

Representation of inflected nouns in the internal lexicon

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The lexical representation of Serbo-Croatian nouns was investigated in a lexical decision task. Because Serbo-Croatian nouns are declined, a noun may appear in one of several grammatical cases distinguished by the inflectional morpheme affixed to the base form. The grammatical cases occur with different frequencies, although some are visually and phonetically identical. When the frequencies of identical forms are compounded, the ordering of frequencies is not the same for masculine and feminine genders. These two genders are distinguished further by the fact that the base form for masculine nouns is an actual grammatical case, the nominative singular, whereas the base form for feminine nouns is an abstraction in that it cannot stand alone as an independent word. Exploiting these characteristics of the Serbo-Croatian language, we contrasted three views of how a noun is represented: (1) the independent-entries hypothesis, which assumes an independent representation for each grammatical case, reflecting its frequency of occurrence; (2) the derivational hypothesis, which assumes that only the base morpheme is stored, with the individual cases derived from separately stored inflectional morphemes and rules for combination; and (3) the satellite-entries hypothesis, which assumes that all cases are individually represented, with the nominative singular functioning as the nucleus and the embodiment of the noun's frequency and around which the other cases cluster uniformly. The evidence strongly favors the satellite-entries hypothesis.

Inflection is the major grammatical device of Serbo-Croatian, Yugoslavia's principal language. In general, the grammatical cases of nouns are formed by adding a suffix to a root morpheme, where the suffix is of the vowel, vowel-consonant, or vowel-consonant-vowel type. Less frequently, inflection involves additional processes, such as vowel deletion and consonant palatalization.

The grammatical cases of Serbo-Croatian nouns produced by inflection are not equal in their frequency of occurrence. Table 1 summarizes the frequency analysis of D. Kostić (1965) on a corpus of approximately 2 million Serbo-Croatian words appearing in the daily press and contemporary poetry. The non-italicized numbers are actual percentages. Thus, for all nouns in the corpus, 12.83% were masculine nouns in the nominative singular, 7.8% were feminine nouns in the genitive singular, .13% were neuter nouns in the instrumental plural, and so on. Reading the totals, we

see that most nouns were masculine and that the nominative singular was the most popular grammatical case. The italicized numbers are normalized percentages and can be read as follows, taking the masculine gender as an example. For any given masculine noun that occurs in the language with frequency f , the nominative singular form of that noun occurs with a frequency of approximately $.29f$, the genitive singular form with a frequency of approximately $.19f$, the dative singular form with a frequency of approximately $.02f$, and so on. In short, the normalized percentage for a given grammatical case of a given gender is the likelihood that, when a noun of that gender appears, it appears in that particular case.

The question of interest to the present paper is how the inflected Serbo-Croatian nouns are represented in lexical memory. Following MacKay (1978) and Manelis and Tharp (1977), we can distinguish two hypotheses about the lexical representation of words with common morphological stems. According to the independent-entries hypothesis, the individual grammatical forms of a Serbo-Croatian noun would be represented in the lexicon by independent representations, one internal representation for each grammatical form. On the derivational hypothesis, rather than all the forms of a given noun being instantiated in the internal lexicon, there would be

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Table 1
Case Frequencies in Percentages

	Singular				Plural			
	Masculine	Feminine	Neuter	Total	Masculine	Feminine	Neuter	Total
Nominative	12.83	8.84	2.88	24.55	3.33	3.58	.69	7.60
	<i>28.89</i>	<i>22.56</i>	<i>20.44</i>		<i>7.50</i>	<i>9.14</i>	<i>4.30</i>	
Genitive	8.56	7.88	3.47	19.91	3.96	3.22	.61	7.79
	<i>19.27</i>	<i>20.11</i>	<i>24.63</i>		<i>8.92</i>	<i>8.22</i>	<i>4.33</i>	
Dative	.87	.38	.31	1.56	.28	.16	.04	.47
	<i>1.96</i>	<i>.97</i>	<i>2.20</i>		<i>.63</i>	<i>.41</i>	<i>.28</i>	
Accusative	5.49	5.48	2.55	13.52	2.21	2.75	.73	5.69
	<i>12.36</i>	<i>13.99</i>	<i>18.10</i>		<i>4.98</i>	<i>7.02</i>	<i>5.18</i>	
Instrumental	1.90	1.94	.86	4.70	.60	.80	.13	1.46
	<i>4.28</i>	<i>4.95</i>	<i>6.10</i>		<i>1.35</i>	<i>1.86</i>	<i>.92</i>	
Locative	3.77	3.42	1.61	8.80	.61	.80	.21	1.62
	<i>8.48</i>	<i>8.73</i>	<i>11.43</i>		<i>1.37</i>	<i>2.04</i>	<i>1.48</i>	
Total	33.42	27.94	11.68	73.04	10.99	11.24	2.41	23.64
	<i>75.25</i>	<i>71.31</i>	<i>82.89</i>		<i>24.75</i>	<i>28.69</i>	<i>17.11</i>	

Note—This table is adopted from D. Kostić (1965). Figures in italics represent the normalized percentages, as related to the particular gender. Percentages do not add to 100% because the rarely occurring vocative case has been omitted.

but one instantiation, probably of the noun's root morpheme. There would also be in memory only a single instantiation of the set of inflectional morphemes. Appropriate combinations of the root morpheme and inflections would be determined by separately stored syntactic rules.

There have been relatively few direct contrasts of the two hypotheses for English lexical items, and the results have been largely equivocal. Manelis and Tharp (1977) compared lexical decision ("Is this letter string a word?") times for pairs of affixed words (words consisting of two morphemes, a root morpheme and a suffix) with lexical decision times for pairs of nonaffixed words (words consisting of a single morpheme). Manelis and Tharp (1977) predicted two possible outcomes from the derivational or, as they termed it, decompositional hypothesis. For a given letter string, decomposition into root and ending could be an obligatory first step, with lexical search for the whole item a contingent later step; or lexical search for the whole item could be the initial obligatory step, with decomposition occurring later and dependent upon failure to find the whole item in memory. Consider the prediction that follows from the notion that decomposition occurs first. A word, whether it be affixed or nonaffixed, is partitioned into root and ending. A test is then made to determine the validity of the combination as an affixed word. If the combination proves valid, a positive response is initiated; if it proves invalid (meaning that the word is nonaffixed), a search of the lexicon is conducted for the nondecomposed letter string. In brief, with everything else equal, the decomposition-first argument predicts faster lexical decision for affixed words than for nonaffixed words. The contrary prediction follows from the decomposition-second argument. If the initial search of the lexicon for the nondecomposed letter string is

successful (meaning that the letter string is a nonaffixed word), then a positive response can be initiated. However, if the search is unsuccessful, then the letter string is decomposed and the combination of root and affix is tested for its validity. Obviously, on the decomposition-second argument, lexical decision should be slower for affixed words. The Manelis and Tharp (1977) investigation failed to find a difference between affixed and nonaffixed words in either direction, a result that favored the independent-entries hypothesis over either version of the decompositional hypothesis.

However, the failure to find evidence for morphological decomposition with suffixed words contrasts with the provision of such evidence by Taft and Forster (1975) for prefixed words. These investigators reported that rejecting real roots (for example, SULTS as in INSULTS) as words took longer than rejecting false roots (for example, NINGS as in INNINGS) as words. The interpretation given was that real stems would be found in the lexicon and a subsequent check would be needed to determine that these lexical entries do not constitute words in the absence of an appropriate prefix.

A further demonstration of morphological decomposition is reported by MacKay (1978), although his experiment is distinguished from the experiment described above in that it looks at the production of words rather than at their perception. Subjects heard verbs (e.g., conclude, decide) that they had to nominalize (conclusion, decision) as rapidly as possible (MacKay, 1978). It was shown that certain nominalizations took longer than others; precisely, the more complicated the derivational process (the more steps intervening between verb form and noun form), the slower the nominalizations.

The source of the discrepancy between the experiments of MacKay (1978) and Manelis and Tharp (1977)

could be relatively trivial, a matter of differences in methodology. On the other hand, the discrepancy might arise from a deep-seated difference between the kind of memory structure needed to recognize words and the kind of memory structure needed to produce them. In the former case, the analogy that has come to be adopted is that of a dictionary: The internal representations of words are coded on orthographic and phonological principles and are accessed accordingly. But in the latter case, that of the requirements of production, the opposite analogy is not that of a dictionary but of a thesaurus (Labov, 1978): The internal representations of words are coded on semantic principles and should be accessed accordingly; for in production, the problem is to locate a word that expresses a given meaning.

Whatever the reason for the equivocality identified above, we should note that, with regard to the representation of inflected nouns, the independent-entries hypothesis and derivational hypothesis are not exclusive. A third hypothesis can be entertained that combines features of the first two. We refer to it, picturesquely, as the "satellite-entries" hypothesis. Here are its distinguishing characteristics: (1) Each grammatical case of a noun has a separate entry in the lexicon; (2) the nominative singular entry functions as the nucleus of the noun and it expresses the frequency of occurrence of the noun that it represents; (3) lexical entries of the remaining grammatical cases cluster (relatively) uniformly about the nominative singular entry and are organized among themselves and in relation to the nominative singular by a (for now unspecified) principle other than frequency. In short, the lexical entries of the oblique cases of a noun are satellites to the lexical entry of the noun's nominative singular.

The second characteristic of the satellite-entries hypothesis reflects a common assumption of hypotheses about lexical memory, namely, that entries in the lexicon express the frequency of the word they represent. We pursue that assumption in the remarks that follow, because it figures significantly in the eventual predictions we wish to make.

There are two fashionable interpretations of how a word's frequency of occurrence is coded in the internal lexicon. The entries in lexical memory may be likened to the files in a filing cabinet ordered according to frequency of usage (Forster & Bednall, 1976; Rubenstein, Lewis, & Rubenstein, 1971; Stanners & Forbach, 1973). A word's frequency of occurrence is expressed in lexical memory by the location of its lexical entry. Thus, on the filing-cabinet analogy, the entries for the most frequently occurring words are to be found at the front of the cabinet (at the start of lexical search), whereas those entries for the least frequently occurring words are to be found at the back of the cabinet (toward the end of lexical search). On this view, lexical search is serial, and its duration is inversely related to the frequency of occurrence of the target word; when no lexical entry is to be found (i.e., when the letter string is a nonword), the search is exhaustive. If the filing-cabinet account of

the coding of word frequency in lexical memory can be referred to as an interentry account, then its popular alternative can be referred to as an intraentry account, for here the emphasis is not on an entry's position relative to other entries but on the individual entry's sensitivity to linguistic stimulation. According to the intraentry account, each lexical entry is a device for accepting evidence about the presence of the word it represents (see the logogen model of Morton, 1969, 1970). In the case in which the word in question occurs very frequently, the evidence needed for detecting its presence is less, or, equivalently, the threshold of its lexical entry is lower, than in the case in which the word in question occurs rarely. On this view, lexical search is parallel, and, in common with the interentry view, its duration is inversely related to a word's frequency of occurrence. It is not so clear, however, how the intraentry view accounts for decision time when no lexical entry is to be found (see Coltheart, Davelaar, Jonasson, & Besner, 1977).

If there is an independent entry for each grammatical case of a Serbo-Croatian noun, then we might suppose that lexical decision times for the grammatical cases of a given noun will vary in proportion to their frequencies of occurrence. In a previous experiment (Lukatela, Mandić, Gligorijević, A. Kostić, Savić, & Turvey, 1978), we examined this prediction from the independent-entries hypothesis and found it wanting. Lexical decision time was not related by a unique, constant multiplier to the corresponding logarithms of the proportional frequencies of three grammatical cases. Rather, the decision time for one case, the nominative singular, was significantly less than the decision time to either of the other two cases (the instrumental singular and the dative singular), which did not differ from each other in terms of decision time, even though they differed in frequency. We interpreted this observation as support for either a derivational hypothesis or a hypothesis consonant with the point of view that the nominative singular is the nucleus entry about which the entries for the other grammatical cases cluster uniformly.

The experiment to be reported here contrasts the satellite-entries hypothesis with the independent-entries hypothesis on the one hand and with the derivational hypothesis on the other. To anticipate, the outcome of the experiment favors the satellite-entries interpretation of the lexical organization of inflected nouns.

The experiment takes advantage of two facts of the Serbo-Croatian language. First, the same letter pattern (and, therefore, phonetic pattern) can represent more than one grammatical case. For example, the inanimate noun *SERPA* (nominative singular form), which means "pot," is written as *SERPE* and pronounced identically in the genitive singular, nominative plural, and accusative cases. Where identities exist, the case frequencies can be compounded. The case identities and their compound frequencies for nouns of the masculine and feminine genders are given in Table 2.

Table 2
Identical Grammatical Cases and Their Compound Frequencies

Masculine Nouns (Inanimate)	Percent Occurrence	Feminine Nouns	Percent Occurrence
Nominative singular, accusative singular	41.25	Nominative singular, genitive plural	30.78
Genitive singular, genitive plural	28.19	Genitive singular, nominative plural, accusative plural	36.27
Locative singular, dative singular	10.45	Locative singular, dative singular	9.70

The second fact to be exploited is that, whereas the nominative singular is the root morpheme in the declension of masculine nouns, it is not the root morpheme in the declension of feminine nouns. For the latter, the root morpheme is an abstraction in the loose sense that the root morpheme never occurs as an actual grammatical case. In terms of distinctions sometimes used by linguists, the root morpheme of masculine nouns is full (it has semantic content) and free (it can stand alone as an independent word), whereas the root morpheme of feminine nouns is less obviously full, and it is certainly not free. Table 3 gives examples of the two genders.

Let us return to the first fact identified above and put it to use as a means of prying apart the perspective of satellite entries from that of independent entries. The compounded frequency of the nominative singular form in the masculine gender proves to be greater than that of the genitive singular form in the masculine gender. For nouns of the feminine gender, this relation is reversed: The nominative singular form occurs less frequently than the genitive singular. Thus, for a masculine noun of frequency of occurrence f , the respective proportional frequencies of the nominative singular and genitive singular letter patterns are approximately .41 f and .28 f . In contrast, for a feminine noun of frequency of occurrence f , the respective proportional frequencies are approximately .31 f and .36 f . The independent-entries hypothesis would predict a shorter latency lexical decision for nominative singular masculine nouns than for genitive singular masculine nouns. That same hypothesis, however, with respect to feminine nouns, would predict either little difference in lexical decision latency for the two grammatical cases or a difference in which the decision time to the genitive singular form is the briefer of the two. In comparison, the satellite-

entries hypothesis makes a considerably simpler prediction: For both genders, the nominative singular will be responded to faster than the genitive singular.

The two hypotheses can be further contrasted with respect to their predictions on lexical decision times to the instrumental singular, which occurs with a proportional frequency of approximately .04 f in the masculine and approximately .05 f in the feminine. The independent-entries hypothesis would predict that decision times to the very low-frequency instrumental singular of both genders should be much longer than the decision times for the high-frequency nominative singular and the high-frequency genitive singular. The satellite-entries hypothesis, in contrast, predicts that lexical decision time for the instrumental singular should, in both genders, be very close, probably identical, to that for the genitive singular and significantly longer than that for the nominative singular. A summary of these contrasting predictions of the two hypotheses is given in Table 4, in which the inequality symbols are in reference to lexical decision time and the letters identify the nominative singular (ns), genitive singular (gs), and instrumental singular (is).

The rationale for pooling the frequencies of visually identical cases is that a reader's sensitivity (in lexical decision) to a given grammatical form of a given noun is determined solely by the relative frequencies with which the reader has seen that grammatical form as a visual object. A different perspective, however, and one that is more consonant with the satellite-entries hypothesis, is that it is the visual form in a sentential context (i.e., as a grammatical object rather than as a crass visual object) that is important, so that there are indeed separate lexical entries for individual cases that are visually identical but grammatically distinct. On this latter

Table 3
Declension of a Masculine Noun and of a Feminine Noun

Case	Masculine		Feminine	
	Singular	Plural	Singular	Plural
Nominative	DINAR	DINARI	ŽENA	ŽENE
Genitive	DINARA	DINARA	ŽENE	ŽENA
Dative	DINARU	DINARIMA	ŽENI	ŽENAMA
Accusative	DINAR	DINARE	ŽENU	ŽENE
Vocative	DINARE	DINARI	ŽENO	ŽENE
Instrumental	DINAROM	DINARIMA	ŽENOM	ŽENAMA
Locative	DINARU	DINARIMA	ŽENI	ŽENAMA

Note—Dinar = money; žena = woman.

perspective, we should predict latency relations on the basis of the uncompounded frequencies, as given in Table 1. The relevant predictions are shown in Table 5, and, as comparison of Tables 4 and 5 reveals, the predictions from compounded and uncompounded frequencies differ only slightly.

Let us now take the second fact identified above, namely, the differential status of the nominative singular in nouns of the masculine and feminine gender, and put it to use for the purpose of distinguishing the satellite-entries perspective from that of derivation. Recalling the Manelis and Tharp (1977) analysis, in lexical decisions, an affixed word would be decomposed into base morpheme and affix, and the combination would then be evaluated for its validity. Consider this derivational account of lexical decisions as applied to the grammatical cases of masculine and feminine nouns exemplified in Table 3. The base morpheme of the masculine noun in Table 3 is DINAR, which is also the nominative singular, but the base morpheme of the feminine noun is ZEN, which is not identical to any grammatical case. By one reading of the derivational account of lexical decisions, the decision process for the feminine nominative singular ŽENA should differ from that for the masculine nominative singular DINAR. Since ŽEN, and not ŽENA, is represented in memory, ŽENA would have to be decomposed into the two morphemes ŽEN and A, and the combination would then have to be assessed for its validity. Therefore, whether decomposition occurs before or after lexical search, the decision process for ŽENA should not differ from the decision processes for the other grammatical cases that are similarly decomposable into the root ŽEN and a single inflectional morpheme. But consider the relation between DINAR and its allied oblique cases. If lexical search for the whole unit preceded decomposition, then DINAR's lexical legitimacy would be determined in the first state, but the determination of (say) DINAROM's lexical status would have to await the second stage. On the decomposition-second version of the derivational view, decision times for the nominative singular of masculine nouns should be shorter than those for the grammatical cases that are inflected and which, in turn,

Table 4
Predictions of Independent-Entries and Satellite-Entries
Hypotheses for Compounded Frequencies

Hypothesis	Masculine Nouns	Feminine Nouns
Independent Entries	ns < gs < is	ns > gs < is
Satellite Entries	ns < gs = is	ns < gs = is

Table 5
Predictions of Independent-Entries and Satellite-Entries
Hypotheses for Uncompounded Frequencies

Hypothesis	Masculine Nouns	Feminine Nouns
Independent Entries	ns < gs < is	ns < gs < is
Satellite Entries	ns < gs = is	ns < gs = is

Table 6
Predictions of Derivational and Satellite-Entries Hypotheses

Hypothesis	Masculine Nouns	Feminine Nouns
Decomposition Second	ns < gs = is	ns = gs = is
Decomposition First	ns > gs = is	ns = gs = is
Modified Decomposition First	ns = gs = is	ns = gs = is
Satellite Entries	ns < gs = is	ns < gs = is

should not differ among themselves. However, if decomposition precedes lexical search, then a different outcome is to be expected. In comparison to the oblique cases, DINAR would resist sensible decomposition and would have to be processed through the subsequent stage of lexical search, in which case lexical decision to the nominative singular would be the slowest, not the fastest.

There is yet another possibility. When DINAR is subjected to the decomposition stage, the decomposition process yields two morphemes, DINAR and the null morpheme, ϕ , which are then assessed as constituting a legal combination. As a modification of the decomposition-first argument, this latter argument predicts no difference in lexical decision times among the grammatical cases of masculine nouns.

Table 6 summarizes the contrasting predictions of the derivational and satellite-entries hypotheses. The important thing to note is that the satellite-entries view differs from the decomposition-first and decomposition-second views in that it predicts the same pattern of latencies for masculine and feminine nouns, and it differs from the modified decomposition-first view in that it predicts a difference among grammatical cases. It remains for us to point out that differences between the derivational and satellite-entries hypotheses remain even if the frequency factor is incorporated into the predictions of the three versions of the derivational hypothesis. Borrowing a strategy popular with writers of mathematics textbooks, we leave the generation of these predictions as an exercise for the reader.

METHOD

Subjects

Sixty undergraduate students from the psychology department of the University of Belgrade participated in the experiment. All subjects had had previous experience with reaction time experiments. Some of the subjects had participated in lexical decision experiments before, but none had done so within 1 month of the present experiment. Moreover, few of the words of the present experiment had been used in the earlier experiments.

Materials

Twenty-seven feminine nouns and 27 masculine nouns were selected according to the following criteria: (1) All the nouns had to be easily imagined (i.e., they had to be concrete nouns); (2) all the nouns had to be easy to read aloud in all grammatical cases (i.e., consonant runs were avoided); (3) all the nouns had to have only a single meaning invariant over grammatical cases; (4) all the nouns had to be regular; and (5) all the masculine nouns had to be inanimate.

Three 35-mm slides were constructed for each noun: one for the noun's nominative singular, one for the noun's genitive singular, and one for the noun's instrumental singular. Accordingly, there was a total of 162 slides in which the string of Roman (see Lukatela, Savić, Ognjenović, & Turvey, 1978) letters (Helvetica light, 12 point), arranged horizontally at the center of the slide, spelled a word in Serbo-Croatian.

A set of 162 nonword slides was constructed by converting each word from a different list of words meeting the same criteria as above into a nonword. This was done in the nominative singular and genitive singular cases by changing the first letter and in the instrumental singular case by changing the last letter, so as to avoid idiosyncratic instrumental endings.

Procedure

On each trial, the subject's task was to decide as rapidly as possible whether the presented letter string was a word or a nonword. Each slide was exposed for 1,500 msec in one channel of a three-channel tachistoscope (Scientific Prototype Model GB) illuminated at 10.3 cd/m². Both hands were used in responding to the stimuli. Both thumbs were placed on a telegraph key close to the subject, and both forefingers were placed on another telegraph key 2 in. farther away. The closer button was depressed for a "no" response (the string of letters was not a word), and the farther button was depressed for a "yes" response (the string of letters was a word).

Latency was measured from stimulus onset. The total session lasted 30 min, with a short pause after every 18 slides.

Design

Each subject saw a total of 108 slides, of which 54 were words and 54 were nonwords, but no subject saw any given letter string or any given noun more than once in the course of the experiment. This was achieved in the following manner. The 54 feminine and masculine nouns were divided into three groups (A, B, C) of 18 nouns each. The 60 subjects were divided into three groups (1, 2, 3) of 20 subjects each. Subjects in Group 1 saw the nominative singular cases of Category A nouns, the genitive singular of Category B nouns, and the instrumental singular of Category C nouns. Subjects in Group 2 saw the nominative singular case of Category B nouns, the genitive singular of Category C nouns, and the instrumental singular of Category A nouns. For subjects in Group 3, the categories were C, A, B, respectively, for nominative, genitive, and instrumental. A similar partitioning into categories and mapping onto subject groups was done for the nonwords.

RESULTS

Figure 1 gives a histogram plot of the mean reaction times for the three grammatical cases of the masculine and feminine nouns. Reaction times smaller than 300 msec and greater than 1,500 msec were excluded from the calculations of the means, as were erroneous responses, which occurred in the present experiment at a rate of less than 2.5%. Only the latencies to words are considered in the analysis below.

Inspection of Figure 1 suggests a difference in the rank order of grammatical case latencies between genders. At the same time, however, the figure does not suggest a pattern of results consonant with the predictions of the alternatives to the satellite-entries hypothesis. A difference between the genders might hold for the absolute latencies. The apparently slower overall response to the masculine nouns might be due to their generally greater length in both number of letters and number of

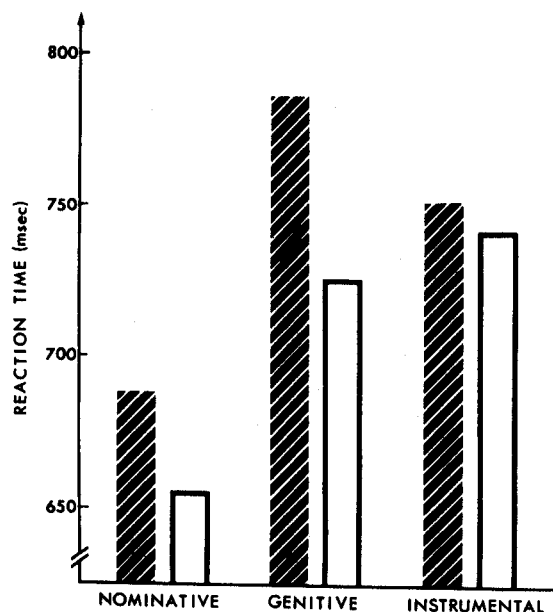


Figure 1. Reaction time to three grammatical cases of nouns of the masculine gender (striped bars) and nouns of the feminine gender.

syllables. Word length is known to contribute significantly to response latencies (Whaley, 1978).

The design of the present experiment was so chosen as to insure that no subject saw the same noun twice. It is a design, however, that raises certain difficulties for situations in which one is concerned with keeping the analysis true to the strictures advocated by Clark (1973), that is, of treating both subjects and letter strings as "random effects" and computing reliability of results over both of these sampling domains. To circumvent these difficulties, we used a variation of a procedure that we have reported previously (see Lukatela, Savić, Gligorijević, Ognjenović, & Turvey, 1978).

A comparison within a gender between any two of the three grammatical cases is composed of two sub-comparisons: one in which the nouns are the same but the subjects are different (comparing decision times for A words, B words, and C words), and one in which the subjects are the same but the nouns are different (comparing decision times for Group 1, Group 2, and Group 3). The two quasi-F ratios for these sub-comparisons are viewed as random variables, the probabilities of which have a chi-square distribution with 2 by 2 degrees of freedom. These new random variables are computed as $r_i = -2 \ln(p_i)$ for any subcomparison r_i for which the F' is at the probability level p_i . The obtained sum of the new variables is then assessed for significance against the chi-square value for the corresponding degrees of freedom. In short, this analysis assesses the likelihood that a set of two quasi-F ratios with probabilities of p_1 and p_2 could have come about by chance.

For the masculine nouns, the nominative singular differed from both the genitive singular [$\chi^2(4) = 28.65$, $p < .001$] and the instrumental singular [$\chi^2(4) = 19.44$,

$p < .001$], which did not differ between themselves [$\chi^2(4) = 5.51, p > .05$]. The same pattern held for the feminine nouns [nominative singular vs. genitive singular, $\chi^2(4) = 29.46, p < .001$; nominative singular vs. instrumental singular, $\chi^2(4) = 35.45, p < .001$; genitive singular vs. instrumental singular, $\chi^2(4) = 1.58, p > .05$].

DISCUSSION

The purpose of the present experiment was to assess three interpretations of how the inflected nouns of the Serbo-Croatian language are represented in the internal lexicon. On one interpretation, the independent-entries hypothesis, it is assumed that each grammatical case is stored in the lexicon as a separate and relatively independent entry. Insofar as an entry in the internal lexicon is believed to embody, either through its relation to the other entries or through its sensitivity to linguistic stimulation, the frequency of occurrence of the word that it represents, it should be argued that the grammatical cases of any given noun must relate among themselves in terms of their frequencies of occurrence. This prediction of the independent-units hypothesis was examined through an investigation of lexical decision to three grammatical cases: the nominative singular, the genitive singular, and the instrumental singular. The relation between the first two cases differs as a function of noun gender: For masculine nouns the nominative singular is of greater compounded frequency, whereas for feminine nouns the genitive singular is (on compounding identical grammatical cases) the more frequently occurring form. In both genders the instrumental singular occurs far less frequently than the other two cases. The pattern of lexical decision latencies to be expected from the independent-units hypothesis was not realized; rather than there being one pattern for the masculine nouns and another for the feminine nouns, there was a single pattern, the same for both genders. Importantly, lexical decision time was briefest for the nominative singular of both genders, and there was no latency difference between the genitive singular and instrumental singular of both genders.

The obtained results are consistent, therefore, not with an independent-units hypothesis as we have interpreted it, but with a hypothesis that assumes that not all grammatical cases are qualitatively alike in lexical status and that the grammatical cases are not ordered among themselves according to frequency of occurrence. One grammatical case, the nominative singular, appears to play a pivotal role due in part, perhaps, to its primacy in acquisition (Carroll & White, 1973a, 1973b). The latter fact is important in another way, too: It argues against a derivational hypothesis in which lexical decision involves successive stages of decomposing into the root and inflectional morphemes and testing the combination for its legality. Morphologically, the nominative singular of feminine nouns is like all other cases, in that

it consists of a root form and an inflectional ending, but the nominative singular of masculine nouns is unlike other cases in that it is the root form and contains no inflectional ending. Two versions of the derivational hypothesis (see Table 6) predict differences between masculine and feminine nouns in the pattern of decision latencies among the grammatical cases. The experiment revealed, however, that the pattern for the two genders is the same, not different. A third version of the derivational hypothesis does predict identical patterns for masculine and feminine nouns, but the predicted pattern is one in which there are no latency differences among grammatical cases. We are reminded that for both genders the experimental outcome was a latency difference that favored the nominative singular over the other two cases. Thus the third version of the derivational hypothesis does not hold either.

Before we draw any general conclusions from the present data, it behooves us to consider an aspect of the design that might give reason for caution. The basis for the fifth restriction on the choice of words described above, that the masculine nouns be inanimate, was that in the declension of nouns of the masculine gender the grammatical cases that are visually/phonologically identical are not the same for nouns denoting animate and inanimate objects. For example, the genitive singular is identical in form to the genitive plural in the case of inanimate nouns and identical in form to the genitive plural and accusative singular in the case of animate nouns. For the compounding of frequencies, it seemed prudent to stay with just one kind of masculine noun, although either kind would have been adequate for the purposes of the experiment. However, in retrospect, our choice to consider only one of the two kinds of masculine noun may have introduced an unnecessary complication. A native speaker of English unfamiliar with Serbo-Croatian might intuit that the contribution of the animate and inanimate nouns to the relative frequencies of masculine grammatical cases given in Table 1 is not the same (for example, one kind of masculine noun might contribute more to the frequency of one case than to another), and, therefore, to select one of the two kinds of masculine noun is to make void the use of the tabulated frequencies.

In English, possession is marked by 's. If this form is taken as sole representative of the genitive case, then given that the use of 's tends to favor animate over inanimate nouns, one might suppose that the genitive case is the hallmark of animate nouns. However, English combines inanimate nouns with the preposition "of" to produce effectively a partitive genitive: "... of the car," "... of the paper" (see Jaspersen, 1962). It is unlikely that these two kinds of genitive differ markedly in their frequencies of occurrence. In Serbo-Croatian, the genitive case, unlike its counterpart in English, is a very complex case, assuming 13 different grammatical functions. Of these functions, one is exclusively related

to inanimate nouns (Stefanović, 1974). As with English, it seems unlikely that the frequency of the genitive case in Serbo-Croatian would be significantly less for inanimate nouns than for animate nouns.

Similar comments need to be made in reference to the instrumental case, for here one might suppose that inanimate nouns take the instrumental form more often than animate nouns. In Serbo-Croatian, there are three categories of instrumental: instrumental case without preposition (eight kinds), instrumental case with the preposition "with" (three kinds), and instrumental case with spatial preposition (above, under, in front of, between/among). Of these three types, only two are exclusively related to inanimate nouns (Ivić, Note 1).

Of course, the point we are trying to establish is that the case frequencies for masculine nouns as reported in Table 1, on the basis of which we formed our predictions concerning the respective hypotheses of lexical organization, are equally applicable to masculine nouns of both the inanimate and animate kinds. Nevertheless, in the absence of case-frequency norms for individual words (which are not currently available), there is still some room for doubt, although we believe it to be small, that the foregoing contention holds. A small empirical point in our favor is that the mean decision times of 39 subjects for 10 animate and 10 inanimate masculine nouns drawn from the stimuli of the previous experiment (Lukatela, Mandić, Gligorijević, A. Kostić, Savić, & Turvey, 1978) were virtually identical for both nominative singular and instrumental singular cases: 594 msec and 680 msec, respectively, for the 10 inanimate nouns and 591 msec and 674 msec, respectively, for the 10 animate nouns. If animate and inanimate masculine nouns differ markedly in the frequency with which they occur in the instrumental case and if decision latency reflected that frequency distinction, then the lexical decision times should have differed.

We would argue, therefore, that, taken collectively, the present experiment and the previous one (Lukatela, Mandić, Gligorijević, A. Kostić, Savić, & Turvey, 1978) support the assumption that the oblique nonnominative singular cases do not differ in relative accessibility due to their differences in frequency of occurrence, but rather that they are equally accessible. To date, we have found little evidence for a difference in lexical decision latencies among the genitive singular, locative singular, and instrumental singular cases (and, therefore, in addition, among their visually identical mates; see Table 2).

Suppose that, after Morton's (1969, 1970) logogen model, we assume that the lexical representation of the nominative singular has a threshold inversely proportional to the frequency with which the noun (indifferent to its particular grammatical case) occurs in the language. Then, given the preceding observation, we should suppose that there is a common threshold level for the logogens of the oblique cases that is at a value equal to

the threshold of the nonnominative singular's logogen incremented by a constant. It is, perhaps, in some such sense as this, in the way in which the thresholds of the lexical entries for oblique grammatical cases are tied by a constant to the threshold of the lexical entry for the nominative singular, that we can begin to interpret the intuitive notion of a satellite organization for the inflected nouns of Serbo-Croatian. In view of the outcome of the present experiment, we conclude that the hypothesis of a nucleus logogen representing the nominative singular and about which the logogens of the oblique cases cluster uniformly is a better candidate for understanding the lexical organization of inflected nouns than either the hypothesis that the cases are represented independently of each other or the hypothesis that they are derived by rule.

Recently (and subsequent to the design and implementation of the present experiment), a description of lexical organization has been proposed (Taft, 1979b) that accommodates the features of both the independent-entries and the decomposition hypotheses. The lexicon is said to consist of a master file and a number of peripheral files: orthographic, phonological, and semantic (Forster, 1976). In the master file, the surface form of each word is separately and completely represented. In the peripheral files, on the other hand (of which the orthographic is the one of special significance to visual word recognition), it is base forms that are represented rather than surface forms. Peripheral files store information that is sufficient for selectively and successfully accessing the master file, where all information is to be found. It is argued that in the orthographic file the first syllable of a word, defined orthographically and morphologically, identifies the base form (Taft, 1979a) and that the frequency of a given base form is defined by the summed frequencies of the individual words of which it is the first syllable (Taft, 1979b). Importantly, in both kinds of file, master and peripheral, the frequency of an entry is a significant determinant of access time.

Consider the lexical representation of an inflected Serbo-Croatian noun from the perspective of the master file/peripheral file notion. There would be for a given noun a single entry in the orthographic file—say, the first syllable—with a frequency determined by the noun's occurrence in the language, and 14 entries in the master file (1 entry for each grammatical case), with their individual frequencies determined by the frequencies of occurrence of the individual cases that they represent. Given nouns such as ŽENA and DINAR, the peripheral file would contain ŽEN and DIN, respectively, whereas the master file would contain, for each of the two nouns, the full form of each grammatical case. Lexical decision occurs via these steps: First, the noun is decomposed into the first syllable and affixes. Second, a search of the peripheral file is conducted for a length of time determined by the frequency of the base form. Third, the master file is accessed (through the address given by

the base-form entry in the peripheral file), and the legality of the base-form/affix(es) combination is ascertained at a speed determined by the frequency of the combination (i.e., by the frequency of the individual grammatical case). We see, in short, that although the master file/peripheral file notion ascribes to the decomposition hypothesis, it predicts the same outcome as the independent-entries hypothesis, namely, that decision times are a function of the relative frequencies of the individual grammatical cases.

Our conclusion concerning the organization of inflected Serbo-Croatian nouns, based as it is on the indifference of decision latency to grammatical case frequency, does not concur with the master file/peripheral file notion, at least not with the current form of the notion, for there are hints that distinct files is a needed conception for certain aspects of lexical access (e.g., Forster, 1979; Glanzer & Ehrenreich, 1979). Therefore, we would expect the general idea to receive further attention and to undergo modification. One major reason for the lack of concurrence may rest with the issue of whether lexical organization is uniform or pluralistic. Chomsky (1970) and others (e.g., Stanners, Neisser, Hemon, & Hall, 1979) have expressed a pluralistic view arguing, for example, that the lexicon's organizational formats for the inflectional forms of English verbs and for the nominal derivations of English verbs need not be identical. And Bradley (1978) has given good empirical reasons for holding distinct the lexical organizations of the closed set of words (often termed function words) from the open set of words. Thus, the fact that the affixed English nouns and verbs studied by Taft (1979b) and the inflected Serbo-Croatian nouns studied by us submit to different explanatory accounts of lexical organization may point less to an opposition of data than to a differentiation of lexical organization according to differences in linguistic forms and functions.

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