From: THE ACQUISITION OF SYMBOLIC SKILLS
Edited by Don Rogers and John A. Sloboda
(Plenum Publishing Corporation, 1983)

BI-ALPHABETISM AND WORD RECOGNITION

Laurie B. Feldman

Dartmouth College
United States of America

THE LINGUISTIC ENVIRONMENT OF YUGOSLAVIA

The linguistic environment in Yugoslavia allows investigation of the interrelation among various symbolic systems. Several Slavic languages are spoken within the boundaries of one relatively small country. This contact among languages permits a variety of bilingual environments to develop and allows for the study of the symmetric and nonsymmetric influences in the acquisition and mastery of two languages. In addition, and more to the focus of the present work, among people whose first spoken language is Serbo-Croatian, which is the official language of Yugoslavia, a large portion learns to read and write that language completely in two different alphabets - Roman and Cyrillic. This reflects, in part, an educational requirement that both alphabets be taught within the first two grades. (The Roman alphabet is taught first in the western part of Yugoslavia and the Cyrillic alphabet is taught first in the eastern part of the country). This bi-alphabetic environment invites study of the relation between two alphabetic symbol systems. In my report, I summarize results of a series of experiments that explored how visually presented letter strings are recognized by readers who command two alphabetic systems. Then I discuss implications of these findings with respect to the interrelation between the two visual alphabetic systems of Serbo-Croatian. Before I review these results, however, some special properties of Serbo-Croatian and its writing systems need to be described.

The Serbo-Croatian language is written in two different alphabets, Roman and Cyrillic. The two alphabets transcribe one language and their graphemes map simply and directly onto the same set of phonemes. These two sets of graphemes are, with certain exceptions, mutually exclusive (see Table 1). Most of the Roman and Cyrillic letters are unique to their respective alphabets. There are, however, a number of letters that the two alphabets have

Table 1: Letters of the Roman and Cyrillic Alphabets and their Phonemic Interpretations.

SERBO-CROATIAN				
ROMAN		CYRILLIC		
PRINTED		PRINTED		LETTER NAME IN I.P.A.
UPPER CASE	LOWER CASE	UPPER CASE	LOWER CASE	
A	a	А	а	a
B	b	Б	б	bə
C	c	Ц	ц	tsə
Č	č	Ч	ч	tʃə
Ć	ć	Ћ	ћ	tʃjə
D	d	Д	д	də
Đ	đ	Ђ	ђ	dʒjə
DŽ	dž	Џ	џ	dʒə
E	e	Е	е	ɛ
F	f	Ф	ф	fə
G	g	Г	г	gə
H	h	Х	х	xə
I	i	И	и	i
J	j	Ј	ј	jə
K	k	К	к	kə
L	l	Л	л	lə
LJ	lj	Љ	љ	ljə
M	m	М	м	mə
N	n	Н	н	nə
NJ	nj	Њ	њ	njə
O	o	О	о	ɔ
P	p	П	п	pə
R	r	Р	р	rə
S	s	С	с	sə
Š	š	Ш	ш	ʃə
T	t	Т	т	tə
U	u	У	у	u
V	v	В	в	və
Z	z	З	з	zə
Ž	ž	Ж	ж	ʒə

in common. The phonemic interpretation of some of these shared letters is the same whether they are read as Cyrillic or as Roman graphemes; these are referred to as common letters. Other members of the shared letters have two phonemic interpretations, one in the Roman reading and one in the Cyrillic reading; these are referred to as ambiguous letters (see Figure 1).

Whatever their category, the individual letters of the two alphabets have phonemic interpretations (classically defined) that are virtually invariant over letter contexts. (This reflects the phonologically shallow nature of the Serbo-Croatian orthography). Moreover, all the individual letters in a string of letters, be it a word or nonsense, are pronounced - there are no letters made silent by context. Finally, Serbo-Croatian is a highly inflected

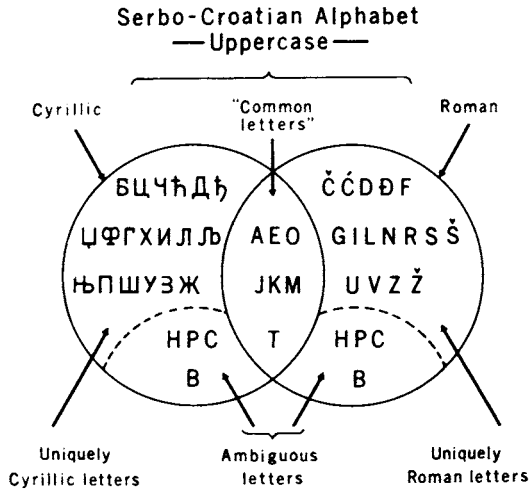

Figure 1: Letters of the Roman and Cyrillic Alphabets.

language. Many aspects of the syntax are marked by appending a suffix, commonly composed of a vowel, or a vowel and a consonant, to some base form.

Given the relation between the two Serbo-Croatian alphabets, it is possible to construct a variety of types of letter strings. A letter string composed of uniquely Roman and common letters (e.g., FABRIKA) or of uniquely Cyrillic and common letters (e.g., ФАБРИНА) would be read in only one way and could be either a word or nonsense. A letter string composed entirely of the common and ambiguous letters (e.g. EKCEP) is bivalent. That is, it could be pronounced in one way if read as Roman and pronounced in a distinctly different way if read as Cyrillic; moreover, it could be a word in one alphabet and nonsense in the other or it could represent two different words, one in one alphabet and one in the other, or finally, it could be nonsense in both alphabets (see Table 2).

The present research focused on the detriment to performance incurred with phonologically bivalent letter strings in both skilled and beginning readers. These effects are interpreted as evidence of the influence of decoding phonology on visual word recognition (i.e. lexical decision and naming). To anticipate, results of the adult studies indicate that the effect of phonological bivalence is evidence of a mandatory phonological analysis in word recognition among skilled readers, an analysis that cannot be described by any conventional (visual) lexical

Table 2: Types of Letter Strings and Their Lexical Status

Composition of Letter String	Phonemic Interpretation	Meaning
AMBIGUOUS and COMMON		
EKCEP*	Cyrillic /ekser/	nail
	Roman /ektsep/	nonsense
PATAK*	Cyrillic /ratak/	nonsense
	Roman /patak/	duck
KACA	Cyrillic /kasa/	safe
	Roman /katsa/	pot
HABOT*	Cyrillic /navot/	nonsense
	Roman /habot/	nonsense
COMMON		
JAJE	Cyrillic /jaje/	egg
	Roman /jaje/	egg
TAKA	Cyrillic /taka/	nonsense
	Roman /taka/	nonsense
UNIQUE and COMMON		
EKSER*	Cyrillic impossible	
	Roman /ekser/	nail
NAVOT*	Cyrillic impossible	
	Roman /navot/	nonsense
ПАТАК*	Cyrillic /patak/	duck
	Roman impossible	
ХАБОТ*	Cyrillic /habot/	nonsense
	Roman impossible	

(*Indicates those letter string types included in the children's experiment)

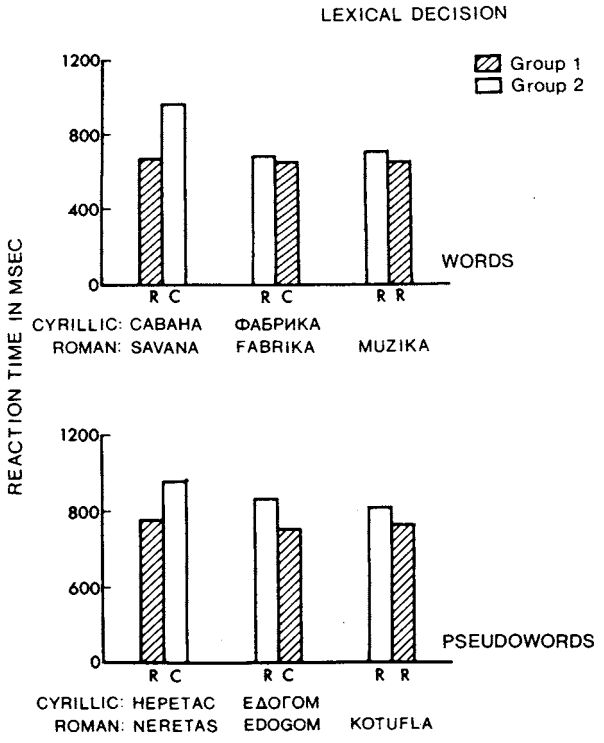

Figure 2: Mean reaction time for lexical decision on AMBIGUOUS (CABAHA) and UNAMBIGUOUS (FABRIKA, MUZIKA) words and pseudowords (in their Roman and Cyrillic transcriptions)

account. Results of the children's study show that reliance on a phonological recognition strategy varies with reading skill and suggests that the successive acquisition of two alphabetic systems by the beginner reader may exaggerate the demands of decoding phonology.

LEXICAL DECISION AND NAMING PERFORMANCE IN BI-ALPHABETIC ADULT READERS

When bi-alphabetic adult readers of Serbo-Croatian performed a lexical decision task, letter strings composed of ambiguous and common characters (i.e., those letter strings that could be assigned both a Roman and a Cyrillic alphabet reading, e.g., CABAHA) incurred longer latencies than the unique alphabet transcription of the same word (e.g., SAVANA) (Feldman, 1981). This effect of phonological ambiguity was significant both for ambiguous words and pseudowords, but it was more consistent for words (see Figure 2). In an analogous naming task where subjects

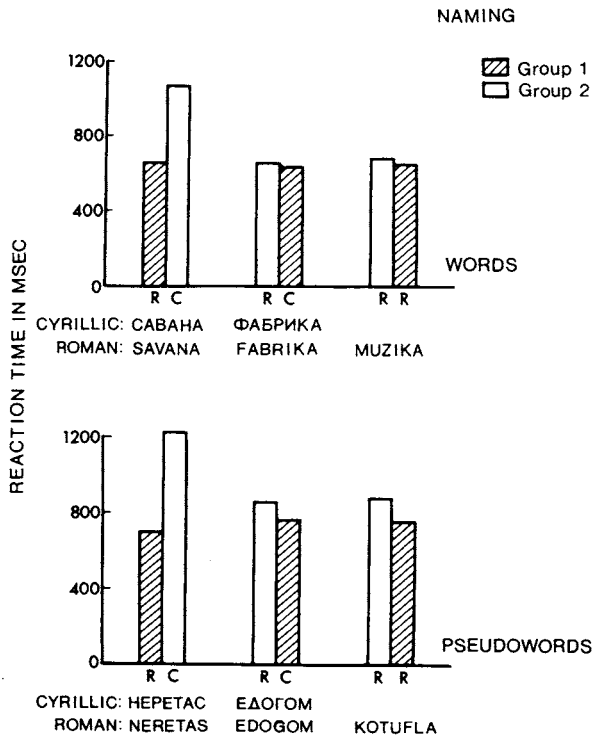

Figure 3: Mean reaction time to name AMBIGUOUS (CABAHA) and UNAMBIGUOUS (FABRIKA, MUZIKA) words and pseudowords (in their Roman and Cyrillic transcriptions).

were instructed to read each letter string as a word if it could be interpreted as such (Feldman, 1981), the same basic pattern of results occurred and the correlation between tasks was significant (see Figure 3).

In those experiments, all phonologically ambiguous letter strings that were words, were words by their Cyrillic interpretation. And, of the word and pseudoword strings that included unique letters, both Roman letter strings and Cyrillic letter strings were presented. Results of earlier lexical decision experiments (Lukatela, Savić, Gligorijević, Ognjenović, & Turvey, 1978; Lukatela, Popadić, Ognjenovic, & Turvey, 1980) have shown that the large decrement to performance incurred when Serbo-Croatian letter strings are associated with two phonological interpretations is not easily explained in terms of an account based on problems of letter identification due to interference between alphabets, however. Even in a pure Roman context, positive decision times to ambiguous Roman words were significantly slowed

and more prone to error relative to decision times to unambiguous Roman words (Lukatela et al., 1978; Feldman, Note 1).

Other variations of the bi-alphabetic lexical decision task invalidate a decision process account of the detriment due to bivalence that posits (post-lexical) interference between conflicting lexical judgments. Lexical decision latencies to letter strings composed entirely of ambiguous and common letters were slowed when: 1) both the Cyrillic interpretation and the Roman interpretation yielded a positive response (Lukatela et al, 1980; Feldman, Note 1); 2) both the Cyrillic interpretation and the Roman interpretation yielded a negative response (Lukatela et al, 1978, 1980; Feldman, 1981); and 3) the Cyrillic interpretation and the Roman interpretation yielded one positive response and one negative response (Lukatela et al, 1978, 1980; Feldman, 1981). Although methodological considerations make it impossible to compare these three results directly, it is evident that the effect of bivalence is not confined to instances in which the Roman and Cyrillic interpretation produce conflicting lexicality judgments.

In contrast, the effects of bivalence did not occur if a letter string composed predominantly of ambiguous and common characters contained even one unique character. Specifically, the presence of one unique letter that occurs as an inflectional suffix on a singular noun, is sufficient to cancel any effect of bivalence in lexical decision (Feldman, Kostić, Lukatela, & Turvey, 1981). It seems that while the presence of ambiguous and common letters is a necessary condition for phonological bivalence and that the size of the effect depends on the number of such ambiguous letters, nevertheless any effect can be cancelled by the presence of even a single character that uniquely specifies alphabet.

At this point it is tempting to conclude that skilled readers of Serbo-Croatian, when performing the lexical decision (and naming) task, are always sensitive to the presence of ambiguous and unique characters. However, results of two experiments suggest that there is need for further qualification. Given the availability of two alphabets for Serbo-Croatian, it is possible to create a novel visual form by mixing characters from the Roman and Cyrillic alphabets within one letter string. When words were selected so as not to include any potentially ambiguous characters in their mixed alphabet form, lexical decision judgment times for words (Katz & Feldman, 1981) and naming times for words (Feldman & Kostić, 1981) were no slower for mixed alphabet forms (e.g. ФLAШA) than for pure alphabet forms of the same letter strings (e.g., FLAŠA). Evidently, skilled readers can perform both lexical decision and naming in a phonologically analytic manner that is indifferent to mixed alphabet distortions to visual form. In conclusion, under the special conditions of bi-alphabetically induced phonological ambiguity, attention to some visual

characteristics of letter strings is manifest only when it serves to disambiguate alphabet.

NAMING PERFORMANCE FOR BI-ALPHABETIC BEGINNING READERS

When beginning readers of Serbo-Croatian performed a naming task, letter strings composed of ambiguous and common characters were named more slowly than the unique alphabet transcription of the same word (Feldman, Note 2). In that experiment, half the letter strings were ambiguous and half were unique to one alphabet. Among the ambiguous letter strings, half were words by their Cyrillic reading (and pseudowords by their Roman reading) and half were words by their Roman reading (and pseudowords by their Cyrillic reading). Further among those letter strings that contained unique and common letters, half were unequivocally Cyrillic and half were unequivocally Roman. Finally, within both ambiguous and unique letter strings, half were words by one of their readings and half were always pseudowords. Subsequent to the bi-alphabetic naming task, each subject named a list of pseudowords, all of which were written in an unequivocally Cyrillic transcription. Third- and fifth-grade students, all of whom had learned Cyrillic print in first grade and Roman print in second grade, served as subjects.

Results indicated that overall, naming was slower for third-graders than for fifth-graders and that both third and fifth graders were slowed more when naming phonologically bivalent letter strings than when naming unique alphabet controls. This result occurred with ambiguous words (both Roman and Cyrillic) and with ambiguous pseudowords. Therefore, the effect of bivalence is consistent with the naming data in adults reported above. The design of this experiment also permitted a comparison of bivalence across alphabets. For third-graders, the degree of impairment was greater when the ambiguous letter string is a word by its Roman reading (and a pseudoword by its Cyrillic reading), e.g., BATAK, than when it is a word by its Cyrillic reading (and a pseudoword by its Roman reading), e.g., EKCEP. For fifth-graders, however, there was no such interaction (see Figure 4). The asymmetric interference of first-learned and second-learned alphabet in naming ambiguous letter strings for younger readers but not for older readers suggests that the asymmetry is only temporary and that it may be equalized through experience.

In subsequent analyses, mean pseudoword naming time was used as a measure of reading skill for each child; the difference between each subject's latency to name all unique words and his or her latency to name all ambiguous words served as a measure of the impairment due to phonological bivalence. The correlation computed between pseudoword naming time and impairment due to phonological bivalence was significant and negative, $r = -.33$, $t = 2.80$,

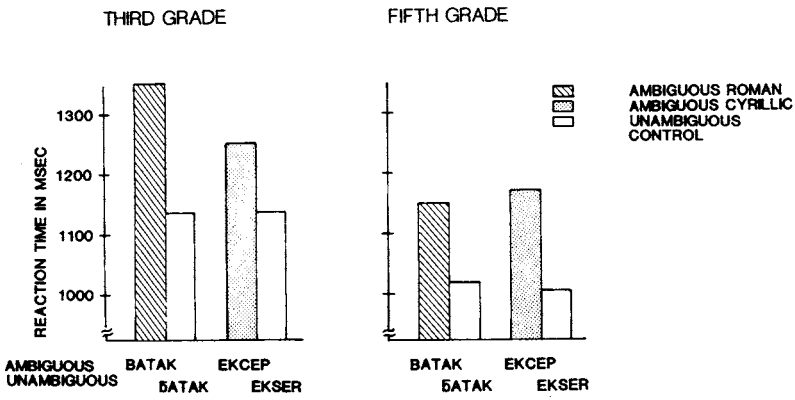

Figure 4: Mean reaction time for third- and fifth-graders to name AMBIGUOUS (Roman and Cyrillic) words and the UNAMBIGUOUS alphabet transcription of the same words.

$p < .05$. That is, those readers who were fastest at decoding pseudowords were most slowed with bivalent letter strings.

In summary, results for naming ambiguous letter strings in both skilled and less-skilled beginning readers revealed a significant effect of phonological ambiguity on naming time. In addition, the phonological analysis required to recognise a phonologically bivalent letter string may be more vulnerable to disruption when that letter string is a word by the second-learned alphabet reading than when it is a word by the first-learned alphabet reading. Finally, using pseudoword naming speed as an index of reading skill, the detriment to performance caused by reliance on a phonologically analytic recognition strategy when naming ambiguous letter strings was exaggerated in skilled beginning readers relative to less-skilled beginning readers.

THE COMMAND OF TWO SYMBOL SYSTEMS

The above results provide the following characterization of bi-alphabetism: 1) When confronted with a letter string composed entirely of ambiguous and common letters, readers are slowed relative to their performance on an alternative transcription of the same word that is comprised of characters that are unique to one alphabet. 2) The presence of a single unique letter is sufficient to neutralize any effect of ambiguous letters. 3) When one word contains a mix of unique letters from both the Roman and Cyrillic alphabets, readers are not slowed relative to the performance on the same letter string transcribed in purely Roman

or purely Cyrillic script. 4) Appreciation of bivalent phonology with a subsequent impairment to performance is enhanced as the efficacy of phonological decoding skill increases. These findings reflect the phonologically analytic nature of word recognition in Serbo-Croatian.

In summary, the findings on phonological ambiguity imply that in the act of reading, full command of the alphabets of Serbo-Croatian does not entail two functionally independent symbol systems. There are experimental circumstances in which violations to alphabetic integrity have no detrimental effect. These include: 1) distortions of surface orthographic form in the case where unique characters from both alphabets are merged together in one letter string or 2) mixed contexts in which some words are printed in Roman and other words are printed in Cyrillic. In other cases, inability to differentiate between alphabets impairs performance. Skilled readers are not able to restrict themselves deliberately to the Roman alphabet when the alphabetic context of the experiment and/or the instructions to the subject would invite an exclusively Roman mode. Collectively, the results of experiments on the two alphabetic systems of Serbo-Croatian suggest that skilled readers typically do not separate these two symbol systems: Command of the two symbol systems of Serbo-Croatian does not assume two autonomous alphabetic systems.

NOTE

[1]In the naming task, a correct reading of an ambiguous pseudoword permitted two options. In analyzing the pseudoword data, either interpretation was accepted. For the word data, there was only one correct interpretation.

ACKNOWLEDGMENTS

The research was supported in part by NICHD Grant 08495 to the University of Belgrade, in part by NICHD GRANT HD 01994 to Haskins Laboratories, and in part NSF dissertation fellowship BNS 7924409 to Laurie Feldman. In addition, funds were contributed by the Faculties of Philosophy and Electrical Engineering at the University of Belgrade and by the University of Connecticut.

REFERENCE NOTES

1. Feldman, L.B. 1981, The influence of lexical status on a phonological strategy for word recognition. Unpublished Manuscript.

2. Feldman, L.B., 1982, Phonological bivalence and the beginning reader. Manuscript in preparation.

REFERENCES

Feldman, L.B., 1981, Word recognition in Serbo-Croatian is primarily phonological. Haskins Laboratories Status Report on Speech Research, SR-66: 167-201.

Feldman, L.B., & Kostić, A., 1981, Word Recognition with mixed alphabet forms. Haskins Laboratories Status Report on Speech Research, SR-66: 203-211.

Feldman, L.B., Kostić, A., Lukatela, G. & Turvey, M.T., 1981, An evaluation of the "Basic Orthographic Syllabic Structure" in a phonologically shallow orthography. Haskins Laboratories Status Report on Speech Research, SR-66: 273-291.

Katz, L. & Feldman, L.B., 1981, Linguistic coding in word recognition: Comparisons between a deep and a shallow orthography. In: C. Lesgold & C. Perfetti (eds.), "Interactive processes in reading", Hillsdale, N.J.: Erlbaum

Lukatela, G., Popadić, D., Ognjenović, P., & Turvey, M.T. Lexical decision in a phonologically shallow orthography. Memory & Cognition, 8: 124-132

Lukatela, G., Savić, M., Gligorijević, B., Ognjenović, P., & Turvey, M.T., Bi-alphabetical lexical decision. Language and Speech, 21: 142-165.