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Lexical representation of regular and irregular inflected nouns*

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Abstract—An experiment is reported in which native speakers/readers of Serbo–Croat made rapid lexical decisions to inflected nouns in three cases: nominative singular, dative/locative singular (these two cases are spelled the same way), and instrumental singular. Both regularly and irregularly declined nouns were used. The regularly declined nouns were divided evenly between the masculine and feminine gender. For regular masculine nouns the nominative singular is linguistically full and free. For regular feminine nouns the nominative singular is linguistically empty and bound. The irregularly declined nouns were all feminine. They were irregular in either the dative/locative singular form or in the instrumental singular form. Predictions were made from the 'satellite entries' view (Lukatela *et al.*, *Memory and Cognition 8*, 415–423, 1980) of how the inflected forms of a Serbo–Croatian noun are organized in the internal lexicon. According to this view each form is said to be represented in a unitary fashion (stem plus suffix) with the nominative singular accessed more easily than the oblique forms which are all accessible to the same degree despite marked differences in their individual frequencies of occurrence. The outcome of the experiment was consistent with the satellite entries hypothesis. Regardless of gender and regularity, mean lexical decision times were the same for the more frequently occurring dative/locative singular and the less frequently occurring instrumental singular, and were the shortest for the nominative singular.

INTRODUCTION

English uses word order as its major grammatical device. In contrast, Serbo–Croat (the principal language of Yugoslavia) relies primarily on inflection to convey grammatical information. Take the Serbo–Croatian nouns as an example. The inflectional morpheme suffixed to each noun stem conveys information with respect to a verb—it specifies that the noun is the verb's subject, or its direct object, or its indirect object, or its instrument, and so on. Additionally, the inflectional morphemes specify whether the noun is singular or plural and on occasion they specify whether the entity that the noun denotes is living or nonliving. (Strictly speaking, information about a noun's gender is contained in the lexicon, not the inflection. While the majority of nominative singular masculine nouns end in a consonant and nominative singular feminine nouns end in -A, the numerous exceptions preclude using this rule.)

Taken together, a stem plus an inflection identify a noun's case. Table 1 gives the singular and plural cases of one masculine and three feminine nouns. Two of these four nouns (DINAR meaning 'money' and FRULA meaning 'flute') are regular in their declension—the stem is constant from case to case. The other two (NOGA meaning 'leg' and KOST meaning 'bone') are irregular—one changes its stem in the dative/locative singular case, the other in the instrumental singular case. The present experiment addresses the question of how noun systems exemplified by the

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declensions of DINAR, FRULA, NOGA, and KOST are represented in the lexical memory of a native speaker/reader of Serbo–Croat. How do the cases of an inflected Serbo–Croatian noun relate among themselves in the language user's internal lexicon?

Table 1.
Exemplary declensions of regular and irregular Serbo–Croatian nouns

		Regular		Irregular	
Number	Case	Masculine	Feminine	Feminine	Feminine
Singular	Nominative	DINAR	FRULA	NOGA	KOST
	Genitive	DINARA	FRULE	NOGE	KOSTI
	Dative	DINARU	FRULI	NOZI	KOSTI
	Accusative	DINAR	FRULU	NOGU	KOST
	Locative	DINARU	FRULI	NOZI	KOSTI
	Instrumental	DINAROM	FRULOM	NOGOM	KOŠĆU
Plural	Nominative	DINARI	FRULE	NOGE	KOSTI
	Genitive	DINARA	FRULA	NOGA	KOSTI
	Dative	DINARIMA	FRULAMA	NOGAMA	KOSTIMA
	Accusative	DINARE	FRULE	NOGE	KOSTI
	Locative	DINARIMA	FRULAMA	NOGAMA	KOSTIMA
	Instrumental	DINARIMA	FRULAMA	NOGAMA	KOSTIMA

Research conducted to date on masculine, feminine, and neuter Serbo–Croatian nouns with regular declensions has suggested a division between the cases, viz., between the representation of the nominative singular case (and, perhaps, the nominative plural case) and the representations of the oblique cases (the non-nominative singular cases). In lexical decision tasks, conducted with written and spoken words, the latency to accept the nominative singular as a word is always less than the latency to accept an oblique case as a word. And among the oblique cases acceptance latencies tend not to differ despite differences in the average frequencies with which they occur (Lukatela *et al.*, 1978, 1980; Katz *et al.*, in press). To exemplify these points, consider regular feminine nouns with FRULA as a typical instance. Suppose that the frequency of occurrence of the word meaning 'flute' in ordinary language usage is f. Then any given grammatical form of this word meaning 'flute' must occur with a frequency that is some proportion of f. Table 2 reports these proportions based on Kostić's (1965) frequency analysis of Serbo–Croatian words appearing in the daily press and contemporary poetry (see Lukatela *et al.*, 1980).

It should be noted that the values cited are averages for all nouns. Frequency norms for individual noun forms are not available for the Serbo–Croatian language. Nonetheless, the frequency estimates should apply to a statistically representative sample of nouns. Our previous work has used nouns chosen pseudorandomly. They were from the midfrequency range and of average length for Serbo–Croat. While this does not ensure that every stimulus item follows the frequency pattern expected from the average case frequencies (e.g., PUŠKOM, the instrumental form of 'rifle' is likely to be more frequent than KRUŠKOM, the instrumental form of 'pear'), a set of randomly chosen items should, on average, follow the expected pattern.

With this caveat in mind, inspection of Table 2 reveals that the nominative singular (FRULA) and genitive singular (FRULE) forms occur with almost equal frequency, 0.23 and 0.20*f*, respectively, and that the frequency of the instrumental singular (FRULOM) is considerably less than both of them, viz., 0.05*f*. The empirically obtained lexical decision latencies, however, do not reflect this frequency relation. In the printed-word experiment of Lukatela *et al.* (1980) the nominative, genitive, and instrumental latencies were, respectively, 652, 725, and 745 ms. In the spoken-word experiment of Katz *et al.* (in press) these latencies were, respectively, 762, 813, and 821 ms. In both experiments the response to the nominative singular was significantly faster than the response to either oblique case, even though one oblique case (FRULE) had the same number of letters, the same consonant–vowel structure, and approximately the same frequency as the nominative singular (FRULA). Further, the response times to the two oblique cases were not significantly different.

Table 2.
Case frequencies in percentages

	Singular				Plural			
	Masculine	Feminine	Neuter	Total	Masculine	Feminine	Neuter	Total
Nominative	12.83	8.84	2.8	24.55	3.33	3.58	0.69	7.60
	28.89	*22.56*	*20.44*		*7.50*	*9.14*	*4.30*	
Genitive	8.56	7.88	3.47	19.91	3.96	3.22	0.61	7.79
	19.27	*20.11*	*24.63*		*8.92*	*8.22*	*4.33*	
Dative	8.7	0.38	0.3	1.56	0.28	0.16	0.04	0.47
	1.96	*0.97*	*2.20*		*0.63*	*0.41*	*0.28*	
Accusative	5.49	5.48	2.55	13.52	2.21	2.75	0.73	5.69
	12.36	*13.99*	*18.10*		*4.98*	*7.02*	*5.18*	
Instrumental	1.90	1.94	0.86	4.70	0.60	0.80	0.13	1.46
	4.28	*4.95*	*6.10*		*1.35*	*1.86*	*0.92*	
Locative	3.77	3.42	1.61	8.80	0.61	0.80	0.13	1.46
	8.48	*8.73*	*11.43*		*1.37*	*2.04*	*1.48*	
Total	33.42	27.94	11.68	73.04	10.99	11.24	2.41	23.64
	75.25	*71.31*	*82.89*		*24.75*	*28.69*	*17.11*	

Note: This table is adopted from Dj. 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.

The independence of lexical decision times from the relative frequencies of the individual cases is underscored by considering the frequency of occurrence of the spellings of the cases. Inspection of Table 1 reveals that different cases share the same spelling. If the ambiguous case forms are presented in isolation, it is impossible for a reader/listener to recognize the grammatical case unequivocally. In such a situation, a person's sensitivity to inflected noun forms ought to be determined solely by the 1relative frequency with which a given visual or auditory form has been encountered.0 Thus, a 'compound frequency' of a given spelling is justifiable and can be determined by adding the frequencies of all forms with the same spelling (see the discussion section for alternative reckonings). When the frequencies of visually identical cases are summed, the proportional frequencies of the nominative singular, genitive singular, and instrumental singular forms of

regular feminine nouns become: 0.31, 0.36, and 0.10*f*, respectively. If a Serbo–Croatian reader's sensitivity (in lexical decision) to a given grammatical case of a given feminine noun is determined solely by the relative frequencies with which the reader has *seen* the spelling of that case, then the genitive singular should be responded to faster than the other cases. Clearly, this hypothesis is not confirmed by the data.

The foregoing observations of the primacy of the nominative singular or citation form of nouns in Serbo–Croat has a parallel in English language studies. Stanners *et al.* (1979) report that base verbs (e.g., hang, shake) are responded to 90–100 ms faster than irregular past tense derivatives (hung, shook) even though the derivatives are of the same length and higher frequency. The same relation also holds between base verbs and nominal derivations closely matched in the variables of frequency and length.

Lukatela *et al.* (1978, 1980) have described the internal representation of the oblique cases as 'satellites' to the nominative singular case. Each grammatical case of a noun has a separate entry in the lexicon with the representation of the nominative singular case functioning as a 'nucleus' around which the representations of the oblique cases cluster to form a 'noun system'. The oblique cases are said to cluster uniformly. There are two senses of uniform. In one sense the oblique cases all lie at approximately the same distance from the nominative singular (consistent with the filing-cabinet view of frequency coding of lexical items e.g., Forster and Bednall, 1976). In the other sense the thresholds of the oblique cases are approximately the same scalar multiple of the nominative singular's threshold (consistent with the logogen view of frequency coding of lexical items e.g., Morton, 1969). The point is that the frequency differences among the oblique cases in ordinary language usage are not reflected in their internal representations.

Stanners *et al.* (1979) offer another way of thinking about the relation between the nominative singular and the obliques. In concert with the satellite hypothesis, they suggest that irregular English verb forms are integrated into a memory structure that includes the base verb in a pivotal role. The process of deciding on the lexical status of the irregular past tense version entails: (1) activating the representation of the past tense; and (2) activating the representation of the base. Assume that these activations are successive. Then lexical decision time for the past tense includes not only the time to find or activate the past tense representation but also to find or activate the base. Presumably the initiation of the lexical decision response must await the completion of this sequence. The result is longer latencies for the past tense version relative to the base version, despite the past tense version's greater frequency of occurrence. (The average Kućera–Francis frequency for base verbs like *hang* is 40.3 and for past tense verbs like *hung* is 65.3).

The satellite entries model shares features in common with both the independent entries account and the decompositional account of how words with common morphological stems are represented internally (Manelis and Tharp, 1977) although it is identical with neither. Thus, by the satellite entries hypothesis each grammatical case is represented as a unit—and not as a separate stem and suffix—but the representation of the basic form of the noun, its citation form, is privileged among the representations of the cases, playing a central organizing role. The orthodox independent entries account argues that each affixed and nonaffixed word is stored as a single unit and the lexical access involves a search for and retrieval of

the whole unit, with search time an inverse function of the item's frequency. The indifference to frequency of lexical decision times for oblique cases argues against the orthodox independent entries account. The argument against the decomposition hypothesis is not so simple. The basic idea behind the decomposition hypothesis is that it is productive (and economical) to store affixed words as separate root morphemes and affixes together with rules for judging the legality of any given combination. Decomposition is a viable strategy to the extent that the root morpheme does not change and the rule of affixation is constant. As expressed by Manelis and Tharp (1977), there are two variants of the decomposition hypothesis, namely, decomposition preceding a search of the internal lexicon and decomposition following a search of the internal lexicon. Consider the situation where decomposition is prefatory to search. First, a given affixed word (for example, a given noun in a given case) is decomposed into its constituent root morpheme and affix. Second, the legality of the combination is assessed. If the assessment is positive a positive lexical decision can be initiated. If the assessment is negative a third step ensues, viz., a search of the lexicon for the whole (undecomposed) item. Consider now the situation where decomposition is not an obligatory first step but a contingent second step that follows an unsuccessful search of the lexicon for the whole affixed item. First, a search is made for the affixed word. If no match is found then a second step is initiated, viz., decomposition into the constituent morphemes. A third step evaluates whether the combination of these morphemes is legal. A positive evaluation results in a positive lexical decision.

Lukatela *et al.*'s (1980) rejection of the decomposition hypothesis in either form was based on the identical pattern of lexical decision latencies for the grammatical cases of regular feminine and masculine nouns. The stem of regular masculine nouns is identical with the citation form, the nominative singular (e.g., DINAR meaning 'money'). The stem of a regular masculine noun, therefore, has semantic content (it is linguistically 'full') and it can stand alone as an independent word (it is linguistically 'free'). In contrast, the stem of regular feminine nouns is not identical with the nominative singular (for example, FRUL versus FRULA); it is empty and bound. On the decomposition hypothesis, FRUL not FRULA would be represented in memory. Accordingly FRULA would have to be decomposed into the two morphemes FRUL and -A, with the combination then assessed for legality. Therefore, whether decomposition occurs before or after lexical search, the decision time for FRULA should closely approximate the decision times for the other grammatical cases that decompose in similar fashion into the stem FRUL and a single inflectional morpheme. With DINAR and its oblique cases the situation is very different. A search preceding decomposition would yield DINAR; however, two further steps (decomposition and the test for the validity of the combination) would be required to find an oblique case such as the instrumental singular DINAROM. Lexical decomposition prior to search would not succeed with DINAR but it would succeed with DINAROM. The test for the legality of combining the constituent morphemes would follow next, and DINAROM would be responded to affirmatively. Meanwhile DINAR would have to await the third step (that of lexical search) for affirmation that it is a word. In sum, both the decomposition first and decomposition second hypotheses predict a difference between the pattern of lexical decision times for regular masculine and feminine nouns. Roughly, the nominative singular and oblique cases of regular feminine

nouns should be associated with approximately equal lexical decision times. For the regular masculine nouns the nominative singular should be responded to either faster (decomposition second) or slower (decomposition first) than the obliques. To reiterate, what Lukatela *et al.* (1980) found was that for both regular masculine and feminine nouns the decision time for the nominative singular was the shortest and the decision times for the oblique cases did not differ significantly from each other (see also Katz *et al.*, in press).

Other readings of the decomposition hypothesis were considered by Lukatela *et al.* (1980) including Taft's "basic orthographic syllable structure" version (1979). None seemed to be strongly supported by the data and the reader is referred to the Lukatela *et al.* (1980) manuscript for discussion of these alternatives (see also Feldman *et al.*, 1983, for a discussion of related issues).

It is important to underscore that a rejection of the claims that: (1) the grammatical cases of a Serbo–Croatian noun are represented in the lexicon as combinations of distinct words corresponding to morphemic constituents; and (2) decomposition into these constituents either precedes or follows lexical search, is not a denial of the psychological reality of morphemes or of the general morphophonemic representation of words in the lexicon. It can be supposed that an inflected form of a Serbo–Croatian noun is represented in the lexicon as a single unit corresponding to the complete word, where this unitary representation *indicates* its stem/suffix structure (cf. Taft and Foster, 1975; Stanners *et al*, 1979). It could also be supposed that once a representation is accessed—and the evidence for Serbo–Croat is that the access is phonologically based (see Turvey *et al.*, 1984, for a review)—then semantic processing of the stem and syntactic processing of the suffix may proceed independently, along the self-contained modular lines suggested by Fodor (1983) (see Katz *et al.*, in press).

The experiment reported here is a further evaluation of the nominative singular/obliques relation that is taken as evidence for the satellite entries hypothesis of lexical organization. (It is, therefore, a further evaluation of the contrasting independent entries and decomposition hypotheses.) The experiment contrasts nouns that preserve the same stem morpheme throughout their declensions (so-called regular nouns) with nouns that do not (so-called irregular nouns). The comparison is made on the nominative singular, dative/locative singular, and instrumental singular cases. Referring again to Table 1, nouns exemplified by DINAR and FRULA are regular in their declensions. Nouns exemplified by NOGA and KOST become irregular but in two different ways. NOGA is irregular in the dative/locative singular case. The change from NOGA to NOZI is exemplary of the rule (which does have exceptions) that when the stem of a noun of any gender ends in -K, -G, or -H the terminal consonant changes to -C, -Z, and -S, respectively, when the inflection is -I. In contrast, KOST is irregular in the instrumental singular case. The transformation of the stem KOST is in accord with two principles that serve to ease articulation in the spoken language: palatalization and equalizing the sounds of successive consonants. As an example of palatalization, a consonant combination such as -TJ (/tjə/) converts to -Ć (/tʃjə/) (Benson, 1971). The equalizing principle requires that, for example, the consonant -S (/s/) preceding -T (/t/) then converts to Š (/ʃ/). These changes, motivated by the spoken language, are mirrored in the written language. While English orthography might transcribe the instrumental singular of KOST as KOSTJU in order to preserve the

morphological relation, the Serbo–Croatian orthography forgoes morphological precision for phonetic precision (KOŠĆU) (see Lukatela and Turvey, 1980; Turvey *et al.*, 1984).

The irregular feminine noun types are of relevance to the present issues in two ways. First, as noted, they involve a change in the stem. Second, they contrast sharply in their patterns of compound frequencies. For both types, the compound frequencies of the nominative singular and instrumental singular are 0.31 and 0.05*f*, respectively. However, the dative/locative spelling NOZI occurs with a compound frequency of 0.10*f* whereas the dative/locative spelling KOSTI occurs with a compound frequency of 0.54*f*. (Actually, KOSTI occurs more than 0.54*f* and KOŠĆU occurs less than 0.05*f* because of the exclusive use of KOSTI as the instrumental case when following a preposition.) Consequently, according to the independent entries hypothesis NOGA and KOST type nouns should yield markedly different patterns of lexical decision times in concert with their markedly different frequency of occurrence patterns. The satellite entries hypothesis, in contrast, predicts that for both NOGA and KOST types the nominative singular decision times should be least and the oblique cases' decision times should be nearly identical.

The change in stem feature can be used to address the satellite entries view versus the decomposition view. Some empirical support has been presented for the intuition that whereas stem and inflectional morphemes might be separately represented for regular forms they are much less likely to be separately represented for irregular forms (Stanners *et al.*, 1979; Job and Sartori, 1984). Apparently, irregular forms are stored as single words. The uniform regularity of the nominative singular (FRULA), dative singular (FRULI) and instrumental singular (FRULOM) declensions of FRULA contrasts with the local irregularity of these declensions of NOGA (viz., NOGA, NOZI, NOGOM) and of KOST (viz., KOST, KOSTI, KOŠĆU).[1] If there is a distinction between the representations of regular and irregular nouns then one might expect that distinction to be revealed in the patterns of lexical decision times. The latency by case interactions should differ. In particular, the latencies for the dative singular and instrumental singular forms should not relate in the same way for NOGA and KOST types of nouns. Moreover, there are suggestions in the theory of Job and Sartori (1984) that the error production patterns ought to differ as well. They hypothesized that decomposable words are prone to incorrect classifications in the lexical decision task, apparently for both impaired and unimpaired decomposition systems. Consequently, NOZI should yield fewer errors than NOGOM, and KOSTI should yield more errors than KOŠĆU. By comparison, the argument from the satellite entries hypothesis is that the patterning of latencies and errors for the regular and irregular nouns in general should not differ nor should the patterning of latencies and errors for the particular comparison of nouns of the NOGA and KOST types.

METHOD

Subjects

Thirty-six high school seniors from the Fifth Belgrade Gymnasium served as subjects. A subject was assigned to one of three groups, according to the subject's appearance at the laboratory, to give a total of twelve subjects per group.

Materials

A basic set of 24 regular nouns drawn from the mid-frequency range (an average frequency of 175 in a corpus of 1.5 million words from Lukić, 1983) was assembled. One half of these were Class A (after Bidwell, 1970) feminine nouns (nominative singular ends in-A, genitive singular in -E, and dative singular in -I); the other half were Class 0 masculine nouns (nominative singular ends in a null morpheme -0), genitive singular in -A, and dative singular in -U). In addition, a set of 24 irregular feminine nouns was assembled, also from the mid-frequency range (average frequency of 213). One half of these were dative/locative irregular (e.g., nominative singular form NOGA is changed into dative/locative singular form NOZI) and the other half were instrumental irregular (e.g., nominative singular form KOST is changed into instrumental singular form KOŠĆU). In sum, 48 nouns were used to produce 48 nominative, 48 dative/locative, and 48 instrumental word stimuli. Corresponding pseudowords were formed by changing one letter in the stem of each of the 48 selected nouns in the nominative and dative/locative cases (leaving the inflectional morphemes intact). For the instrumental case, 24 pseudowords were created in this same way. But the remaining 24 pseudowords were created by changing a letter in the inflectional ending (see Lukatela *et al.*, 1983). The presence of these items ensured that subjects could not simply base their responses on the lexicality of the stem irrespective of the inflection. (That this procedural safeguard was successful is indicated by the fact that there was no difference in error rate between the two types of pseudoinstrumentals ($F<1$).) All pseudowords followed phonotactic constraints of the Serbo–Croatian language. A given subject saw 16 of each stimulus type (8 of each pseudoinstrumental form) with all word classes evenly divided among the 16 stimuli.

Design

A given subject never encountered a given word or pseudoword more than once. Each subject saw 48 word and 48 nonword stimuli. All stimuli were evenly divided into nominative, dative/locative, and instrumental forms and evenly divided into masculine regular, feminine regular, dative/locative irregular, and instrumental irregular classes.

Procedure

A subject was seated before the CRT of an Apple IIe computer. A fixation point was in the center of the screen. On each trial, the subject first heard a brief warning signal (a 500 ms long burst of 800 Hz) after which the fixation point was replaced by a letter string (Roman upper-case) centered on the screen for 1400 ms (to be consistent with the procedure of Lukatela *et al.*, 1980). The intertrial interval was 3 s. Subjects were instructed to decide as rapidly as possible whether or not the letter string was a word. Decisions were indicated by depressing a telegraph key with both thumbs for a NO response or by depressing another key with both forefingers for a YES response. Latencies were measured from the onset of presentation of the letter string. If the response latency was longer than 1400 ms, a message appeared on the screen requesting that the subject respond more quickly. After the warning message the stimulus was repeated although the decision latency to its second presentation was not used in data analyses. The experimental sequence of 96 stimuli was preceded by a practice sequence of 24 different stimuli.

If a given subject made more than four errors during the practice sequence, that sequence was automatically repeated.

RESULTS AND DISCUSSION

Responses that exceeded 1500 ms and those less than 400 ms were excluded from the latency data and were included in the error analyses.[2] Table 3 presents the lexical decision times and errors averaged over subjects for the noun data. (The decision times and errors for the individual words are presented in the Appendix.)

Table 3.
Mean lexical decision times, percentage error, and proportional frequency of spelling of noun stimuli as a function of regularity, gender, and case

		Case		
Regularity	Gender	Nominative	Dative/Locative	Instrumental
Regular	Feminine	FRULA[a]	FRULI	FRULOM
		626[b]	687	686
		0[c]	2	2
		0.31[d]	0.10	0.05
	Masculine	DINAR	DINARU	DINAROM
		644	733	732
		1	1	1
		0.41	0.11	0.04
Irregular	Feminine	NOGA	NOZI	NOGOM
		638	707	705
		1	10	1
		0.31	0.10	0.05
	Feminine	KOST	KOSTI	KOŠĆU
		604	667	683
		0	0	3
		0.37	>0.55	<0.05

[a] Exemplary noun
[b] Mean decision time
[c] Mean percentage error
[d] Proportion of times noun appears in the identified spelling

A 3 (Case) × 2 (Regularity) × 3 (Counterbalancing Group) analysis on the noun data addressed the question of whether decision time coordinated with grammatical case in the same way for both regular and irregular nouns. The answer was positive. Both the ANOVA on the subjects' means and the ANOVA on the items' means failed to yield an F value greater than unity for the regularity by case interaction. Case itself was highly significant by both analyses, Min $F'(2,162)=24.13$, $p<0.001$. Regularity, on the other hand, was significant only by the subjects' analysis: $F(1,35)=7.09$, MSe=16668, $p<0.02$. (For the items' analysis, $F(1,46)=1.77$, MSe=4803, $p>0.10$.)

A 3 (Case) × 2 (Gender) analysis addressed the question of whether or not decision time coordinated with grammatical case in the same way for both regular masculine and regular feminine nouns. The significance of this question derives from the fact that the relation between the citation form (the nominative singular)

and the other grammatical forms is not the same for the two genders, with possible consequences for lexical storage/lexical access theories as detailed in the introduction. Again, neither the ANOVA on subjects' means ($F(2,70)=1.62$, MSe=4980, $p>0.05$) nor the ANOVA on items' means ($F(2,46)=1.08$, MSe=1534, $p>0.05$) suggested that the effect of case depended on the gender of regular nouns. Case itself was highly significant by both analyses, Min $F'(2,104)=16.22$, $p<0.001$. And gender itself was significant under both analyses (although Min F' was not): $F(1,35)=7.09$, MSe=16669, $p<0.01$, for subjects' means and $F(1,22)=5.05$, MSe=21459, $p<0.05$ for items' means; the responses to feminine nouns were uniformly faster than the responses to masculine nouns. This difference is probably attributable to differences between the relative frequencies of the two groups of nouns (not of their case forms). Although all were chosen from the mid-frequency range, the mean frequency of the masculine nouns was 126 and the mean frequency of the feminine nouns was 224. Additionally, oblique masculine forms contained one more letter than oblique feminine forms, and nominative masculine forms had variable endings compared to the constant -A of nominative feminine forms. These latter factors may have made the feminine nouns easier to perceive.

A 3 (Case) × 2 (Type of Irregularity) analysis addressed the question of whether decision time coordinated with grammatical case in the same way for nouns whose declension was irregular in the dative/locative case and for nouns whose declension was irregular in the instrumental case. Neither ANOVA produced an F value greater than one for the interaction of type of irregularity and case. However, type of irregularity proved to be significant: Min $F'(1,40)=4.17$, $p<0.01$. Nouns whose declensions were irregular in the instrumental singular case (KOST type) were uniformly responded to faster than nouns whose declensions were irregular in the dative/locative case (NOGA type).

Among pseudowords, there was an effect of Case, Min $F'(2,176)=11.61$, $p<0.001$ (nominative=758 ms, dative/locative=766 ms, instrumental=824 ms), and a marginal interaction between Case and Regularity, Min $F'(2,163)=2.94$, $p<0.06$. Both of these reflect the longer decision latencies for regular pseudoinstrumentals with word stems and illegal inflections.

The results of the experiment are favourable to the satellite entries hypothesis. To begin with, in corroboration of Lukatela *et al.* (1978, 1980) and Katz *et al.* (in press) lexical decision time was shortest for the nominative singular case and undifferentiated among the oblique cases—here, the dative/locative singular and instrumental singular. As an alternative principle of lexical organization, we have already entertained and dismissed the notion of compound frequency, defined here as the sum of the frequencies with which a given spelling occurs. But there are other options and we will consider three. First, frequency may yet prove important if it is calculated by *averaging* (rather than summing) the frequencies of cases that share the same spelling. Second, because a grammatical case is not always spelled uniquely, it might be more proper to claim that the fastest decisions are associated with a particular spelling rather than with a particular kind of grammatical information. Third, because varying numbers of cases share a single spelling, perhaps the relative number of cases 'competing' for a given spelling is critical. Each of these will be considered in turn.

Average frequencies can be obtained by dividing a given compound frequency by the number of cases comprising it. On the basis of present data alone, this

organizing principle cannot be ruled out. As Fig. 1 shows, low average frequencies tend to be associated with slower decision times than relatively higher average frequencies. Disentangling satellite entries from the average frequency hypothesis, therefore, requires exploration of other data sets. A number of our previous investigations of the organization of the noun system have compared genitive with nominative and instrumental singulars. Average frequencies for these items can be computed as described in the foregoing. Among masculine nouns, the average frequency of the genitive DINARA (singular 0.19 + plural 0.09 ÷ 2 = 0.14) is more than three times greater than the instrumental singular (0.14 versus 0.04), yet their decision times do not differ (Lukatela *et al.*, 1980; Katz *et al.*, in press; Kostić and Katz, submitted); genitive is nearly three times more frequent than dative/locative (0.14 versus 0.05), but response times are the same (Kostić and Katz, submitted): and nominative singulars are only one third more frequent than genitive (0.21 versus 0.14), yet they are responded to significantly faster (Lukatela *et al.*, 1980; Katz *et al.*, in press; Katz and Kostić, submitted). In contrast, all of these data are coherent in the satellite entries model.

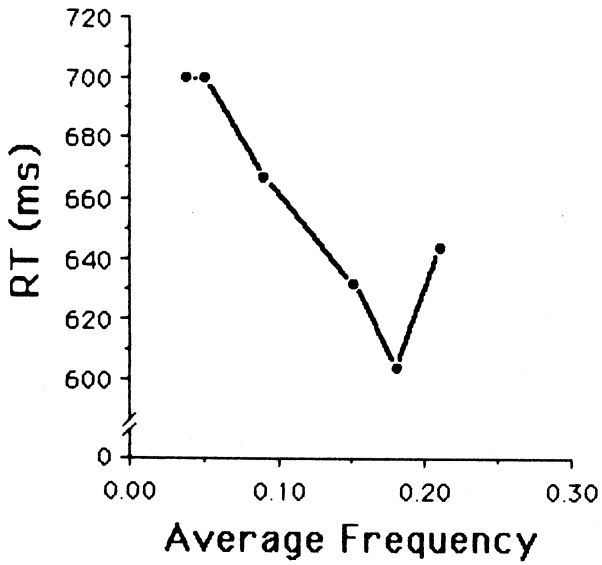

Figure 1. Lexical decision time (in ms) as a function of the average frequency of cases sharing the same spelling.

If spelling rather than grammatical information is the relevant factor, then number of letters or frequency of occurrence should prove significant. Against this spelling hypothesis are the facts that: (1) equal decision times were observed for two spellings of the same length but widely different compound frequencies (e.g., KOSTI versus KOŠĆU); and (2) equal decision times were observed for two spellings where one of them was both longer and less frequent than the other (e.g., FRULI versus FRULOM) (see Table 3). These observations are buttressed by data from a comparison of the genitive (DINARE) with the instrumental (DINAROM) from Lukatela *et al.* (1980). Regardless of how one chooses to calculate frequency

(see above), the genitive is more than six times more frequent than the instrumental. It is also one letter shorter. Yet lexical decision times to nouns in the two cases do not differ. In sum, spelling is not the relevant characterization of the independent variable governing the noun latency data.

As a final alternative, if the number of cases that share a particular spelling is the primary influence on lexical decision latencies to that spelling, then we should expect those spellings comprising, say, two cases (nominative singular/accusative singular of DINAR and KOST, nominative singular/genitive plural of FRULA and NOGA, and dative singular/locative singular of DINAR, FRULA, and NOGA) to be associated with similar decision times. As a corollary, KOSTI ought to be quite different because it is shared by six cases. But as Table 3 shows, all nominative combinations are faster than all dative/locatives and the six case KOSTI is somewhere in the middle (and faster than all of the one case spellings). A similar result can be found in Lukatela *et al.* (1980) where the genitive singular FRULE is also shared with three plural cases. Again, decision latencies to words of four case spellings are greater than some two case spellings and less than other two case spellings. Number of cases in competition for a given spelling, then, does not seem relevant to decision latency.

Two claims can now be made, coordinate with the arguments of Lukatela *et al.* (1980). One is that the nominative singular form of nouns, the lexical citation form, has a privileged status in lexical access and lexical organization. The second is that the grammatical cases of an inflected noun are not stored individually as separate stem and inflectional morphemes.

As suggested in the introduction, the more rapid lexical access of the nominative singular form relative to the oblique forms may be attributed to one of the following: (1) the nominative singular form's lower threshold of activation; (2) the nominative singular form's more anterior location relative to its oblique counterparts in the lexicon conceptualized as a filing cabinet (Forster and Bednall, 1976); or (3) the fact that accessing any oblique form always involves backtracking to the nominative singular form. Evidence from the German language (Gunther, 1983) and language acquisition (Carroll and White, 1973a, b) suggests that, however construed, the advantage of the nominative singular's representation cannot be attributed simply to the frequency with which it occurs in the written language. Rather, it appears that the advantage has more to do with the prominence of, and priority given to, the nominative singular in acquisition and in grammatical function.

We believe that the data present a number of counter arguments to the decomposition hypothesis. The first follows from the preceding remarks about the primacy of the nominative singular. To reiterate, we wish to claim that noun nominative singulars with either full (e.g., KOST) or empty (e.g., FRULA, NOGA) stem morphemes are represented as single units and that these particular unitary representations are more sensitive or more anterior or more pivotal (relative to their oblique counterparts) by virtue of the citation form's privileged role in language acquisition and grammar. Consider, to the contrary, that there are separate visual logogens for stems and affixes (cf. Morton and Patterson, 1980; Job and Sartori, 1984). As an example, suppose that FRULA is parsed into FRUL and -A and that these constituent morphemes then activate two distinct logogens. Because FRUL is shared by all cases, the activation threshold of FRUL cannot be

the basis for the nominative singular's superiority in lexical decision. And because - A is a commonplace inflection (it inflects, among others, all masculine and neuter nouns in the genitive, all neuter nouns in the accusative, some masculine nouns in the accusative, regular feminine nouns in the genitive plural, neuter adjectives in the nominative and accusative plural, and frequently occurring verbs in the present tense), it is unlikely that its activation threshold can be the basis for the nominative singular's superiority either.

Among decomposition models, this leaves only the interconnection between the two visual logogens that is advanced as the means for checking on illegal combinations (Job and Sartori, 1984). If this interconnection is stronger and the check can be made faster for the constituent morphemes of the nominative singular (e.g., FRULA, NOGA) than for the constituent morphemes of the oblique cases, then the superiority of the nominative singular in lexical access would be rationalized. But what would give rise to differences in such interconnections? The most obvious answer is 'frequency of occurrence' but it has already been noted that the nominative singular form is responded to most rapidly even when it is not the most frequent (i.e. when the interconnection between FRUL and -A (the nominative singular) ought to be less strong than that between FRUL and -E (the genitive singular)).

Finally, recall the hypothesis (following Job and Sartori, 1984) that because regular forms are more likely to be decomposed than irregular forms, the errors in lexical decision should be more pronounced for regular forms. The overall low error rate ruled out an ANOVA on errors. Inspection of Table 3, however, suggests an outcome contrary to the foregoing hypothesis: Errors were numerically greater for the irregular forms (e.g., NOZI, KOŠĆU) than for the regular forms (NOGOM, KOSTI).

This outcome is also contrary to the unitary view advocated by the satellite entries perspective. The arguments laid out in the introduction suggested that within the satellite organization the irregular and regular forms of an irregularly declined noun should be responded to with the same speed and accuracy. As indicated in Table 3, however, the average error rate for irregular words (2.5%) is twice that for regular words (1.2%). Table 3 also indicates that this difference derives primarily from nouns that are irregular in the dative/locative case. Inspection of the Appendix reveals that this error rate is inflated by two items in particular, KRUŠCI ('pear') and PUŠCI ('rifle'). These two irregular words happen to be instances in which the irregular forms prescribed by textbook grammar (and employed in the experimental materials) are not identical with the irregular forms in actual everyday usage. An informal test conducted after the experiment revealed a tendency among long-time residents of Belgrade to decline KRUŠKA ('pear') and PUŠKA ('rifle') (see Appendix) in the dative and locative cases as KRUŠKI (/kruʃki/) and PUŠKI (/puʃki/), respectively, rather than as the textbook spellings KRUŠCI (/kruʃtsi/) and PUŠCI (/puʃtsi/). The relatively higher error rates on these particular irregular nouns, therefore, may have had little to do with a basic difference between regular and irregular forms. (This explanation is mitigated somewhat by an incidental observation of Feldman and Turvey (1983). In an experiment designed to assess priming effects between morphologically related words, a few irregular words were included among the stimuli. Longer latencies and more errors were observed for irregular forms and the difference between