

BI-ALPHABETICAL LEXICAL DECISION*

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The Serbo-Croatian language is written in two alphabets, Roman and Cyrillic. The majority of the total number of alphabet characters are unique to one or the other alphabet. There are, however, a number of shared characters, some of which receive the same reading in the two alphabets, and some of which receive a different reading in the two alphabets. Letter-strings were constructed, all of which could be given a phonological interpretation in Roman, but only some of which could be given a phonological interpretation in Cyrillic; some of these letter-strings had a lexical entry in Roman, some had a lexical entry in Cyrillic, some had a lexical entry – the same or different – in both alphabets, and some had no lexical entry in either alphabet. In three experiments, subjects reading in the Roman alphabet mode decided as rapidly as possible whether a given letter-string was a word. Taken together, the experiments suggest that in the lexical decision task, Serbo-Croatian letter-strings (where their structure permits) receive simultaneously two phonologic interpretations. Whether or not this phonologic bivalence impedes lexical decision in the assigned alphabet mode depends on whether or not the letter-string has a lexical entry in at least one of the alphabets.

INTRODUCTION

Our concern is with the processes involved in recognizing visually presented words. There is a good deal of evidence to suggest that visual word recognition may be mediated by a phonologic recoding (for example, Meyer, Schvaneveldt and Ruddy, 1974; Rubenstein, Richter and Kay, 1975). At the same time, substantial evidence can be found for the contrary view, namely, that word recognition can proceed independently of phonologic recoding by means of a direct mapping between graphemic analysis and the lexicon (for example, Forster and Chambers, 1973; Kleiman, 1975; Green and Shallice, 1976; Marcel and Patterson, in press). Given these observations, it would seem prudent at this stage in the development of the theory of word recognition to accept both processes as available to the experienced reader. Presumably, whether one or the other is used, or both are used, depends in a principled fashion on the circumstances. In this light, we may consider Fig. 1 as a reasonably representative depiction of the procedures that support word recognition and the relations among them (see Meyer *et al.*, 1974; Marcel and Patterson, in press).

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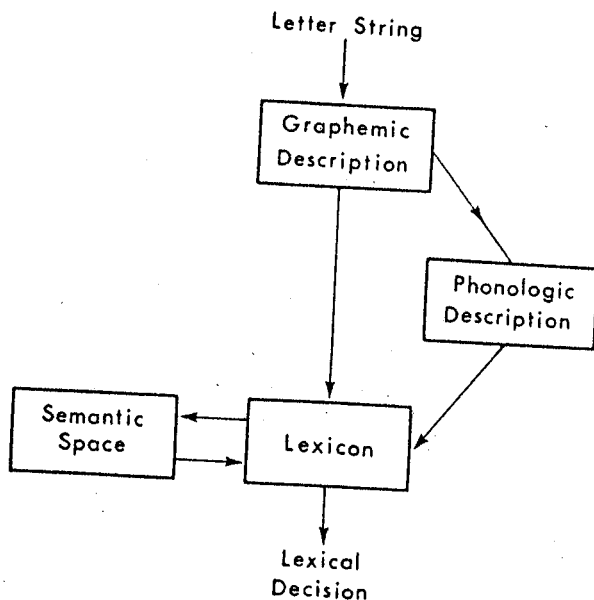


Fig. 1. A general model of lexical access.

To clarify, the model depicted in Fig. 1 assumes two relatively independent routes by which the lexicon can be accessed: one route is a direct route from the graphemic description; in the other route, phonological analysis intercedes between the graphemic description and the lexicon. The model separates the lexicon from the semantic space in the manner of Morton's (1970) logogen model and Quillian's (1969) Teachable-Language Comprehender. The contents of the lexicon — the lexical entries — can be thought of as abstract entities that are activated by or matched to appropriate stimulation from the eyes, the ears and the semantic space. Lexical entries have pointers to their respective locations in the semantic space, and one lexical entry is assumed for each entry in the semantic space; thus, homographs will have as many lexical entries as they have meanings. As intimated above, the relation between the semantic space and the lexicon is not unidirectional. The semantic space relates to the lexicon in the sense of priming semantically related lexical entries. The distinction between the lexicon and the semantic space is drawn primarily in terms of organization: in the lexicon, entries are said to be organized according to frequency of occurrence or usage, whereas in the semantic space the entries are said to be organized according to semantic relations.

Insofar as Fig. 1 represents a reasonable account of the processes yielding visual word recognition, the experiments reported here examine the depicted model through the use of the special situation that is provided by the popular use of two alphabets — the Roman and the Cyrillic — in Yugoslavia.

The modern Serbo-Croatian orthography was constructed at the beginning of the 19th

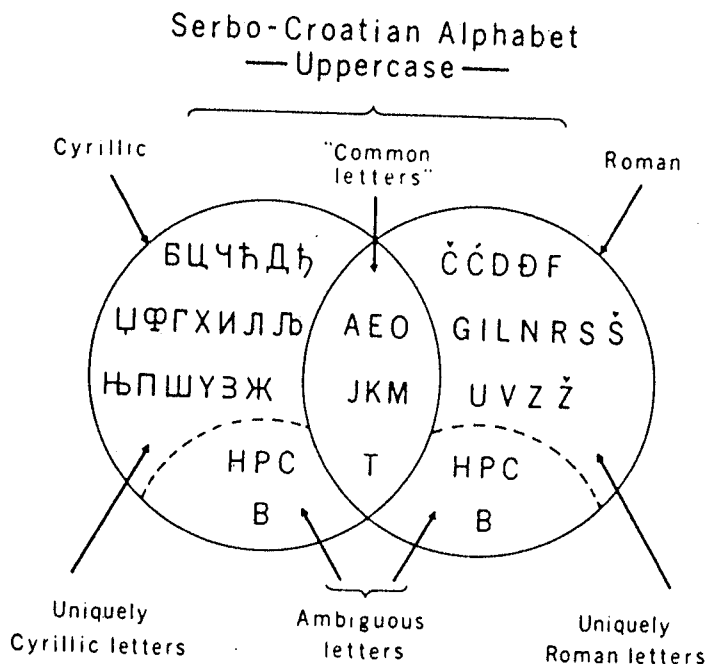


Fig. 2. The upper-case letters of the Roman and Cyrillic alphabets.

century. The properties of the modern alphabet are that each letter stands for a phoneme and the phonemic interpretation of each individual letter is largely invariant and unaffected by preceding and following letters and letter clusters. All letters are pronounced; there are no letters which are made silent by context.

Both the Roman and the Cyrillic alphabets possess the above properties, and in many areas of Yugoslavia both alphabets are used by the local population. This situation is due, in part, to the educational system, which teaches both alphabets in the first and second grade and, in part, to the fact that reading materials come in both alphabets. In Eastern Yugoslavia the children are taught to read and write Cyrillic during their first school year, and Roman during their second; in Western Yugoslavia the children learn first Roman and then Cyrillic.

The Cyrillic and Roman alphabets in Serbo-Croatian letters can be divided into four different groups, which are illustrated in Fig. 2. Some letters have the same shape and pronunciation in both alphabets. We will refer to these letters as "common letters." The word for 'aunt,' for example, is written TETKA in Roman and in Cyrillic. However, there are also several letters of the same shape that represent, in the two alphabets, different utterances. We will call them "ambiguous letters." The word 'deer', for example, is spelled CPHA in Cyrillic. However, if CPHA were read as Roman, the pronunciation would be different and the "word" itself would be meaningless. Similarly, one can

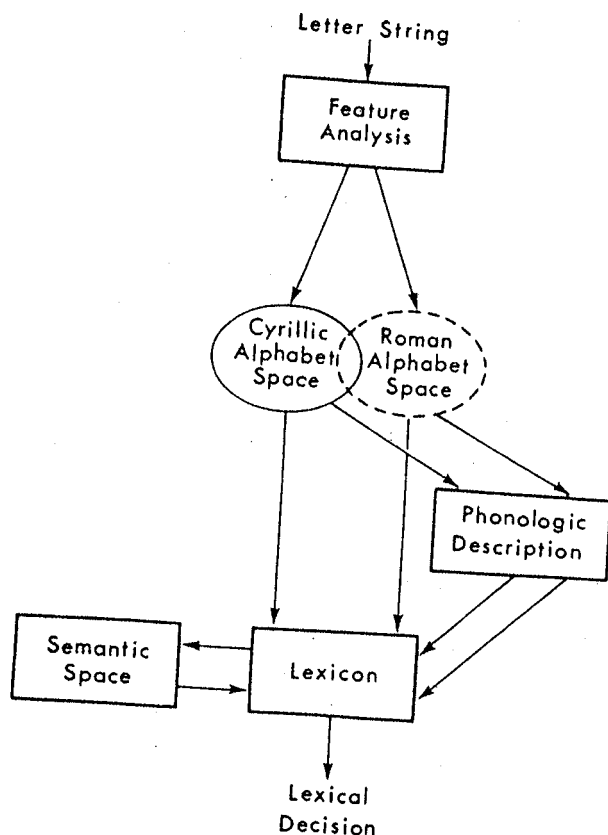


Fig. 3. A modification of the general model of lexical access incorporating the two alphabet spaces.

combine ambiguous and common letters to write words that have one pronunciation and meaning if read as Cyrillic, and a different pronunciation and a different meaning if read as Roman. Finally, the remaining letters are specific either to the Roman or Cyrillic alphabets. We will refer to these as "the uniquely Roman" or "the uniquely Cyrillic" letters, respectively.

It is evident that the relation between the two alphabets is not the same as the relation between the upper- and lower-case alphabets of, say, English. It is also evident from the preceding that Serbo-Croatian provides a special situation for the study of word perception in particular, and reading in general.

The use of the two alphabets in the Serbo-Croatian language invites a modification of Fig. 1 along the lines suggested by Fig. 3. In particular, two largely separate but partially overlapping alphabet spaces are introduced, where the overlap is constituted by the representations of the common letters. The stage of graphemic description in Fig. 1 is

understood in Fig. 3 as the assigning of representations (structural descriptions) in one or the other (or both) alphabet spaces to the letters in the input letter-string. These representations in the alphabet spaces can constrain a search through the lexicon without further mediating steps. In addition, they can map onto their respective phonologic descriptions, in which case the search through the lexicon is phonologically constrained. As in our discussion of Fig. 1, it is assumed that both kinds of search can occur together. However, the redesigning of Fig. 1 to accommodate two largely separate alphabet spaces brings with it the question of how the four routes to the lexicon — two graphemic and two phonologic — relate in the processing of Serbo-Croatian letter strings.

The experiments reported here are directed at lexical decision. A subject, on presentation of a string of spatially adjacent letters, is required to respond whether the string is a word or not. The minimal form of this procedure can be referred to as the single lexical decision task. A more complex form presents two letter-strings, spatially separated, at the same time and requires the subject to respond "yes" if both letter-strings are words and "no" otherwise (Meyer and Schvaneveldt, 1971). This procedure might be referred to as the paired lexical decision task; it is used when the relation between letter-strings is of interest (see Meyer *et al.*, 1974). Two of the present experiments (Experiments I and II) employ a variant of the paired lexical decision task in which two (related or unrelated) letter-strings are presented in succession (rather than simultaneously) and in which the subject must make two successive lexical decisions, one on the first letter-string and one on the second. The remaining experiment (Experiment II) uses a single lexical decision task.

Consider lexical decision from the perspective of the Roman mode, that is, from the perspective of whether a string of letters is a word when read in the Roman alphabet. Table 1 identifies eight types of letter-string (LS) composed from the Roman alphabet and the correct lexical decision for each string in the Roman mode. A letter-string that is constructed from Roman letters is, in the first place, a string in which there are no uniquely Cyrillic letters and, in the second place, a string in which there are letters common to the two alphabets and sometimes letters that are ambiguous (see Fig. 2). Table 1 demonstrates that of the letter-strings constructed from the Roman alphabet: all can be given a phonological interpretation in Roman (P_R), but only some can be given a phonological interpretation in Cyrillic (P_C); some can have a lexical entry when read as Roman (L_R); some can have a lexical entry when read as Cyrillic (L_C) — even when they do not have a lexical entry when read as Roman — and some can have a lexical entry in both alphabets.

An examination of lexical decision on the letter strings of Table 1 should reveal the relation between accessing the lexicon graphemically and accessing the lexicon phonologically.

EXPERIMENT I

The first experiment explores several relationships in the paired lexical decision task. It seeks to replicate the observation of a priming effect (Meyer and Schvaneveldt, 1971):

TABLE 1

Types of letter strings in the Roman alphabet

Type of letter string (LS)	Lexical entry (L)		Phonological representation (P)		Symbolic representation	Is it a word in Roman?
	In Roman (L _R)?	In Cyrillic (L _C)?	In Roman (P _R)?	In Cyrillic (P _C)?		
LS1	Yes	No	Yes	No	LS1 $\left\{ \begin{array}{l} \circ LR \\ \circ PR \end{array} \right.$	Yes
LS2	Yes, two	No	Yes	No	LS2 $\left\{ \begin{array}{l} \infty 2LR \\ \circ PR \end{array} \right.$	Yes
LS3	Yes	Yes	Yes	Yes	LS3 $\left\{ \begin{array}{l} \bullet \circ LR, LC \\ \bullet \circ PR, PC \end{array} \right.$	Yes
LS4	Yes	No	Yes	Yes	LS4 $\left\{ \begin{array}{l} \circ LR \\ \bullet \circ PR, PC \end{array} \right.$	Yes
LS5	Yes	Yes	Yes	Yes	LS5 $\left\{ \begin{array}{l} \circ LR = LC \\ \circ PR = PC \end{array} \right.$	Yes
LS6	No	Yes	Yes	Yes	LS6 $\left\{ \begin{array}{l} \bullet LC \\ \bullet \circ PR, PC \end{array} \right.$	No
LS7	No	No	Yes	Yes	LS7 $\left\{ \begin{array}{l} \bullet \circ PR, PC \end{array} \right.$	No
LS8	No	No	Yes	No	LS8 $\left\{ \begin{array}{l} \circ PR \end{array} \right.$	No

the lexical decision on a letter-string that composes a word is facilitated if the preceding letter-string is a semantic relative (Fischler, 1977). Additionally, and more important, the first experiment examines the influence of alphabet ambiguity on lexical decision. Suppose the reader is reading in Roman, that is, accepting and rejecting letter-strings as words *in Roman*, then we can ask whether the latency of decision on any given string will be affected by the fact that the string is a word *if read in Cyrillic*. To anticipate the design of

the experiment: a subject operating in the Roman alphabet mode will be confronted, on some small proportion of the trials, by letter-strings that happen to be words in the Cyrillic alphabet mode, but may or may not be words in the Roman alphabet mode.

Method

Subjects. Twenty students from the University of Belgrade Faculty of Philosophy served voluntarily as subjects. All the students had normal or corrected-to-normal vision, all had received their elementary education in Eastern Yugoslavia, and none had had previous experience with visual-processing experiments. One subject was eventually dropped from the analysis because of too many responses in excess of 1500 msec.

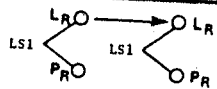
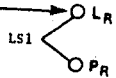
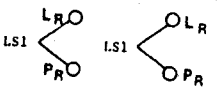
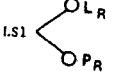
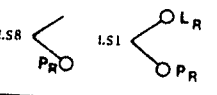
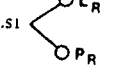
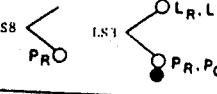
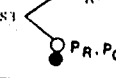
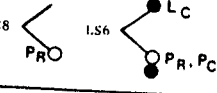
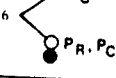
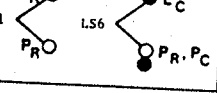
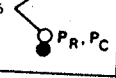
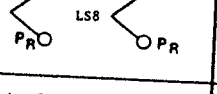
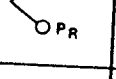
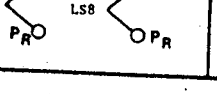
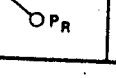
Materials and design. Letraset black upper case Roman letters (Helvetica Light, 12 point) were used to prepare the letter-strings. A string of three to six letters arranged horizontally at the center of a 35 mm. slide represented a word or a non-word in the Roman alphabet. The criterion for choice of words (in all three experiments) was that they belonged to the vocabulary of elementary school children. From published word frequency data for Serbian children (Lukić, 1970), words from the midfrequency range were chosen; too frequent words and too rare words were avoided. In addition, for both word-strings and non-word-strings, rare consonant clusters were avoided.

The letter-strings were grouped into pairs such that either member of a pair could be a word or a non-word. All in all, there were eight different types of pairs, and these are given in Table 2 along with the proportion of trials on which each type appeared in the experiment.

First consider Types 1 and 2. The first and second members of a pair were LS1 and LS1 (see Table 2) for both pair types. In short, those were word/word pairs in the Roman alphabet that were unclassifiable in the Cyrillic alphabet. In Type 1, the two letter-strings were associatively related — in Type 2, they were not. Associative norms are not available (to our knowledge) in Serbo-Croatian, so associated and non-associated pairs were determined by a panel of native Yugoslavians. In contrast with the research of Meyer, Schvaneveldt and Ruddy (1975), different sets of letter-strings were used to construct the associated and non-associated pairs. When a single set of letter-strings is used for this purpose, care must be taken in assigning subjects to pairs so that a given subject never sees the same letter-string twice. Thus, half the subjects must see half of the Type 1 pairs and the non-corresponding half of the Type 2 pairs; the other half of the subjects then see the other halves of the Type 1 and Type 2 pairs. While this design strategy has the advantage of permitting the comparison of the same letter-strings in the associated and non-associated cases, there are complications in analysing the data according to the strictures suggested by Clark (1973) (see Meyer *et al.*, 1974; Scarborough, Cartese and Scarborough, 1977).

Type 3 pairs were composed from letter-strings of types LS8 and LS1, that is, they were non-word/word pairs in Roman but unclassifiable (unreadable) in Cyrillic. The words in these pairs were different from the second words in the Type 1 and Type 2 pairs. The Type 3 pairs will provide a further but limited control for the Type 1 pairs and the appropriate control for the Type 4 pairs. Type 4 pairs are composed from letter-

TABLE 2

Type of pair	Letter Strings		Example		Correct response	Relative frequency	Reaction time (msec)	Percent of errors		
	First	Second	First	Second				Regular	Slow	Total
1			OBLAK — KIŠA STENA — KAMEN		Yes	0.11	634 ±62	1.5	1.5	3
2			NAKIT — MLEKO TRAVA — KUĆA		Yes	0.11	726 ±87	2	2	4
3			ŠUFALJ — TOČAK EČANJ — GUMA		Yes	0.20	722 ±84	2	0.5	2.5
4			NUPER — CEH LASET — KACA		Yes	0.09	940 ±164	20	6	26
5			DINAK — PEREP NIGA — POCA		No	0.09	886 ±178	19	13	32
6			GUSKA — TABAH KULA — BETAP		No	0.09	915 ±208	20	14	34
7			ŽITEF — VUREM RILAP — GAFULJ		No	0.11	864 ±135	3.5	3.5	7
8			PČELA — MEREZ LEKAR — DEVIŠ		No	0.20	817 ±125	6	-	6

strings of type LS8 and LS3, that is, non-word/word pairs in Roman and unclassifiable/word pairs in Cyrillic. The significant feature of the second letter-string of each Type 4 pair is that the Roman reading and the Cyrillic reading specify different words. In short, the second member of Type 4 pairs is a word in both alphabets. For example, CEH means 'bill' in Roman and 'shadow' in Cyrillic. A comparison of Type 3 and Type 4 pairs

permits a determination of whether accepting a string as a word is facilitated by the string's lexical membership in both alphabets.

Type 5 and Type 6 pairs were, respectively LS8, LS6 and LS1, LS6. That is to say, Type 5 pairs were non-word/non-word in Roman and unclassifiable/word in Cyrillic. An examination of responses to the second members of these pairs will permit the determination of whether rejecting a string as Roman is affected by the fact that the string has a lexical entry in Cyrillic. The controls for Type 5 and Type 6 pairs are provided by Type 7 and Type 8 pairs. Type 7 pairs are non-word/non-word (LS1/LS8) in Roman and unclassifiable in Cyrillic. Type 8 pairs are word/non-word (LS1/LS8) in Roman and unclassifiable in Cyrillic.

Our intention was to have the subject operate in the Roman alphabet mode. We sought to achieve this by creating a context (as opposed to giving an instruction) in which all letter-strings were readable as Roman and in which very few letter-strings were readable as Cyrillic. There were never any uniquely Cyrillic letters. Strings that were readable in Cyrillic were constructed from the letters common to the two alphabets. A subject saw 72 pairs in the experimental session, that is, 144 letter-strings. Of these 144 letter-strings, only 27 contained ambiguous characters. These 27 were the only strings that could be read as Cyrillic and they only occurred as second members of a pair.

The 72 pairs seen by a subject were presented in four blocks. In each block the pairs of each type were presented in a pseudo-random order. The sequence of blocks was balanced across subjects according to a Latin-square design. The same string of letters was never judged more than once by a subject.

Procedure

The subject was seated at a three-channel tachistoscope (Scientific Prototype, Model GB). The subject was instructed to focus on the fixation point in the center of a pre-exposure field that was present at all times except during presentation of a letter-string. An auditory warning signal preceded the first letter-string in a pair. Onset of the letter-string triggered an electronic counter that was stopped when the subject pressed either one of two buttons on a response panel in front of him. Both hands were used. Both thumbs were placed on a telegraph key button close to the subject and both forefingers on another telegraph key button two inches further away. The subject depressed the closer button (thumbs) if the letter-string was a Roman non-word, and the other further button (forefingers) if the letter-string was a Roman word. As soon as a button was depressed, the first letter-string of a pair was replaced by the second. When the second letter-string was presented, another electronic counter was triggered. The subject now judged whether the new string of letters was a word or a non-word and again made his answer by pressing the telegraph keys in the manner described. Regardless of the subject's response time, the second letter-string in each pair was always automatically replaced after 1500 msec. by the pre-exposure field.

Results and discussion

For all analyses, only the response latencies and errors with respect to the second

letter-strings were considered. Data were excluded from trials on which the response to the first letter-string was incorrect. Incorrect classifications and correct classifications that exceeded 1500 msec. were defined as errors. The basic datum was the reaction time (RT) for each subject for each type of stimulus. Table 2 summarizes the results of the experiment.

There are two main aspects of the data. First, the latency of recognizing that the second letter-string was a word was significantly affected by the associative relation between the two strings; precisely, where the first string was an associate of the second, lexical decision on the second was enhanced (see Meyer *et al.*, 1975). The mean difference between Type 1 and Type 2 second-string latencies was 92 msec., $F'(2,25) = 10.01$, $p < 0.001$ (see Clark, 1973). A similar relation clearly holds between Type 1 and Type 3 second string latencies (see Table 2).

Second, it is evident from Table 2 that a letter-string that was nonsense in Roman but a sensible Serbo-Croatian word in Cyrillic was rejected as a word with some difficulty. In support of this claim, we may note that rejection latencies for the second letter-strings of Type 5 and 6 pairs were generally slower than those for the second letter-strings of Type 7 and 8 pairs. We cannot assess the significance of this contrast because of the enormous error rate that accompanied performance on Types 5 and 6. However, this error rate is instructive. A Wilcoxon signed-ranks test contrasting the proportion of correct second-string responses to Type 5 and 6 pairs with the proportion correct to Types 7 and 8 pairs proves significant ($T_{17} = 2$, $p < 0.01$). In approximately 20% of the trials containing a letter string that was a non-word in Roman *but a word in Cyrillic*, subjects responded (incorrectly from the perspective of the experiment) that the letter-string in question was in fact a word. In approximately 10% of the trials containing Roman non-word/Cyrillic-word letter strings, correct responses (that is, rejections) took in excess of 1500 msec. In contrast, for the case of letter-strings that were non-words in Roman and unclassifiable in Cyrillic (that is, Type 7 and 8), only five per cent of the trials on average were in error in the sense of the string being classified as a word rather than as a non-word. For those Type 7 and 8 strings, approximately less than two per cent of these trials were correct classifications in excess of 1500 msec. We may assume, therefore, that on at least one-third of the trials in which subjects viewed Roman non-word/Cyrillic-word letter strings, the subjects responded to the Cyrillic interpretation of the strings.

There are two ways to regard the latter observations. In the first place, it can be argued that the conditions of the experiment did not successfully induce a Roman alphabet mode. Against this argument, however, is the fact that of the 144 letter-strings seen by a subject during the training and test trials, only 27 of them contained ambiguous characters, that is, only 27 strings *suggested* a Cyrillic encoding. Significantly, none of these strings contained any uniquely Cyrillic letters. Furthermore, we should remark that other than the aforementioned 27 strings, *no other letter strings were even readable as Cyrillic* — hence, our classification of these strings as neither words *nor* non-words in Cyrillic (see Table 1). The point is that by the design of the experiment, there was very little to encourage the reader to lapse, even occasionally, into the Cyrillic mode of processing.

In the second place, we might regard the comparison of Type 5 and 6 pairs with Type

7 and 8 pairs as indicating that although a reader is in the Roman mode, this does not necessarily prohibit the accessing of the lexicon by Cyrillic script. In the model depicted in Fig. 1, two routes to the lexicon are described. Are both routes *usable* by the Cyrillic version of a letter-string when that string is being treated as Roman? Of course, there is nothing in our data that permits an acceptable answer, but let us, for the time being, entertain the following argument: to be in the Roman mode means, essentially, to apply the grapheme-to-phoneme mapping rules that befit the Roman alphabet and its allied orthography. On the face of it, simultaneous application of two different grapheme-to-phoneme rule systems seems unlikely given the necessity of keeping the ambiguous characters from mutually interfering. In short, the argument is that the Roman-relevant rules and the Cyrillic-relevant rules cannot operate concurrently, for they are mutually incompatible (see Turvey and Prindle, 1978).

Consequently, following this argument, when a reader is in the Roman mode, the phonological route to the lexicon is not open to Cyrillic script. If the Cyrillic version of a letter-string does access the lexicon when a reader is in the Roman mode, it can only be by way of the graphemic route.

Consider the string POCA that is not a word in Roman. The graphemic description of this string does have a lexical referent since POCA is a word in Cyrillic; thus a graphemically constrained search of the lexicon will yield a positive answer to the question of lexical membership. On the other hand, the phonological description of this string — given that the reader is in the Roman mode — does not have a lexical referent. In consequence, a phonologically constrained search of the lexicon will yield a negative answer to the question of lexical membership. If it is the case that normal word recognition proceeds, at the very least (see Henderson, 1974), along both graphemically constrained and phonologically constrained lines simultaneously, then we can appreciate that for the Yugoslavian, a letter-string like POCA is, in terms of lexical membership, an ambiguous string. We may well suppose that it is this conflict between the graphemically determined answer and the phonologically determined answer that gives rise to the large number of errors in Type 5 and 6 pairs. Insofar as these errors are far fewer than correct decisions, we may further suppose that in cases of conflict the lexical decision is preferentially biased toward the outcome of the phonologically constrained search.

Let us now consider the curious outcome for the second letter-strings of Type 4 pairs. Each of these strings is distinguished by the fact that it can be pronounced in both alphabets, though the pronunciations are different, and it is a word in both alphabets, though the words are different. The literature on lexical decision for strings with more than one meaning suggests that strings with multiple meanings are accepted as words faster than strings with a single meaning. The latency difference is pronounced where there is a relatively large difference in number of meanings (Jastrzembski and Stanners, 1975), but marginal where the difference is minimal, such as two meanings versus one (see Clark, 1973; Forster and Bednall, 1976). What makes the present finding curious is that multiple meaning *hinders* lexical decision and thus runs counter to the more common observation. Positive decisions were over 200 msec. slower than those for letter-strings that were words only in the Roman alphabet (second strings of Type 3 pairs can be used for comparison), and approximately 23% more of the responses were in error.

A Wilcoxon signed-ranks test on proportions of correct responses for Type 4 and Type 3 second strings is significant ($T_{15} = 1, p < 0.01$). In short, when a string of letters was a word in both alphabets, responses were very slow (the slowest for all types, see Table 2) and on a relatively large number of occasions, subjects actually decided that these strings were in fact *Roman non-words*.

In light of the research on lexical decision and multiple meaning, it would seem that the response tardiness and error cannot be due to the fact that a Type 4 string was a word in both Roman and Cyrillic, but rather to the fact that a Type 4 string could be *phonologically interpreted in both alphabets*. This interpretation argues against our earlier definition of "being in the Roman mode" as the abrogating of the phonological route to the lexicon by the Roman grapheme-to-phoneme rules. In short, the Cyrillic version of a letter-string that is being responded to explicitly as Roman might well access the lexicon by the phonological route.

EXPERIMENT II

The second experiment seeks to determine whether the impaired lexical decision on the second letter-strings of Type 4 pairs in Experiment I was due to two lexical entries or to two alternative phonological interpretations. The present experiment focuses on letter-strings LS1, LS2 and LS3 (see Table 1). LS1 can be read as Roman but not as Cyrillic and is a word in Roman; LS2 can be read as Roman but not as Cyrillic and is two words in Roman, that is, it is synonymous with a homograph in English; LS3 can be read as Roman *and* as Cyrillic and it is a word in Roman *and* a word in Cyrillic. Therefore, while LS2 and LS3 are alike in that they both have two lexical entries, they are dissimilar in that LS2 has but one phonological interpretation, whereas LS3 is phonologically bivalent.

We are reminded that research on English words reveals that lexical decision on homographs is either equivalent to or faster than lexical decision on letter-strings with a single lexical entry. Given this fact, we would expect the relation among decision times for the letter-strings of the present experiment to be roughly $LS1 > LS2 = LS3$. If, on the contrary, two lexical entries impede decision time over one lexical entry — a possible interpretation of the Type 4 results of Experiment I — then the expected relation should be $LS1 < LS2 = LS3$. However, if it is the case that while two lexical entries do indeed facilitate decision time over one lexical entry, this facilitation is overridden by the impeding influence of two phonological interpretations, then the relation should be $LS1 > LS2 < LS3$.

Method

Subjects. Twenty-two students from the Psychology Department of the University of Belgrade participated as subjects. The majority came from Eastern Yugoslavia.

Materials. Letter-strings of three to six letters were composed from Letraset, black uppercase Roman letters (Helvetica Light, 12 point). These were arranged horizontally at the center of 35 mm slides.

Sixty of the letter-strings were words: 20 LS1, 20 LS2 and 20 LS3. The 60 non-words were of the kind LS7 (see Table 1). Each class of words consisted of three subclasses: ten nouns, eight verbs and two adjectives. It is important to note that LS3 is a mix of common and ambiguous letters (see Fig. 2). No uniquely Cyrillic letters were used and only the 20 letter-strings of the type LS3 could be read in Cyrillic; as before, the other strings were unreadable in the Cyrillic mode.

Design and procedure

Each subject saw the full complement of words and non-words. Four randomizations of the 120 letter-strings were partially counterbalanced across the subjects. Each letter-string was exposed for 1500 msec. in one channel of the three-channel tachistoscope used in Experiment I. Exposure luminance was 10.3 cd/m^2 . A timer was initiated at the onset of a slide and was terminated when the subject depressed either the "Yes" buttons or the "No" buttons as described in Experiment I. The first twelve trials were taken as practice trials.

Prior to the experiment each subject was instructed as follows: "Subsequent to the warning signal a string of Roman letters will be presented. Your task is to respond as quickly as possible whether the string of Roman letters is a word or nonsense."

Results

Incorrect responses or responses that were either too fast (less than 300 msec.) or too slow (more than 1100 msec.) were excluded. For LS1 and LS2 the error rate was approximately 4%. For LS3 the error rate was 19%. The basic datum was the mean RT for each subject for each type of letter-string. The latencies for LS1, LS2 and LS3 were, respectively: $585 \pm 53 \text{ msec.}$, $564 \pm 58 \text{ msec.}$ and $639 \pm 36 \text{ msec.}$

Because of the high error rate associated with LS3, an analysis of latencies is imprudent. Nevertheless, an analysis was conducted, and as suspected, it revealed a significant difference between LS3 and LS2 ($F' = 7.93$, d.f. = 1, 28, $p < 0.01$) and a significant difference between LS3 and LS1 ($F' = 4.4$, d.f. = 1, 30, $p < 0.05$). LS1 and LS2 were not different. A more appropriate test, a Wilcoxon signed-ranks test on proportions of correct responses, yielded a significant difference between LS3 and LS2 ($T_{18} = 5.5$, $p < 0.01$) and a significant difference between LS3 and LS1 ($T_{19} = 5.5$, $p < 0.01$). The difference between LS1 and LS2 was not significant.

Discussion

The relation among the three types of letter-strings is the same whether we consider latencies or errors: $LS1 > LS2 < LS3$. The inference we wish to draw is that decision time to LS3 is impeded, not because it has two lexical entries, but because it has two phonological interpretations. The acceptance of this inference, however, depends on whether we can be convinced that the distinction between LS2 and LS3 is solely the phonological bivalence of the latter.

The letter-string of type LS2 has two lexical entries, both of which are accessed through the Roman alphabet; LS3 has two lexical entries, one of which is accessed

through the Roman alphabet and one of which is accessed through the Cyrillic alphabet. This distinction between LS2 and LS3 might be important if the lexicon is sensitive to the alphabet by which a lexical entry is accessed. Consider a subject faced in the Roman mode by a string of type LS6. Here he must reject the string as a word, even though it is a word in Cyrillic. Is it that he is able to do so, in part, because the positive, graphemically constrained search is registered as being of Cyrillic origin? That is, there is a tag on the output from the lexicon that indicates the alphabet through which the entry was found. If, in the Roman mode, a graphemically constrained search is successful, but is tagged "Cyrillic," then it can be rejected. The idea that a lexical entry might be tagged according to the alphabet of the string that matched it is reminiscent of the claim in bilingual research that remembered words can be identified as to the language in which they were received (for example, Saegert, Hamayan and Ahmar, 1975). At all events, we should inquire into a style of processing that distinguishes excited lexical entries by the alphabetic source of their excitation.

Processing the alphabet characters of the Serbo-Croatian language might proceed as follows. Initially, the graphemic features are determined and the resultant feature lists (or structural descriptions) are matched in parallel with the representations of the Cyrillic characters and the Roman characters in the relatively separate Cyrillic and Roman alphabet spaces (see Fig. 3). Suppose that matches are found in both alphabet spaces for all characters in the string — as would be true for LS3 — then we can imagine that *two* graphemically constrained lexical searches are initiated. In the case of LS3, both of these searches determine a lexical entry; we need only to assume that both of these entries are tagged according to the search that discovered them.

Now we know from the comparison of decision times for LS2 and LS1 that the poor decision performance of LS3 is not due to *two* lexical entries as such. If (for the sake of argument) we rule out phonological bivalence as an influence on decision time, then it must be the case that the poor performance on LS3 is due either to: (1) the fact that there are two different tags, indicating that the lexicon was successfully accessed by both the Cyrillic- and the Roman-directed search or to (2) the fact that two separately directed searches were conducted simultaneously, or to both (1) and (2).

If conflicts of the kind intimated in (1) and (2) above are the source of the decision time difference between LS3 and LS2 (for LS2 would invite only one lexical search and only one lexical tag, namely the Roman), then they can be investigated with letter-strings composed entirely from the common letters (see Fig. 2). A letter-string so composed (LS5 in Table 1) should, by the preceding reasoning, invite two separately directed lexical searches and yield both a Roman and a Cyrillic tag. A letter-string of type LS5, by definition, is common lexically and phonologically to the two alphabets.

The third experiment examines letter-strings of type LS5 as part of a general examination of the relationship between lexical entry and phonological bivalence in determining lexical decision time.

EXPERIMENT III

The third experiment is like the first and unlike the second in that it uses the paired lexical decision task. As with Experiment I, the focus is on the decision time for the second letter-strings of a pair. For some of the analyses that are of interest in the third experiment, the nature of the first letter-strings of a pair is of significance; for most analyses, however, the nature of the first string is irrelevant. In the third experiment, six of the letter-strings depicted in Table 1 were examined with LS2 and LS3 excluded. In keeping with the preceding two experiments, the focus of the third experiment is on lexical decision in the Roman mode.

(i) *Priming across alphabets.* It was observed in the first experiment that where the first word of a pair was associated with the second, accepting the second as a word was facilitated. It was also observed that the latency to decide that a letter-string was a non-word in the Roman alphabet was retarded if that letter-string was a word in the Cyrillic alphabet. Suppose that the first string of a pair was a Roman word (and unclassifiable in Cyrillic), and the second string was a Roman non-word but a word in Cyrillic that was associated with the (first string) Roman word. Would the latency to reject the second string as a Roman word be further protracted? If priming occurs across alphabets, then we would expect that the first string's Roman lexical entry would, through the semantic space (see Fig. 1), facilitate the second string's Cyrillic lexical entry and in consequence augment the difficulty in rejecting the second string as a Roman non-word. The relevant comparison is that between Type 1 pairs and Type 2 pairs in Table 3. In both Type 1 and Type 2 pairs, the first strings are LS1 and the second strings are LS6 (see Table 3); but only in Type 1 pairs is there an association between lexical entries.

(ii) *Priming within an alphabet.* A comparison between Type 3 and Type 4 pairs, as shown in Table 3, provides a measure of priming within an alphabet. In these pairs the first strings are LS1 and the second strings are LS4; in Type 3 pairs the lexical entries of the successive strings are associated. The comparison between Type 3 and Type 4 pairs differs from the similar comparison of Experiment I, for in the first experiment the second strings were LS1.

(iii) *Significance of phonological ambivalence per se.* If the latency to reject a Roman nonword is impeded by the fact that a letter-string can receive an alternative phonological interpretation in Cyrillic, then this impedance should be realized even when the letter-string is a non-word in Cyrillic. Experiment I had compared LS6 and LS8 and observed that errors and decision latency on LS6 significantly exceeded these measures on LS8. While LS6 is phonologically bivalent, it also has a lexical entry. The third experiment asks whether a similar relation exists between LS7 and LS8. Neither of these types of letter-strings has a lexical entry, but the former (LS7) has two phonological interpretations to the latter's (LS8) one (see Table 1). The relevant comparison is between the second letter-strings of Type 5 and Type 6 pairs and between the second letter-strings of Type 7 and Type 8 pairs (see Table 3).

(iv) *Significance of potential for two lexical searches and two alphabet tags.* The third experiment contrasts the lexical decision on LS5 to that on LS1 in the spirit of the hypotheses developed in the discussion of Experiment II. According to these hypotheses,

decision times and errors should relate as $LS5 > LS1$. We recall that letter-strings of type LS5 are composed entirely from the common letters. Consider then the contrast between LS5 and LS1: LS5 would find a match in both the Roman and Cyrillic alphabet spaces (see Fig. 3), but LS1 would find a match only in the Roman space; LS5 would receive a phonological interpretation (the same) whether read in the Roman mode or the Cyrillic mode, but LS1 receives a phonological interpretation only in the Roman mode; LS5 would find a lexical entry (the same) whether read in Roman or Cyrillic, but LS1 has a lexical entry only in the Roman mode. If ambivalence in lexical search or ambivalence in assigning the alphabetic source of lexical outputs is a significant determinant of lexical decision time, then it follows, as argued above, the decision times should relate as $LS5 > LS1$. The relevant comparison is given by the second letter-strings of Type 9 and Type 10 pairs (see Table 3).

Method

Subjects. The participants in the experiment were 40 students from the Department of Psychology at the University of Belgrade. The majority of the students had received their elementary education in Eastern Yugoslavia. They were not unfamiliar with RT experiments.

Materials and design. Slides containing either a word or a non-word were prepared in the manner described for Experiments I and II. The criteria for choice of words were as described in Experiment I.

There were ten different types of letter-string pairs that were of interest; these are shown in Table 3 along with examples of the letter-strings and the approximate relative frequency with which each pair type appeared in the trials of the experiment. Other pairs were included to insure a balance between words and non-words and to keep the proportion of strings readable in Cyrillic at a minimum; these pairs were not analysed.

First consider pairs of Type 1 and Type 2 whose first and second members are, respectively, letter-strings LS1 and LS6. The second members of these pairs, therefore, were non-words in Roman and words in Cyrillic. In Type 1 pairs, the lexical entry of the second member of the pair was associatively related to the first member of the pair, for example, OLUJA (in Roman) translates as 'storm' in English and BETAP (in Cyrillic) translates as 'wind' in English. No associative relation holds between members of Type 2 pairs. The pairs of Type 2 were obtained by interchanging first members of the Type 1 pairs. Type 2, therefore, provides a control for the possible priming effect of Type 1.

The first and second members of Type 3 and Type 4 pairs were letter-strings of Type LS1 and Type LS4. The second members of these pairs, therefore, were words in Roman and non-words in Cyrillic. In Type 3 pairs the members were associatively related; for example, FLASA (in Roman) translates as 'flask' and BOCA (in Roman) translates as 'bottle'. No associative relation holds between members of Type 4 pairs; these pairs were obtained by interchanging first members of the Type 3 pairs.

Consider pairs of Type 5 and Type 6. The members of Type 5 pairs were LS1 and LS7 in that order; the members of Type 6 pairs were LS1 and LS8 in that order. Letter-strings of Type LS7 can be read in *both* Roman and Cyrillic, but are non-words in both alphabets. These letter-strings are composed from a mixture of common and ambiguous

TABLE 3

TYPE OF PAIR	LETTER STRINGS	EXAMPLE	PERCENT OF ERRORS		
			TOTAL	SLOW	REGULAR
1	FIRST - SECOND		REACTION TIME (MSEC)		
			RELATIVE FREQUENCY		
2			CORRECT RESPONSE		
3					
4					

letters. They were constructed by taking a letter-string of Type LS3 and replacing either one or two of the ambiguous consonants in these strings by other ambiguous consonants so as to produce letter-strings that were readable and nonsense in both alphabets. Letter-strings of Type LS8 are readable *only* in Roman. They were constructed by taking a letter-string of Type LS1 (which is not readable in Cyrillic) and replacing one ambiguous consonant by another to produce a nonsense string.

Other constraints on generating strings of Types LS7 and LS8 should be noted. First, strings should be consonant-vowel sequences as opposed to consonant clusters, in order to increase the likelihood that the ease of giving a phonological interpretation to the strings be equivalent in Roman and Cyrillic. Consonant clusters (for example, CK in CKOJ) differ in ease of pronunciation and frequency of occurrence from one alphabet to the other (thus, CK is easier to say and is more frequent in Cyrillic). Second, care was taken in determining letter-strings of Type LS7 so that, on the average, these strings were

5	A		GUSKA — BAMEP KULA — HAJEH	NO 0.06	749 ±91	2.	2.	4.
	B		GUSKA — POHO KULA — EBOC	NO 0.06	728 ±41	4.4	—	4.4
6	A		PTICA — RANTA VESLO — DAZAN	NO 0.11	749 ±52	3.	3.	8.
	B		VESLO — RANTA PTICA — DAZAN	NO 0.11	729 ±52	1.5	3.7	5.2
7	A		ŽAKAT — POHO KULA — EBOC	NO 0.06	763 ±60	6.	4.	10.
	B		ŽAKAT — BAMEP KULA — HAJEH	NO 0.06	736 ±83	1.6	1.6	3.2
8	A		NAVET — ŠUĆA MANEK — RAGON	NO 0.11	753 ±54	4.	2.	6.
	B		MANEK — ŠUĆA NAVET — RAGON	NO 0.11	783 ±71	2.3	—	2.3
9	A		MEKRE — TETKA ŽUDOS — JAMA	YES 0.11	663 ±38	3.	—	3.
	B		SIDEK — TETKA NALIR — JAMA	YES 0.11	684 ±47	4.5	0.7	5.2
10	A		AŽULE — MAČKA VUREM — SESTRA	YES 0.11	632 ±39	1.	—	1.
	B		EČANJ — MAČKA GUFEČ — SESTRA	YES 0.11	658 ±16	1.5	—	1.5

different by the same number of letters from Roman and Cyrillic words.

Pairs of Type 7 and Type 8 were the same as pairs of Type 5 and Type 6 in all significant respects, except that (1) the first members of a pair were LS8, that is, non-words in Roman and unclassifiable (not readable) in Cyrillic, and (2) the second strings of Type LS8 in Type 8 pairs were different from the second strings of Type LS8 in Type 6 pairs.

Finally, let us consider Type 9 and Type 10 pairs. The first and second members of Type 9 pairs were LS8 and LS5, respectively; and the first and second members of Type 10 pairs were LS8 and LS1, respectively. Only the second members were of interest. Composed solely of common letters, letter-strings of Type LS5 were words so chosen as to overlap in frequency of occurrence with the words of Type LS1.

Each of the 40 subjects judged 144 letter-strings according to the instructions used in Experiment II. Both the instruction and the construction of the letter-strings were meant

to induce the Roman mode. As before, there were no uniquely Cyrillic letters, and of the 144 letter-strings only 32 of them (approximately 23%) could be read as Cyrillic.

An individual subject never saw the same letter string twice (see Table 3). A subject received either all the A versions of the ten types of pairs or all the B versions. A subject was assigned either to the A versions or the B versions on order of arrival at the laboratory. The 56 pairs seen by a subject were presented in four blocks. In each block the pairs of each type were presented in a pseudo-random order. The sequence of blocks was balanced across subjects according to a Latin square design.

Procedure. The apparatus, method of response, etc., were identical to those of the first experiment.

Results

The experiment was designed so that for a given pair type, one half of the subjects saw one half of the pairs and the other half of the subjects saw the other half of the pairs. This design guaranteed the general feature that no subject saw the same letter-string twice and the particular feature that in the Type 1, Type 2 comparisons and in the Type 3, Type 4 comparisons, the same letter-strings could be used for associated and non-associated pairs. As remarked above, this design imposes difficulties when one is trying to keep the data analysis true to the strictures suggested by Clark (1973); that is, where both subjects and letter strings are treated as "random effects" and reliability of results is computed over both of these sampling domains.

In the kind of analysis¹ we chose, individual quasi- F ratios were computed for comparisons within a comparison. For example, the comparison between Type 3 and Type 4 includes the following sub-comparisons: (a) comparisons in which subjects are the same but letter-strings are different: Type 3A v. Type 4A and Type 3B v. Type 4B; and (b) comparisons in which subjects are different but letter-strings are the same: Type 3A v. Type 4B and Type 3B v. Type 4A. For some types in Table 3, and for other comparisons we wish to consider, the subcomparisons on different subjects, some letter-strings do not exist. In general, then, the subcomparisons will be those where *subjects* are the same.

The quasi- F ratios for the subcomparisons of a given comparison were considered as random variables whose probabilities have a Chi-square distribution. Suppose that the F' for subcondition X was at the probability level, $p = x$ and the F' for subcondition Y was at the probability level, $p = y$. The new random variables are computed as $r_1 = -2 \ln(x)$ and $r_2 = -2 \ln(y)$ and their sum determined. The Chi-square distribution has $2k$ degrees of freedom where k is the number of variables (for our example, there are four degrees of freedom). The obtained sum of the new variables is then assessed for significance against the Chi-square value for the corresponding degrees of freedom. The gist of this method is that it asks: Given a set of individual quasi- F ratios with probabilities, p_1, p_2 , etc., is it likely that this set of probabilities could have occurred by chance?

Let us consider the results for the comparisons of initial interest, namely, those

¹ L. Katz, personal communication.

described in the introduction to the experiment. As with the previous two experiments, the RTs (and sometimes the errors) to the second letter string of a pair were analysed. First, no F' ratios greater than unity were found for the subcomparisons of Type 1, Type 2 pairs. The high error rate suggests that this negative conclusion be treated with caution. A Wilcoxon signed-rank test on proportions of correct responses was conducted. Of the possible subcomparisons only two were significant: Type 1B v. Type 2B ($T_{13} = 8, p < 0.05$) and Type 1A v. Type 2B ($T_q = 6, p < 0.05$). The error data, therefore, suggest that priming occurred across alphabets.

Second, the subcomparisons of Type 3 and Type 4 pairs revealed the following F' values: for 3A v. 4A, $F'(1,11) = 4.41, p < 0.06$; for 3B v. 4B, $F'(1,18) = 2.45, p < 0.02$; for 3A v. 4B, $F'(1,19) = 7.10, p < 0.02$; for 3B v. 4A, $F' < 1$. These comparisons provide a curious mix, suggesting that priming within an alphabet did and did not occur. In part, these data may reflect the inadequate procedure used for determining associative relation — the use of a small panel of judges rather than associative norms. The availability of the latter for research with English words provides a more reliable basis for selecting pairs of associated words and thus a better opportunity for observing priming.

Third, inspection of Table 3 is sufficient to conclude that there was no difference between the second letter-strings of Type 5 and Type 6 pairs (LS7 and LS8, respectively) and no difference between the second letter-strings of Type 7 and Type 8 pairs (again LS7 and LS8, respectively). In short, phonological bivalence *per se* did not seem to retard lexical decision.

Fourth, the comparison between Type 9 and Type 10 was a straightforward F' analysis (the second letter-strings of 9A and 9B were identical, as were the second letter-strings of 10A and 10B). The analysis proved significant $F'(1,25) = 7.35, p < 0.02$, indicating that latency of response for strings of common letters was slower than the latency for letter-strings that did not have the same status in both alphabets.

The lack of difference in lexical decision time to LS7 and LS8 should be contrasted with the significant difference reported in the first experiment for the comparison of LS6 and LS8. The contrast suggests the following hypothesis: *phonological bivalence impedes lexical decision only if there is a lexical entry in one or the other alphabet*. The confirmation of this hypothesis would lie with showing that, in addition to the already demonstrated equality, $LS7 = LS8$, the following decision-time inequalities hold: $LS4 > LS1$, $LS6 > LS7$ and $LS4 > LS5$ (see Table 1).

In words, the first inequality is that a letter-string that receives a phonological interpretation in each alphabet and has a lexical entry in Roman should be accepted as a Roman word more slowly than a letter-string that similarly has a lexical entry in Roman but receives a single phonological interpretation (in Roman). The following subcomparisons of the present experiment provide the appropriate test: 4A with 10A and 4B with 10B. The individual analyses were highly significant, respectively, $F'(1,12) = 8.51, p < 0.01$, and $F'(1,20) = 9.98, p < 0.01$, yielding, by the method described above, $\chi^2(4) = 18.42, p < 0.003$. On the average, decision time to LS4 was 115 msec. in excess of decision time to LS1. Clearly, the sought-after relation, $LS4 > LS1$, holds.

In words, the second relationship ($LS6 > LS7$) is that a letter-string that receives a phonological interpretation in each alphabet and a lexical entry in Cyrillic should be

rejected as a Roman word more slowly than a letter-string that receives two phonological interpretations but has no lexical entry in either alphabet. The following subcomparisons of the present experiment provide the test: 2A v. 5A and 2B v. 5B. The individual analyses were, respectively, $F' (1,16) = 4.22, p < 0.06$ and $F' (1,15) = 7.03, p < 0.02$, yielding $\chi^2(4) = 13.59, p < 0.01$. On the average, decision time to LS6 exceeded that to LS7 by 76.5 msec. The second of the two sought-after relations, $LS6 > LS7$, would appear to hold. Caution is induced by the relatively high error rates; favoring the conclusion, however, is the fact that the error difference between LS6 and LS7 is in the same direction as the latency difference.

Prior to considering the third desired relationship, namely, $LS4 > LS5$, let us look analytically at the finding that decision latency to the second letter-strings (LS5) of Type 9 pairs was slower than the decision latency to the second letter-strings (LS1) of Type 10 pairs. In view of the discussion that concluded Experiment II, we should interpret the slower decision time for LS5 as indicative of either a conflict produced by two separately conducted lexical searches or by the assignment of two alphabet tags to the determined lexical entry. While significant, the latency difference between LS5 and LS1 was not that great, a matter of only 28.5 msec. The magnitude of the difference restrains us from concluding that the slower latency to LS5 is evidence against the hypothesis that, with reference to LS3 (that is, letter-strings that have two different phonological interpretations and two different lexical entries), the source of impedance in lexical decision is phonological ambivalence rather than a conflict in lexical search or alphabet tagging.

From other research that we have conducted (Lukatela, Savić, Ognjenović and Turvey, 1978), we have good reason to believe that for Yugoslavian readers indigenous to Eastern Yugoslavia, there is a bias toward regarding common letters as essentially members of the *Cyrillic* alphabet. The majority of the subjects in the present series of experiments were from Eastern Yugoslavia. This would mean, perhaps, that in the present experiment there was a tendency, however slight, for subjects to regard letter-strings of the LS5 type as non-Roman. If so, then a latency difference between LS5 and LS1 might be expected. At all events, we can better appreciate the importance of contrasting LS5 and LS4. The LS4 type is phonologically bivalent but has a single lexical entry in Roman; LS5 is not phonologically bivalent but it similarly has a single lexical entry, one that can be assessed through either alphabet. If lexical decision is slowed primarily by the fact that a lexical entry can be found and/or tagged through both alphabets, then the acceptance latency for LS5 should exceed that to LS4. If, on the other hand, lexical decision is slowed primarily by phonological bivalence contingent upon the presence of a lexical entry in one or the other alphabet, then the acceptance latency to LS4 should be greater than that to LS5. The relevant comparisons are: 4A with 9A and 4B with 9B. Respectively, the analyses revealed that $F' (1,13) = 3.6, p < 0.08$ and $F' (1,16) = 5.2, p < 0.03$, yielding $\chi^2(4) = 12.06, p < 0.02$. The results of the comparison permit the claim that the inequality, $LS4 > LS5$, holds; the above hypothesis is thereby verified.

This concludes the analysis and discussion of Experiment III, but two points of general concern to this experiment, and the others, deserve comment. First, while the analysis proposed by Clark (1973) has been applied throughout, there are a number of places where its application necessitates a conservative evaluation of the results. The point

of Clark's arguments concerning the analysis of experiments using words as stimuli is that the word-sample chosen may not permit a generalization of the results beyond that sample — hence Clark's advocating treating words as a random effect, rather than as a fixed effect in the analysis. For a number of the analyses reported in the present paper, the words comprising the experimental sample constituted a significant proportion of the total number of words meeting the specified criteria. In short, we could, in a number of places, have treated words as a fixed effect, thereby enhancing the possibility of a significant outcome.

Second, comparisons were sometimes made in the present series of experiments between conditions that differed not only in the variable of interest, but also in whether the correct response to the first and second letter-strings in a pair was the same or different. Where the correct response to the successive strings in a pair was the same, a facilitation of response to the second might be expected. However, inspection of Tables 2 and 3 suggests that such facilitation did not occur and therefore could be ruled out as a source of confusion in the present data. With regard to Table 2, response latency to LS1 in Type 2 pairs (Yes-Yes) did not differ from response latency to LS1 in Type 3 pairs (No-Yes); with regard to Table 3, compare pairs of Type 6 (Yes-No) and Type 8 (No-No) and pairs of Type 5 (Yes-No) and Type 7 (No-No); and finally, returning to Table 2, a comparison of pairs of Type 7 (No-No) and Type 8 (Yes-No) reveals a difference in the direction opposite to a facilitation prediction.

CONCLUDING REMARKS

It has been assumed that by experimental design and by instruction, a subject could be seduced into one of the two possible alphabet modes, specifically the Roman mode, and that the subject remained true to the Roman mode throughout the presentation of the letter strings. It is, of course, a strong possibility that any given subject may have swayed between modes during the course of an experiment and that subjects differed in the degree to which they adhered to the assigned mode. That is, with respect to some letter-strings, the attitude of a subject was that of a Roman reader, and with respect to other letter-strings, the subject's attitude was that of a Cyrillic reader. If true, we would expect that on some trials a subject's behaviour would be consistent with the Cyrillic reading of a letter-string rather than the Roman reading. This would contrast with the claim that on any given trial, any given subject assigned both phonological readings simultaneously. Let us see if we can disarm this mode-switching argument.

The lesson to be learned from the error rates to LS1 (see Tables 2 and 3) is that if a subject is switching modes, he or she does not adopt a mode prior to and impervious to a given letter-string. It would seem that a letter-string's structure must be discerned as able to support the non-assigned alphabet mode for that mode to be realized. The LS1 can be read in Roman but not in Cyrillic. If subjects adopted the Cyrillic mode indifferent to the structure of a letter-string (and prior to the string's presentation), then we should expect the error rate on strings of type LS1 to be large and equivalent to that on type LS4; that, most obviously, was not the case. We might wish to argue, therefore, that a

typical subject's strategy was as follows: the orthography of a given letter-string was discerned as supporting both Roman and Cyrillic readings and then *one* of the two alphabet modes was engaged to give the letter-string a phonological interpretation with the chosen mode varying across trials. On this strategy we should expect decision time for LS3 to differ unappreciably from decision time to LS1 (see Table 1). According to the aforementioned strategy, whatever alphabet mode the subject engages, the lexical quest will be positive and, presumably, as rapid as that for LS1 – a case of a single phonological reading and a single lexical entry. The evidence, we are reminded, is to the contrary: LS3 decision time was appreciably slower than LS1 decision time (see Table 2 and Experiment II).

The kind of mode-switching "model" considered in the preceding remarks is one that assumes mode switching between trials. While there is reason to doubt this kind of mode switching, there remains the possibility of mode switching *within* a trial. Argument must rest with this point, however, for there are, in theory, an indefinite number of plausible within-trial mode-switching models – some of which would yield the pattern of obtained results and some of which would not. In the absence of any (presently discernible) significant constraints on the construction of such models, we consider the enterprise of doing so ill-advised.

We may as well suppose, therefore, that the data of the present series of experiments can be taken at face value, that is, as indexing the influences of the Cyrillic-related phonology on "reading" letter-strings in the Roman mode. What is to be made of the term *mode* in the present context? As generally used, it is a slippery term (see Turvey and Prindle, 1978). Assume that it refers to the *how* of processing. (In contrast, *mode* could refer to the *what* of processing, for example, speech material versus non-speech material.) Evidently, to be in the Roman mode does not mean, as proposed above, that the phonologically-mediated route to the lexicon is abrogated by the Roman grapheme-to-phoneme rules. That route, apparently, can be shared and, perhaps, without liability. Indeed, the reading we are giving to the present data is that in the lexical decision task, the ascription of phonological interpretation is obligatory and that a letter string – if its structure permits – will receive both the Roman and the Cyrillic phonological interpretations. Without going into detail, the notion of "being in the Roman mode" seems to refer to a selective operation that is late, rather than early, in processing – much like the claim made for selective attention by some students (for example, Norman, 1968) of the phenomenon who locate attention subsequent to a fairly complete pattern recognition process. One possibility is that to be in the Roman mode means that the link between the lexicon and the semantic space, as depicted in Figs. 1 and 3, is prohibited for the Cyrillic processing of a letter-string. Experiment III provided some evidence counter to this interpretation (the priming across alphabets), but further experimentation is required.

All things considered, we take the bottom line of the present series of experiments to be this: in the lexical decision task, Serbo-Croatian letter-strings (where their structure permits) are ascribed, simultaneously, two phonological readings; and whether or not this phonological bivalence impairs lexical decision in the assigned alphabet mode depends on whether or not the letter-string has a lexical entry in one of the alphabets.

The full implication of this latter result for a general theory of word recognition must await subsequent investigations.

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