alphabet and reading mode 
in self-paced reading task

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The study examined the influence of alphabet (Cyrillic vs. Latin) and reading mode (silent reading vs. reading aloud) on sentence reading speed in Serbian. Entire-sentence and single-word reading times were obtained from the moving window paradigm in the self-paced sentence reading task. Sentences printed in Latin took less time for reading than sentences printed in Cyrillic and silent reading was more rapid than reading aloud. Single-word processing results followed the pattern observed in entire-sentence analysis. Faster reading of Latin sentences and words is likely a consequence of subjects’ predominant exposure to this alphabet. Reading aloud was slower than silent reading due to the articulation process, which is present in the former but not in the latter. The effect of the alphabet did not depend on reading mode, suggesting that the two modes of reading involve essentially same cognitive processes. Aloud reading procedures do not seem inappropriate for the research of bialphabetism.

Keywords: bialphabetism, sentence reading, reading aloud, silent reading, self-paced reading task

Concurrent use of two writing systems in one language is called bialphabetism, or synchronic digraphia. This fairly uncommon phenomenon can be observed in several languages, such as Serbian, Korean and Japanese. In Serbian, words can be printed in two alphabetic systems: Cyrillic and Latin. In each of them, every letter of the alphabet has a phonemic interpretation that does not change over letter contexts and every phoneme is represented by a single grapheme1. Moreover, all the letters of both alphabets are pronounced – there are no silent letters. Literate people in Serbia are proficient readers of both the Cyrillic and Latin alphabet. In general public, it is often claimed that

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1 Exceptions to this rule are three phonemes that are encoded by two graphemes in the Latin alphabet: Lj, Đž, Nj.
the two alphabets are not used with equal frequency (i.e. it is generally believed that in the present-day Serbia Latin is more often used of the two). However, exact quantification of alphabetic predominance in an environment is a difficult task. One such effort has recently been made in the city of Novi Sad, Serbia (Vejnović, Milin, & Zdravković, 2010) showing that the Latin alphabet is indeed more frequently used than the Cyrillic. This has been evidenced by the fact that 88% of all public signage on the streets of Novi Sad is printed in Latin. Also, around 75% of the books printed in Serbia are in Latin, and the example of university textbooks used for the undergraduate courses of psychology at the University of Novi Sad is even more convincing: all but one out of more than forty textbooks are in Latin. Finally, it has been pointed out that the Latin alphabet is predominantly used on the Internet, television and other media.

There is a considerable number of studies that compared processing of the Cyrillic and Latin alphabet in Serbo-Croatian/Serbian language (e.g. Bujas & Bujas, 1938; Rogaček, 1973; Rot & Kostić, 1988; Pašić, 2004; Vejnović et al., 2010) and studies that examined bialphabetism in other languages (e.g. Hino, Miyamura, & Lupker, 2011; Gjini, Maeno, Iramina, & Ueno, 2005; Hino, Lupker, Ogawa, & Sears, 2003; Koyama, Kakigi, Hoshiyama, & Kitamura, 1998). Many of these examined the difference in speed and accuracy measures for letters, words and sentences presented in different alphabets. Several factors were proposed as potential causes of the alphabetic difference in the studies where difference had been found. Such are the order of the alphabet acquisition, frequency of the active use of the alphabets, extent of alphabet exposure and visual/perceptual characteristics of the letters.

Previous research failed to demonstrate that the letters of either of the two Serbian alphabets (taken as a set) were visually superior to the letters of the other one (e.g. Ognjenović, Škorc & Morača, 1995; Rot & Kostić, 1986; 1987; 1988). On the other hand, when the comparison shifts away from single characters to the processing speed of entire words, the findings are mixed. For example, Rot and Kostić (1988) did not find the effect of alphabet in a lexical decision task. However, in more recent experiments of Vejnović and colleagues (Vejnović et al., 2010; Vejnović, Dimitrijević & Zdravković, 2011), subjects consistently named the Latin-printed words faster than the Cyrillic-printed ones. These experiments were conducted in Novi Sad, Serbia, and Banja Luka, Bosnia and Herzegovina. Importantly, according to the objective indicators that were used in these studies, the use of the Latin alphabet was more extensive than that of the Cyrillic in both of the environments.

Obviously, processing of isolated words is different than reading words in sentence context. The latter involves factors that are not present in the former (e.g. word order, sentence structure, intralexical priming, predictability of the upcoming text, etc.) (Morris, 2006). These higher-level processes build upon the word-level processing and this raises the question of whether the established word-level alphabet effect translates to the processing of larger units (i.e. to the tasks that are more akin to normal reading). One possibility is that the alphabet
effect is retained in these sentence/text reading tasks. Alternatively, higher-level factors could perhaps neutralize the word-level alphabet effect in the sentence context. In case of such an outcome, the word-level effect may turn out to be a mere artefact of ecologically invalid task of single-word processing, and thus is ultimately irrelevant for the understanding of normal reading.

Up until now, the studies of the influence of alphabet on readability of entire sentences and texts in Serbian/Serbo-Croatian have resulted in equivocal findings. In the first research of this kind (Bujas & Bujas, 1938), a weakly illuminated Latin text was found to be more easily read than a Cyrillic text. Since one half of the examined subjects had first acquired the Cyrillic and the other half the Latin alphabet, the authors concluded that the Latin was more easily read, and attributed this to superior visual characteristics of Latin letters. The principal finding of this study was replicated in the research of Rohaček (1973). In this research, subjects were given 500ms to read sentences printed in one of the two alphabets and their task was to repeat either certain words of those sentences or entire sentences. The stimuli that were presented in Latin were recognized more quickly and reproduced with higher accuracy. On the other hand, Rot and Kostić (1988) also examined reading speeds of entire sentences printed in Cyrillic and Latin, but they failed to find significant differences between the alphabets. They concluded that the effects encountered in the earlier studies may have been caused by the subjects’ predominant use of Latin and not by genuine superior readability of Latin letters. More recently, Pašić (2004) reported faster reading times for texts printed in Cyrillic. Participants in this study were elementary school children who firstly acquired the Cyrillic alphabet (and thus, at the time of testing, presumably received more training in it than in the Latin, which they acquired later on). In spite of the reported difference in reading speeds between the alphabets, Pašić pointed out that subjects’ performance in two alphabets was equal on most of the other measures of reading success2. These inconsistent findings were obtained from different paradigms, and by the application of very different methodology. The studies were also conducted in different epochs, communities, and language variants (Serbian, Croatian, and Bosnian) of what was previously considered one language (Serbo-Croatian or Croato-Serbian). These methodological differences, as well as an insufficient attention that has been paid to the relative experience of the tested subjects with the two alphabets, is a likely cause of the diverse results of the studies.

The process of reading can be performed in two different modes: silent reading and reading aloud. Silent reading is considered to be the main indicator of literacy in the contemporary society (Lundberg, 1994; Torgesen, 2005) and a more efficient of the two reading modes (Share, 2008). Reading aloud, on the other hand, is still often used in ceremonies (e.g. speeches, religious services, etc.) and for reading to others (e.g. preliterate children) (de Jong & Share, 2007).

2 Other indicators of reading success that were used in this study were the percentage of spelling errors (substitutions, additions and omissions), single word reading errors and word repetition errors.
Importantly, reading aloud procedures are very often used in experimental studies of reading, since they provide a convenient way for the examination of reading processes (Juel & Holmes, 1981; Share, 2008). Indeed, major models of word recognition (Coltheart et al., 1993; 2001; Seidenberg & McClelland, 1989) are in fact models of reading aloud. Nonetheless, conclusions of the studies and implications of the models based on reading aloud are often generalized to silent reading (Juel & Holmes, 1981; Share, 2008). This might not necessarily always be appropriate, especially when the orthographic factors are of major concern – as is the case of the studies of bialphabetism.

Numerous studies examined reading pace in two types of reading. These studies clearly show that reading rates for silent reading are faster than for reading aloud (Anderson & Dearborn, 1952; Barker, Torgesen & Wagner, 1992; Buswell, 1937; Cole, 1938; Carver, 1990; de Jong & Share, 2007; Juel & Holmes, 1981; Levin, 1979; Swanson, 1937; Wanat, 1971). Whether this difference is only quantitative, i.e. whether the tasks of reading aloud and silent reading are based on the same underlying processes is still debated. Some authors (Baron, 1979; Buswell, 1937; Cole, 1938; Coltheart, 1978; Wanat, 1971; de Jong & Share, 2007) believe that the two tasks are importantly different. These authors point out the differences in eye movements and levels of text comprehension. In this view, reading aloud involves a more thorough phonological analysis than silent reading (de Jong & Share, 2007; Share, 2008; Corcos & Willows, 1993). By the same token, in reading aloud less attention is dedicated to the analysis of orthographic structure and meaning (Corcos & Willows, 1993). This account is not universally accepted, however. According to the opposing view, two reading modes involve essentially the same cognitive processes and the only difference between them is that the performance in reading aloud is slower than in silent reading. Furthermore, the lag in aloud reading mode is a mere consequence of the time that is required for the articulation process to take place (Anderson & Dearborn, 1952; Juel & Holmes, 1981; Swanson, 1937). Describing the current state of affairs, Share (2008) concluded that that reading aloud and silent reading seem to have much in common but that it is unlikely that they invoke identical cognitive processes in exactly the same way. If this indeed is the case, extensive use of reading aloud paradigms in the research may have resulted in a biased picture of the true nature of reading, and alphabet effects in reading in particular. More specifically, predominant use of reading aloud paradigms may have overrated the role of phonological variables and underestimated the role of orthographic and other non-phonological factors (Share, 2008). However, very few studies directly examined the factors that may exhibit different effects in silent reading and reading aloud, and to our knowledge no bialphabetic study of such kind was conducted.

In this study, we aimed to examine the reading times of entire sentences and individual words that are printed in two Serbian alphabets, the dependence of reading speed on reading mode, and a possible interaction of these two factors. In line with the recent results of the word naming experiments (Vejnović
et al., 2011; 2010) which were obtained from the subjects very similar to ours (psychology students of the same university, mostly female, similar age), we expected that our sentence reading experiment would yield faster reading times for the Latin stimuli. We also expected that silent reading times would be shorter than the aloud reading times, as the reading mode experiments had previously demonstrated (Anderson & Dearborn, 1952; Juel & Holmes, 1981; Swanson, 1937). Finally, we sought to examine the possible interaction of alphabet and reading mode. Having in mind the notion that reading aloud does not emphasize the orthographic processing as much as silent reading, we wanted to check whether reading aloud procedures underestimate the effect of alphabet, i.e. we wanted to test whether this effect was more prominent in silent reading mode. This issue is of importance for the understanding of the relationship between two modes of reading. Moreover, it is also particularly important for the interpretation of the results of the previous studies of bialphabetism that applied aloud reading procedures, and would ultimately be instrumental in advising for or against the use of aloud reading procedures in future research of this kind.

**Method**

**Participants:** Twenty-four undergraduate students of psychology at the Faculty of Philosophy, University of Novi Sad, participated in the experiment, fulfilling their study requirements. All subjects were native Serbian speakers; all first acquired the Cyrillic alphabet, and had normal or corrected-to-normal vision.

**Stimuli:** Eighty five-word-long sentences were used in the experiment. The sentences were of a very common syntactic structure for Serbian: subject + verb (auxiliary verb + verb) + object and/or adjective clause. All sentences were printed in monospace Courier New font, size 32pt, half in the Cyrillic alphabet and the other half in the Latin. Summed lemma frequency and summed number of syllables of all sentences were controlled for across alphabets.

**Design:** Two factors were manipulated in the experiment: Alphabet (Cyrillic/Latin) and Reading mode (silent/aloud). Alphabet was repeated both by subjects and stimuli, and Reading mode was only repeated by stimuli. Sentence reading times and individual word reading times were registered. Besides the experimental measures, subjects’ reading fluency measures – assessed by the Chain Test (Nevala & Lyytinen, 2000) – and subjective measures of the amount of their experience with the two alphabets were also collected.

**Procedure:** Self-paced reading task procedure was employed in the experiment. The advantage of this procedure is that it offers an insight into subjects’ reading pace, since it provides information on individual word reading times for each word of the sentence. The task was performed in the moving-window paradigm, which was chosen because it is more akin to the natural process of reading than other types of self-paced reading tasks, and its measures are correlated with the eye movement measures in normal reading (Just et al., 1982).

The experiment was run on a standard PC configuration (PC AMD Sempron 2600+ processor / 1.61GHz / 256MB RAM, with the monitor set to 70Hz vertical refresh rate and the 1024×768 pixels resolution), by the use of the DMDX software (Forster & Forster, 2003). Presented sentences were left-aligned on the display; the first letter of the first word was placed at 15cm from the monitor edge. A trial was introduced by five graphical masks – five strings of ‘x’ characters. Each of the masks hid one of the words from the sentence to be presented, and the length of each string was of the same size as the word it was masking (Figure 1). Subject commenced the reading by clicking the left mouse button, which unmasked the first
of the words. Upon its reading (either silently or loudly), subject would click the left mouse button again, which would reveal the next word in the sentence while simultaneously masking the previously read word back. In this way, at any given time during the experiment, only one word would be displayed on the screen.

\begin{verbatim}
хх xxxx xxxx xxxx xxxxxxxx.
Он xxxx xxxx xxxx xxxxxxxx.
xx пије xxxx xxxx xxxxxxxx.
xx xxxx црну xxxx xxxxxxxx.
xx xxxx xxxx кафу xxxxxxxx.
xx xxxx xxxx ујутро.
\end{verbatim}

Figure 1. Six steps in the presentation of a five-word sentence that was used in the experiment (English translation of the sentence reads: “He drinks black coffee in the morning”).

Subjects were familiarized with the procedure in the practice trials that preceded the experiment. After every 4–6 sentences, a yes/no question would follow, in order to check for comprehension of the previously read sentence. Experiment was divided into two blocks (the Cyrillic and the Latin), and the order of presentation of the stimuli was randomised within the block. The instruction that was printed in the same alphabet as the upcoming stimuli preceded the presentation of each block.

Upon completing the self-paced reading task, subjects were administered two alphabetic versions of the Chain Test (Nevala & Lyytinen, 2000) and the scales for the subjective assessment of the amount of experience with the alphabets. The Chain Test is a procedure that is commonly used as a measure of reading fluency. The test requires the subjects to read one page of a text in which the words are not separated by blank space and to separate the words by drawing vertical lines between them as fast as they can. The subjects performed the Cyrillic and the Latin version of the test, and the number of accurately positioned vertical lines during the course of one minute was counted for each alphabetic version of the test. The self-assessment measures were obtained from the four seven-point scales on which the subjects judged their amount of experience with the alphabets. The first scale assessed the exposure to the Cyrillic alphabet, the second assessed the exposure to the Latin alphabet, and the third and forth scales assessed the frequency of use of the Cyrillic and the Latin alphabet, respectively.

Results

Linear mixed-effect modelling was carried out in R software environment for statistical computing and graphics (Bates, 2005; Bates, 2006; Baayen, Davidson, & Bates, 2008). Results were analyzed in two separate analyses: entire sentence reading times were used in the main analysis and additional analysis of individual word reading times was also conducted in order to examine the robustness of the findings of the main analysis.

Entire-sentence analysis

Alphabet and Reading mode as fixed factors and Subjects and Stimuli as random factors were fitted on log-transformed sentence reading times in the main data analysis. Close inspection of the distribution of sentence reading times revealed small number (1.7%) of extreme outliers that were removed
from further analysis. After this, possible non-linearities and significant by-item and/or by-subject random slopes were examined. Both Alphabet and Reading mode required by-subject weights for the intercept that were not correlated with the by-subject adjustment for the intercept. Simply put, the effects of Alphabet and Reading mode varied across subjects in terms of both the intercept and the linear slope, and these two adjustments were not correlated. The final model was refitted after the removal of absolute standardized residuals that exceeded 2.5 standard deviations. Both fixed factors exhibited significant influence on the reaction times (see Figure 2). Reading of the Latin sentences was significantly faster than reading of the Cyrillic ($\beta=-0.108$, $t=-2.36$, df=1847, $p=0.002$). Significantly shorter reaction times were registered for silent reading than for reading aloud ($\beta=-0.125$, $t=-2.59$, df=1847, $p=0.0006$). Interaction of the two factors was non-significant.

![Figure 2. Fixed effects of Alphabet and Reading mode on sentence reading times (in ms).](image)

**Single-word analysis**

Three fixed factors, Alphabet (Cyrillic/Latin), Reading mode (aloud/silent) and Word position (1, 2, 3, 4, 5), were used in the single-word analysis. The third factor, Word position, was introduced in order to examine the positional effect of the word within a given sentence and its possible interaction with Alphabet and Reading mode. Log-transformed lemma frequency, Number of syllables in the word, Log-transformed previous reaction times and Trial order were included into the model as control covariates, and Subjects and Stimuli were modelled as random factors. The point of inflection for the log-transformed reaction times distribution was at 5.3 log units. A certain number of very short reaction times (shorter than 5.3 log units) was registered because the subjects accidentally clicked the response button or could easily predict the upcoming words from the previous context and thus did not need to read them. Because of this, RTs
shorter than 200ms (5% of the entire data set) were excluded from the analysis.
Collinearity of the predictors was tested prior to final modelling. With all nine
mentioned predictors included in the model, the condition number κ was 48.
A rather high level of collinearity was caused by the collinearity of Previous
reaction time with the rest of the predictors, hence this control covariate
was removed from the model. A high correlation ($r=-0.72$) between Lemma
frequency and Number of syllables was also observed, and thus only Lemma
frequency was kept in the final model. Finally, with these two control covariates
excluded, the condition number decreased to $κ=10$, which is an acceptable level
of collinearity. Accordingly, the final set of fixed predictors included Alphabet,
Reading mode, Word position, Log-transformed lemma frequency and Trial
order. Examination of non-linearities and possible interactions yielded the
same structure of random effects as in entire-sentence analysis. Data points
with absolute standardized residuals exceeding 2.5 standard deviations were
removed from the final (refitted) model. The final model showed a (marginally)
significant effect of Alphabet ($β=-0.086$, $t=-1.84$, df=8934, $p=0.018$) and a
significant effect of Reading mode ($β=-0.276$; $t=-5.63$, df=8934, $p=0.0001$). As
in the case of entire sentences, reading was more rapid in the silent mode, and
the Latin alphabet was read more rapidly than the Cyrillic. Therefore, our main
predictors, Alphabet and Reading mode, affected the reading times in a similar
way as in the entire-sentence analysis (see Figure 3). The only difference was
that effect of the alphabet in the single-word analysis was less prominent than in
the entire-sentence analysis.

The nature of Word position effect was rather complex, since this effect
was non-linear and interacted with Reading mode (see Table 1 and Figure 4).
Table 1. Partial linear and nonlinear effects of predictor Word position and its interaction with Reading mode. Levels of significance were established using Markov Chains Monte Carlo – MCMC procedure.

<table>
<thead>
<tr>
<th>Component</th>
<th>$\beta$</th>
<th>T</th>
<th>df</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear component</td>
<td>0.304</td>
<td>-13.66</td>
<td>8934</td>
<td>0.0001</td>
</tr>
<tr>
<td>Nonlinear component</td>
<td>0.049</td>
<td>14.33</td>
<td>8934</td>
<td>0.0001</td>
</tr>
<tr>
<td>Linear interaction</td>
<td>0.116</td>
<td>5.99</td>
<td>8934</td>
<td>0.0001</td>
</tr>
<tr>
<td>Nonlinear interaction</td>
<td>0.017</td>
<td>-5.37</td>
<td>8934</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

The drop in reading times between the first and the second word was almost twice as large in aloud reading mode ($t=9.83$, df=1875, $p=0.000$) as in silent reading ($t=4.88$, df=1813, $p=0.000$).

Control covariates Trial order and the Word lemma frequency had a significant effect on reading times: reading speed increased during the experimental session as a consequence of practice ($\beta=-0.001$, $t=-13.11$, df=8934, $p=0.0001$), and the more frequent words took less time for processing ($\beta=-0.017$, $t=-10.17$, df=8934, $p=0.0001$).

Self-assessment measures

On the seven-point scales, mean score for the self-assessed Frequency of use of the Cyrillic alphabet was 4.15 (SD=1.53) and 5.45 (SD=0.91) for that of the Latin alphabet. Mean score for the Exposure was 3.9 (SD=1.17) for the Cyrillic and 5.5 (SD=0.45) for the Latin alphabet. These results evidenced subjects’ conviction of their somewhat more extensive experience with the Latin alphabet. However, the difference obtained from the self-assessment measures was less prominent than the objective data suggest, which arguably reflects the subjects’ bias towards the judgements of balanced experience with the two alphabets and/or their inability to assess their experience with the alphabets with
high precision. The two measures were highly correlated \( r=0.63, p<0.001 \) and did not significantly affect the reading times in the self-paced reading task for the corresponding alphabet. The performance on the Chain Test was predictive of general reading speed in the self-paced reading task \( (\beta=0.002, t=-3.55, p=0.001) \): subjects who managed to correctly put more separators in the Chain Test also required less time to read the sentences in the self-paced reading task. No significant differences were found in the Chain Test performance depending on the alphabet in which the texts were printed.

**DISCUSSION**

The first goal of this study was to determine whether there was a difference in reading speed when the Serbian sentences were printed in the Latin and Cyrillic alphabet. So far, the results of the research of this kind have been equivocal (see for example Bujas & Bujas, 1938; Rohaček, 1973; but also Pašić, 2004; and Rot & Kostić, 1988). One finding that is especially relevant for our study (because it has been obtained recently, in the same environment, and in very similar subjects) has indicated that the individual words printed in the Latin alphabet are named more rapidly than the words printed in the Cyrillic (Vejnović et al., 2010). This result has been attributed to the subjects’ unequal experience with the alphabets, given that the objective measures have demonstrated a clear predominance of the Latin alphabet in subjects’ environment. Due to close similarities of our subjects and the subjects of the mentioned experiment, we expected that a similar advantage of reading of Latin text would be observable in our experiment, where the task was to read entire sentences. Secondly, we also wanted to examine whether the mode of reading – silent reading versus reading aloud – may affect sentence reading performance patterns in the two Serbian alphabets. As aloud reading implies an additional articulation process on top of the cognitive processes that characterize silent reading, and since the articulation prolongs the time required for reading (Juel & Holmes, 1981), we expected to encounter the reading mode effect in both alphabetic versions of our task. Moreover, we also wanted to check whether perhaps the advantage of the Latin may be more exaggerated in silent reading mode, since the actual size of the orthographic effect could turn out to be partially obscured in aloud reading task, due to the extended reading times caused by the articulation processes. The choice of the self-paced reading paradigm enabled us to explore these effects both at the level of sentence reading and individual word processing. Our expectation was that the individual word effects should follow (and hence reconfirm) the pattern of results observed in the entire sentences.

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3 In a pilot study, two bipolar scales (with their extreme values corresponding to the exclusive experience with one or the other alphabet) were used instead of the four unipolar ones. The choice of scale type did not affect the results: two bipolar/relative experience scales were also highly correlated, but neither of them was predictive of the reading times.
The first important finding of our experiment is that there is a significant effect of alphabet on sentence reading times. Our subjects took less time for reading the sentences that were printed in the Latin than for those that were printed in the Cyrillic alphabet. Moreover, the same effect was encountered when the speed of reading was analyzed at the level of individual words (that were processed within the sentence context). Thus, the outcome of this study supports the findings of Vejnović et al. (2010) and extends their conclusions beyond the single-word processing to the ecologically more relevant task of sentence reading. Secondly, sentence reading times were also affected by the mode of reading: as expected, silent reading resulted in shorter reading times in comparison to reading aloud. Again, this effect was observed both at the level of entire sentences and individual words. Accordingly, our predictions regarding the influences of these two factors – alphabet and reading mode – were confirmed. Importantly, however, the two factors did not interact, which suggests that each of them influences reading independently of the other one. In other words, the assumption of a less pronounced orthographic/alphabetic effect in aloud reading than in silent reading mode (presumably reflecting the difference in the nature of the two tasks) was not supported by the data. Therefore, this result is in line with the view by which aloud reading and silent reading are essentially the same task, except that the former requires an additional articulatory process and in consequence takes a bit more time to be performed (Anderson & Dearborn, 1952; Juel & Holmes, 1981; Swanson, 1937). Consequently, predominant use of reading aloud procedures does not seem to affect the conclusions on the orthographic/alphabetic effects that were drawn from reading-aloud procedures. Our results do not dissuade from the application of such procedures.

The size of the obtained effects varied across subjects. Given that the subjects were sampled from a rather homogeneous group (they all were psychology students under the age of 25, residents of Novi Sad, and mostly female), we believe that the observed individual differences may have likely arisen due to differences in reading fluency, i.e. the difference between the slower readers and the faster ones. The results of the Chain Test (Nevala & Lyytinen, 2000) support this assumption: more fluent readers, those who performed better on the Chain Test, also performed better on the self-paced reading task.

Results of the secondary, single-word analysis followed the findings obtained from the reading of entire sentences. The only perceivable difference was that the effect of the alphabet was somewhat attenuated in the single-word analysis, which is a consequence of a greater variation between subjects at the level of the individual words. Individual differences in the processing speed of the two alphabets seem to play a less important role in sentence reading than at the level of single-word processing. Furthermore, position of the word in the sentence exhibited a non-linear effect on reading speed. Reading speed increased from the beginning of the sentence until its third word, after which there was a decrease in the processing speed of the last two words. This non-linear effect was dependent on the mode of reading: when subjects read the text loudly, positional differences between word reading speeds were more exaggerated
than when the sentences were read silently. The cause of this interaction will be discussed further on.

All of our subjects read the words and sentences printed in the Latin alphabet more rapidly than the sentences printed in the Cyrillic, and we now turn to the question of the possible cause of this effect. As noted in the introductory section, there are several factors to which this unequal processing of the two alphabets can be attributed. Namely, these are the following: a) visual characteristics of the graphemes; b) age/order of alphabet acquisition; and c) practice (exposure, frequency of use) with the alphabets. As for the first among them, no convincing evidence can be found in the literature that would suggest that the letters of either alphabet are visually/perceptually superior to the letters of the other one (see Ognjenović et al., 1995; Rot & Kostić, 1986; 1987; 1988). Additionally, it has been argued that visual characteristics of letters play even a less important role when the analysis moves away from the low-level letter perception towards higher-levels of word or sentence reading (Rot & Kostić, 1988), as was the case in this study. Therefore, we do not believe that this factor is responsible for the alphabetic differences observed in our study. The second potential cause – the age or order of alphabet acquisition – can positively be excluded as the potential cause of alphabet effect, too: even though all of our subjects first acquired the Cyrillic alphabet, there was none among them who processed this alphabet faster than the Latin. Therefore, we believe that the reason for faster reading of the Latin alphabet was the third one: more exposure or more practice that our subjects have received with this alphabet. Indeed, the objective measures of the presence of the two alphabets in the contemporary Serbian society are in accordance with the general public notion: the Latin alphabet is convincingly more present than the Cyrillic. As commented, a recent report of Vejnović et al. (2010) has shown that 88% percent of public signage on the streets of Novi Sad is printed in Latin. Similarly, Latin is the alphabet of choice for the great majority of Serbian media (newspapers, TV stations, internet pages), and the estimated share of Latin-printed books in the total yearly book production in Serbia goes beyond 75%.4 Unfortunately, the self-assessment measures of our subjects’ frequency of use and exposure to the alphabets did not succeed in illustrating this sufficiently. When judging their experience with the alphabets, the subjects tended to choose the intermediate, moderate values, thus underestimating the persuasive predominance of the Latin as evidenced by the objective data obtained from their environment. Consequently, their self-assessment measures were not predictive of their reading performance. Our subjects may have simply been unable to assess their experience with the alphabets with sufficient precision, but their judgements may have been contaminated by the social bias, too: these judgements were probably affected by a quite strong prescriptive social notion present in the contemporary Serbian society, according to which the two alphabets ought to be used with equal frequency (or even that

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4 The example of the students of psychology at the University of Novi Sad (who were the subjects of our study) is also very persuasive in this respect: only one out of more than forty textbooks that are used for the undergraduate courses is printed in Cyrillic.
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The Cyrillic alphabet ought to be the preferred one). Nevertheless, given that the observed differences in reading speed clearly cannot be accounted for by either of the two other potential factors, and given the convincing objective evidence of the Latin alphabet predominance in our subjects’ environment, we argue that the alphabetic differences obtained in our study were most likely caused by the amount of everyday experience that our subjects had had with the two alphabets. Future research should look for objective measures of the experience of each individual subject with the alphabets, and in that way provide an even stronger support for this view.

The default mode for reading is reading silently. Although learning to read typically starts with training to read loudly, this reading mode is generally considered as a rather infrequent. Reading aloud is also argued to be a more difficult mode of reading, as reader is required to pay attention to articulation and monitor the pronunciation of what is being read (Juel & Holmes, 1981). A result of our study – longer reading times of sentences in aloud reading mode – supports this notion. The effect of articulation is evident both when entire sentences are regarded and when the sentence reading times are broken down into reading times of individual words. Furthermore, individual word reading times in aloud reading mode varied to a greater extent as a function of word position than the word reading times in silent reading mode. This effect was primarily observable in the first and the last words of the sentences. Though first words of the sentences took relatively longer time for processing in both reading modes, this effect was more pronounced when the subjects read the sentences loudly. This additional time that was used for the aloud reading of the first words reflects the cost of programming and execution of the muscular movements in speech production. Since the articulation process is absent in silent reading mode, silent readers are in position to immediately and entirely focus on the cognitive processing of the text. Slowdown of reading speed at the end of the sentence, which was also apparent in both reading modes, had likely been caused by the higher-level comprehension processes that were set off when most/all of the individual words in the sentence had been processed. Evidently, the processes that correspond to the extraction/construction of the sentence meaning should be the most prominent towards the end of the sentence, because of the insufficient semantic and syntactic information that is available while the first and middle words of the sentences are being read.

Conclusively, this research showed that readers in the present-day Serbia are faster when processing the Latin alphabet than when processing the Cyrillic. This holds true for both sentence reading and single-word processing, and irrespectively of whether the reading is performed in a faster, silent reading mode or slower mode of reading aloud. On the basis of previously discussed evidence, we conclude that the effect of the alphabet most likely emerged due to the predominance of the Latin alphabet in the readers’ environment. This result has at least two practical implications: a) for the situations where the fast reactions are of crucial importance, the design of the communication tools (e.g. different types of displays) would benefit from the use of Latin alphabet;
b) if preservation of cultural identity and tradition is of the primary concern, the results of our study could be taken as an evidence for the need to encourage the use of the Cyrillic alphabet. The authors do not express their views with respect to this multi-faceted social issue, given that its complexity extends beyond the field of cognitive psychology. Instead, we limit ourselves to exploring and pointing out the cognitive aspects of bialphabetism. Other than that, the study also confirmed that aloud reading requires more time than silent reading and that this effect becomes more pronounced as the analysis moves away from single-word to entire-sentence reading. Finally, our study was the first one to examine the relationship between the two reading modes and the two Serbian alphabets. The obtained results suggest that our subjects’ superior reading speed of Latin sentences does not depend on the reading mode. Such an outcome dispels the doubt about the findings of the earlier studies of bialphabetism that were obtained from aloud reading paradigms and at the same time justifies the use of aloud reading paradigms in the future research of bialphabetism.

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**REFERENCES**


