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Beyond Orthography and Phonology: Differences between Inflections and Derivations

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The influence of morphological structure was investigated in two types of word recognition tasks with Serbian materials. Morphological structure included both inflectional and derivational formations and comparisons were controlled for word class and the orthographic and phonological similarity of forms. In Experiments 1, 2, and 3, the pattern of facilitation to target decision latencies was examined following morphologically-related primes in a repetition priming task. Although all morphologically related primes facilitated targets relative to an unprimed condition, inflectionally related primes produced significantly greater effects than did derivationally related primes. In Experiments 4, 5, and 6 subjects were required to segment and shift an underlined portion from one word onto a second word and to name the result aloud. The shifted letter sequence was sometimes morphemic (e.g., the equivalent of ER in DRUMMER) and sometimes not (e.g., the equivalent of ER in SUMMER). Morphemic letter sequences were segmented and shifted more rapidly than their nonmorphemic controls when they were inflectional affixes but not when they were derivational affixes. These results indicate that (a) morphological effects cannot be ascribed to orthographic and phonological structure, (b) the constituent morphemic structure of a word contributes to word recognition and (c) morphemic structure is more transparent for inflectional than for derivational formations.

Morphology underlies the productivity of the word-formation process and a word's fit into the syntactic frame of a sentence. Linguists distinguish between two classes of morphological formations. Words that differ in their derivational affixes but share a base morpheme (e.g., CALCULATION, CALCULATOR) are generally considered to be different lexical items and to have different meanings. Words that differ in their inflectional affixes (e.g., CALCULATING, CALCULATED) but share a base morpheme are generally considered to be versions of the same word, with the particular version that appears in a sentence being determined by the syntax of the sentence. In general, inflectional formations are more productive, do not change word class membership relative to the base morpheme and are more constrained by syntax (Anderson, 1982) than are derivational formations. In addition, meanings of inflected forms tend to be compositional of the meaning of the base and affix morphemes whereas meanings of derived forms are less often compositional. The present study examines how inflectional and derivational formations are processed.

Four principles of lexical storage have been proposed for words composed of several morphemes, that is morphologically-complex words. First, a principle of economic storage makes it appealing to represent complex forms in terms of a *base morpheme*. Accounts based on base mor-

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phemes are adequate for inflectional forms (e.g., Caramazza, Laudanna, & Romani, 1988) but are less plausible for derivations, in part, because (a) the formation rules for derivations are complex and there is no way to ascertain whether a particular form has been created and (b) the semantic contribution of the base morpheme to the meaning of the morphologically complex derivational form is unpredictable. Second, accounts based on the *stem* (base morpheme plus derivational affix, if any, e.g., Burani & Laudanna, 1992) posit different representations for inflections and derivations. For example, in a lexical decision task where both items are formed around the same base morpheme, words with a derivational affix produce different patterns of facilitation between items relative to words with only an inflectional affix (Laudanna, Badecker, & Caramazza, 1992). Although it is likely that the lexical representation of inflected and derived forms differs, the relation between the two types of formations is underspecified. Third, morphologically complex words may be represented mentally as *whole forms,* without reference to their constituents (Butterworth, 1983). Fourth, Caramazza and his colleagues have proposed that *both base morpheme and whole word* are units for lexical access, that these alternatives are not mutually exclusive (e.g., Caramazza, Miceli, Silveri, & Laudanna, 1985), and that word frequency may play a key role (Caramazza et al., 1988).

The repetition priming paradigm (Stanners, Neiser, Hernon, & Hall, 1979), yielded evidence that morphological relationships constitute a principle of organization within the internal lexicon. The influence of morphological relatedness is assessed by comparing lexical decision latency or accuracy to the target preceded by a morphological relative to (a) a first presentation of the target word (i.e., no prime) and (b) an identical repetition of the target word. Sometimes the reduction in reaction times and errors that occurs with morphological relatives as primes is equivalent to the effect of an identical repetition (e.g., Fowler, Napps, & Feldman, 1985). Other times, decision latencies to targets following morphological relatives are reduced relative to first presentations but are slower than identical repetitions. The latter pattern is ambiguous. It has been interpreted as evidence of separate lexical entries (e.g., Stanners et al., 1979) and as evidence of interrelated entries (e.g., Fowler et al., 1985).

Facilitation due to morphological relatedness occurs in the lexical decision task across a variety of languages including Serbian (Feldman & Fowler, 1987) and Hebrew (Bentin & Feldman, 1990), as well as English (Fowler et al., 1985; Feldman, 1992) and American Sign Language (Hanson & Feldman, 1989) and across a variety of conditions. Facilitation in repetition priming has been observed when prime and target are in either the same or different modalities (Fowler et al., 1985; see also Kirsner, Milech, & Standen, 1983). Primes can be morphologically complex and targets can be morphologically simple or primes can be simple and targets complex (Feldman & Fowler, 1987; Schriefers, Friederici & Graetz, 1992). The latter observation is significant because morphologically simple forms tend to be higher in frequency than morphologically complex forms. For complex targets, both derived and inflected formations show effects based on morphological relatedness (Fowler et al., 1985; Schriefers et al., 1992).

Several studies have tried to compare patterns of facilitation at long or at short lags for prime-target pairs related by inflection and by derivation. Differences in facilitation (ms) for targets following morphologically related and unrelated primes are summarized in Table 1. As shown there, inflectional primes typically produce greater facilitation than derivational primes but the difference is often not statistically significant. For example, the words POTARONO and POTETE are related by inflection and the words POTATORE and

TABLE 1
COMPARISON OF FACILITATION FOR INFLECTIONAL AND DERIVATIONAL TARGETS FOLLOWING IDENTITY, INFLECTIONAL, AND DERIVATIONAL PRIMES IN IMMEDIATE AND LONG-TERM PRIMING TASKS

Type of prime				
Identity	Inflectional	Derivational[1]	Derivational[2]	Interval
Study				
Stanners et al. (1979) Exp. 1[a]				Long
166	181			
160	150			
140	131			
Stanners et al. (1979) Exp. 2[b]				Long
84	49			
99	39			
Stanners et al. (1979) Exp. 3[c]				Long
120		72		
118		32		
Fowler et al. (1985)[d]				Long
101	78			
42		47		
Feldman & Fowler (1987) Exp. 1[e]				Long
54	45			
Feldman & Fowler (1987) Exp. 2[f]				Long
90	74			
Feldman & Fowler (1987) Exp. 3[g]				Long
58	50			
Feldman & Bentin (in press) Exp. 1[h]				Long
68	60	59		
Schriefers, Friederici, & Graetz (1992) Exp. 2[i]				Long
108	99	50		
90		26	44	
Laudanna, Badecker, & Caramazza (1992) Exp. 1[j]				Immediate
	26	35		

[a] Simple regular targets and inflected primes, e.g., BURNS–BURN.
[b] Simple regular targets and irregular inflected primes, e.g., HUNG–HANG.
[c] Simple regular targets and regular derived primes, e.g., SELECTIVE–SELECT.
[d] Simple targets with sound change primes, e.g., HEALTH–HEAL.
[e] Simple targets with regular inflected primes, e.g., DINARA–DINAR.
[f] Inflected targets with simple and inflected primes, e.g., DINAR(OM)–DINARA.
[g] Simple targets with inflected sound change targets e.g., PETKU/PETKOM–PETAK.
[h] Complex targets with complex primes, e.g. NAFAL/NEFEL–NOFEL.
[i] Simple and complex targets with simple and complex primes, e.g., ROTE/ROTLICH–ROT.
[j] Complex targets and primes, e.g., RAPIVANO/RAPITORE–RAPIRE.

POTETE are related by derivation. In a lexical decision task, both pairs produced faster latencies than unrelated pairs (Laudanna et al., 1992; Exp. 1). In these experiments, morphological relationship was defined on a single lexical item in Italian. Similarly, SPARIZIONE, meaning *disappearance,* is defined as a derivation whereas SPARIVANO, meaning *they disappeared,* is defined as an inflection. Only the latter slowed recognition of (morphologically-unrelated) SPARATI which is the past participle of *shot* and is formed from a different but homographic base morpheme (Laudanna et al., 1992; Exp. 3). In a repetition priming task with German materials (Schriefers et al., 1992), inflectional primes consisting of different inflected adjective forms produced greater facilitation than derivational primes consisting of abstract

nouns formed from adjectives. Finally, in Hebrew (Feldman & Bentin, in press), morphological relationship was defined over the word pair because it is not always obvious which item is derived from which but no differences between inflections and derivations were observed in the repetition priming task. In short, the pattern of results observed with various priming procedures indicates that differences between inflectional and derivational facilitation have appeared but that they are often not reliably significant in separate comparisons.

The repetition priming results summarized above clearly demonstrate that under some conditions, morphological effects do arise in word recognition tasks. However, contrasts between the effects of inflections and derivations have not been compelling. Some of the experiments included both inflectional and derivational forms but they did not explicitly compare these types of morphological formations. When planned comparisons between inflectionally and derivationally related prime-target pairs have been included, results have been equivocal. For example, whereas Stanners et al. (1979) reported significant differences in magnitude of facilitation for these two types of formations when they were regular only, Fowler et al. (1985) found no significant difference although small numerical differences typically were evident. Although these experiments with English materials included a comparison of facilitation with inflectional and derivational primes, this comparison is not without its problems. In English, inflectional formations tend to be more similar in form and meaning than are derivational formations (or alternatively, forms related by inflection share a stem as well as a base morpheme whereas forms related by derivation typically share only a stem). This observation is relevant because at short lags, orthographic overlap is sometimes reported to influence the pattern of facilitation in this and similar tasks (Emmorey, 1989; Napps & Fowler, 1987; Stolz & Feldman, in press). Moreover, the number of inflectional affixes for English is severely limited relative to the number of derivational affixes. These limitations impede a rigorous experimental comparison between inflectional and derivational formations with English materials.

By contrast, in Serbian it is possible to identify inflection-derivation pairs with only minimal differences in form and meaning. One such contrast entails agents and other nouns formed from verbs. For example, PEVAČ, meaning *singer,* is formed from the verbal base morpheme PEV and the derivational affix AČ. The same base morpheme appears in all present tense forms of the verb *to sing* including PEVA and PEVAM. Other sets of inflection-derivation pairs entail verb forms that share a base morpheme but differ in aspect (which reflects temporal properties of the verb). Perfective and imperfective aspect can be marked by the vowel of the suffix, by a prefix or by an infix. Although it is sometimes difficult to ascertain which is the derived form, it is well established that perfective and imperfective verbs in Serbian are derivationally related to each other. (Therefore, in the present study, derivation will be defined relative to a target.) Of course, each can be inflected to produce different verb forms. For both agent and aspect type of derivations, it is possible to identify inflectional forms with the same base morpheme so that the orthographic and phonemic overlap of primes with targets is matched across derivational and inflectional comparisons.

The first three of the present experiments were repetition priming experiments in which native speakers of Serbian performed a lexical decision task with Serbian materials. Targets were preceded by other forms that were either inflectionally or derivationally related to the target. Inflectional and derivational formations were matched for phonological and orthographic overlap with the target. In Experiment 1, targets such as PEVA (third person singular verb) were preceded an average of ten items ear-

lier in the list by (a) an identical repetition, PEVA (b) the inflectionally-related prime, PEVAM (first person singular verb) or (c) the derivationally related prime, PEVAČ (nominative singular of agentive). Inflectional and derivational primes were matched with respect to orthographic and phonological similarity to the target but derivational forms did not preserve the word class of the target. In Experiment 2, prefixed or infixed imperfective verb targets in third person plural such as OBARE and GURNU were preceded by (a) an identical repetition, (b) an inflectionally related prime, OBARIM or GURNEM (first person singular verbs), or (c) a derivationally related prime, BARIM or GURAM (first person singular verbs) that differed in aspect. In Experiment 3, perfective targets such as NOSE (third person plural verbs) were preceded by (a) an identical repetition, (b) an inflectionally related prime, NOSIM (first person singular verbs) or (c) a derivationally related prime, NOSAM (imperfective first person singular verbs) where the last differed in aspect. Here, all primes and targets were verb forms and prime-target similarity was matched across one half of the inflectional and derivational primes. Using planned comparisons, target facilitation in lexical decision following inflectionally related primes and derivationally-related primes was compared and facilitation following derivationally related primes relative to first presentations was assessed.

In order to ascertain that the morphological effects observed in repetition priming were not specific to the lexical decision task, the effect of morphology was also investigated in a second experimental task. In Experiments 4, 5, and 6, subjects were required to segment and shift the final sequence of letters from a visually-presented source word to a target word and to name the new form aloud. Morphemic segments were compared with their phonemically and orthographically matched but nonmorphemic controls and both inflectional and derivational segments were examined. The structure of experimental materials for the present study is described in Table 2.

Experiment 1

By linguistic accounts, the component structure of inflections is more transparent than that of derivations. The repetition priming task has proven itself to be sensitive to morphological relations between prime and target, but attempts to compare the patterns of facilitation in repetition priming for inflectionally and derivationally related prime-targets pairs have not yielded unambiguous results. This outcome may reflect the fact that in English, derivational affixes tend to be composed of more letters and to be semantically less compositional than are inflectional affixes. Experiment 1 was designed to compare these two types of morphological formations when effects of affix length are matched. In Serbian, it is easier to meet these constraints than in English because extensive families of words are formed from the same base morpheme.

Methods

Subjects. Twenty-seven first-year students from the Department of Psychology at the University of Belgrade participated in Experiment 1. All were native speakers of Serbian. All had vision that was normal or corrected to normal and had prior experience in reaction-time studies.

Stimulus materials. Twenty-seven Serbian word triples were selected. Fourteen consisted of a noun target in nominative case with an inflectionally related form in instrumental case and a derivationally related verb form. For example, the nominative target BROD, meaning *boat,* was paired with its instrumental BRODU and with BRODI, the third person singular of the verb meaning *to sail* which is derivationally related to BROD, the target. The remaining thirteen triples consisted of verb targets in one of three singular person forms with another inflected form of that same verb and with the agentive derived

TABLE 2
THE MORPHOLOGICAL CONSTITUENTS OF MORPHOLOGICALLY SIMPLE AND COMPLEX WORDS IN SERBIAN

	Stem			
Word	Base	Suffix: Derivation	Suffix: Inflection	Meaning
PEVAM	PEV		AM	I sing
PEVAČ	PEV	AČ		Singer
NOSIM	NOS		IM	I carry (per)
NOSAM	NOS		AM	I carry (imper)
PRESOM	PRES		OM	Press (instru)
PRELOM	PRELOM			Fracture
CEVI	CEV		I	Pipes (nom plur)
CEDI	CED		I	He wrings
JEDEM	JED		EM	I eat
BEDEM	BEDEM			Embankment
ZIDAR	ZID	AR		Brick layer
KADAR	KADAR			Sequence
BAJAM	BAJ	AM		I do magic
SAJAM	SAJAM			Fair
BAŠTICA	BAŠT	ICA		Garden (dimin.)
KOŠTICA	KOŠTICA			Pit

from that verb. For example, the target PEVA, meaning *he sings,* was paired with PEVAM, meaning *I sing,* and PEVAČ meaning *singer.* All words were highly familiar and contained between three and seven letters and all were printed in Roman script. They are listed in the Appendix. Twenty-seven orthographically and phonemically regular pseudowords were generated by changing one or two letters (vowel with vowel or consonant with consonant) in bases of other real words. Triplets were generated for these pseudowords in a fashion analogous to that for words (i.e., affixes were real).

A member of each morphologically related word (and pseudoword) triple appeared once as a target and once as a prime. In the identity condition, the same form occurred twice. In the inflectionally related condition, the prime was another inflected form of the target and it necessarily preserved word class. In the derivationally related condition, the prime was a verbal form for noun targets and a noun form for verb targets. Inflectionally and derivationally related primes were each one or two letters longer than the target and within a pair, that overlap was perfectly matched phonemically as well as orthographically. Finally, the full target was contained within the inflectionally and derivationally related primes. For example, both BRODI and BRODU are each one letter longer than and include the target BROD. Primes and targets were separated by an average of 10 intervening items with a range of 8 to 12 items.

Procedure. Individually tested subjects performed a lexical decision task. On each trial, a visual fixation signal accompanied by an auditory signal appeared for 200 ms, then a target letter string printed in uppercase was presented for 750 ms. As each target letter string appeared on the CRT of an Apple II computer, the subject pressed a telegraph key with both hands to indicate whether or not it was a word. A press of the farther key signaled "yes" and the closer key, "no." Reaction time was measured

from the onset of the letter string. The interval between subject's response and the onset of the next experimental trial was 2000 ms.

Design. For Experiment 1, three test orders each containing 114 items were created. Half of the items were words and half pseudowords. Fifty-four items were primes and 54 items were targets. Words and pseudowords were presented equally often as primes and as targets. In addition, there were six filler items introduced to maintain the requisite lags. Each test order included nine tokens of each of the three types of primes (viz., identity, inflectional, derivational) and across test orders, each target was preceded by all three types of prime. Subjects were randomly assigned to one of the three test orders and a practice list of ten items preceded each experimental list.

Results and Discussion

Errors and extreme response times (greater than 2 *SD* or less than −2 *SD* from each subject's mean) were eliminated from all reaction time analyses. Accordingly, about 4% of all responses were eliminated. Table 3 summarizes the mean recognition times over subjects for target words and pseudowords preceded by identity, inflectional and derivational primes and for the first presentation of those same words as a prime.

Analyses of variance were performed on target latencies for words and pseudowords using subjects ($F1$) and items ($F2$) as random variables. The analysis included the first presentation of the target as the no prime condition, targets preceded by themselves as the identity condition, targets preceded by an inflected form and targets preceded by a derived form. For words, there was a significant effect of type of prime on target latencies [$F1(3,78) = 15.66$ $MS_e = 641$, $p < .001$; $F2(3,78) = 8.13$, $MS_e = 1597$, $p < .001$] but the effect of prime with the error measure missed significance [$F1(3,78) = 2.66$, $MS_e = 46$, $p < .054$; $F2(3,78) = 0.88$]. The results of planned comparisons on decision latencies indicated that facilitation from derivationally-related primes was significantly weaker than facilitation from inflectionally related primes [$F1(1,26) = 6.58$, $MS_e = 383$, $p < .016$; $F2(1,26) = 3.1$, $MS_e = 4950$, $p < .08$] and significantly different from the no prime condition [$F1(1,26) = 6.14$, $MS_e = 804$, $p < .02$; $F2(1,26) = 4.05$, $MS_e = 6468$, $p < .05$]. Target latencies following derivational primes tend to be slower than target latencies following inflectional primes. For pseudoword targets, the effect of type of prime was significant for neither reaction times nor errors.

Facilitation was assessed by examining differences in latencies (and errors) to targets preceded by a prime and to first pre-

TABLE 3

MEAN LEXICAL DECISION LATENCIES (AND ERRORS) FOR TARGETS ON THEIR FIRST PRESENTATION, OR WHEN PRECEDED BY IDENTITY, INFLECTIONALLY AND DERIVATIONALLY RELATED PRIMES IN EXPERIMENT 1

	Type of prime			
	None	Identity	Inflectional	Derivational
	PEVA	PEVA PEVA	PEVAM PEVA	PEVAČ PEVA
	RT ERR	RT ERR	RT ERR	RT ERR
Words				
	569 (8)	524 (8)	536 (9)	550 (12)
Facilitation		45 (0)	33 (−1)	19 (−4)
Pseudowords				
	664 (8)	666 (8)	663 (9)	644 (7)
Facilitation		−2 (0)	1 (−1)	20 (1)

sentations of targets. Consequently, prime presentations necessarily occurred earlier in the list than did targets. Because there is evidence that latencies get faster as subjects proceed through the list, and because facilitation following derivations tended to be weak relative to facilitation following inflections, it is important to determine whether or not facilitation from derivations was correlated with serial position of the prime. In Experiment 1, the correlation between serial position of the prime and the difference between latencies for first presentations and latencies following derivational primes was $r = -.048$. Therefore, the magnitude of facilitation was not distorted by the no prime baseline. Note, however, that any potential baseline problem is not relevant when comparing facilitation following inflectional and derivational primes because position of the target (and the target item) were identical.

The present experiment with Serbian materials replicates previous findings in the same language (Feldman & Moskovljević, 1987; Feldman & Fowler, 1987) as well as other languages (Fowler et al., 1985; Bentin & Feldman, 1990). Specifically, relative to a no prime condition, morphologically related word forms facilitated each other at lags that average 10 intervening items but pseudoword analogs did not. In summary, facilitation was observed in the pattern of target latencies for all types of morphologically related primes and the amount of facilitation varied by type of prime. It is interesting to note that although identity and inflectional primes tended to yield statistically equivalent facilitation in earlier studies (e.g., Feldman & Fowler, 1987), under some circumstances derivations have been observed to produce facilitation that was significantly reduced relative to the identity condition (Feldman & Moskovljević, 1987; Exp. 2; Schriefers et al., 1992). Nevertheless, no published experiment with Serbian materials included, or even permitted, a direct comparison between inflectional and derivational types of primes.

The present study extends previous repetition priming results in Serbian by contrasting two types of morphological formations while tightly controlling their similarity. With phonemic and orthographic overlap equated between inflectionally and derivationally related prime forms, there was evidence of enhanced facilitation for targets following inflectionally related primes relative to derivationally related primes. This distinction can be represented in the lexicon. Perhaps the linkage between whole word forms that share a base morpheme is stronger (or the internal coherence of their constituents is weaker) for inflectionally related forms than for derivationally related forms.

Unfortunately, the composition of experimental materials in the present experiment is consistent with another account. In Experiment 1, all derivational formations differed in word class from their morphologically related target whereas all inflectional formations (necessarily) preserved word class. Specifically, translations of agentives such as *singer* primed verb targets such as *he sings* and verb forms such as *he sails* primed derived noun targets such as *boat*. While such changes are, in fact, characteristic of derivational processes in all languages, they make an unequivocal interpretation of the contrast between inflectional and derivational pairs more difficult. It is important to note that although, in the repetition priming task, no effects of semantic similarity have been reported with visually presented relatives and lags of 10 items (Bentin & Feldman, 1990; Napps, 1989) or with auditorily presented materials presented successively (Emmorey, 1989; but see Radeau, 1983; Slowiaczek, in press), it is nevertheless possible that derivations are semantically more distinct from their targets than are inflections and that semantic similarity can, under some circumstances, contribute to the pattern of facilitation. Accordingly, Experiment 2 entailed a comparison of the pattern of facilitation with Serbian inflections and derivations that (a) consistently preserved word class, (b) were semantically quite close in meaning, and (c)

were constructed with attention to their orthographic similarity to the target.

Experiment 2

Inflectional affixes tend to alter the meaning of the base morpheme in predictable ways (Aronoff, 1976) whereas the effect of derivational affixes is less consistent. Consequently, inflectional formations tend to be similar in form and meaning to other forms that share a base morpheme (and stem) and differ with respect to inflectional affix whereas derivational formations tend to differ in form and meaning from other forms that share a base morpheme and differ with respect to derivational affixes (and stem). In Serbian it is possible to identify inflection-derivation pairs with only minimal differences in meaning and form. One such contrast entails verbs that differ with respect to aspect. Generally stated, aspect reflects the temporal properties of the verb. These include inceptive forms of stative verbs and iterative forms of verbs that describe discrete events.

All the experimental materials for Experiment 2 were verb forms. Targets were preceded by identity, inflectionally or derivationally related primes. Inflected primes were other forms of the same verbs that differed in person. Derived primes were forms of lexically-distinct verbs composed from the same base morpheme that differed in aspect and person from the target word. The manipulation on derivation alternated perfective and imperfective forms. Semantically, this distinction is relatively minor entailing contrasts between semantic notions such as completed and progressive actions in HE SAT DOWN and HE WAS SITTING or between events and states such as HE RECOGNIZES and HE KNOWS. [Note that progressivity is grammaticalized in English whereas stativity is lexicalized (Lyons, 1977).] It is important to underscore, however, that in Serbian, unlike English, the perfective and imperfective forms of the verbs included in the present study are considered distinct lexical entries.

It is relevant to note that there is no consensus about the morphological status of aspectual formations either across languages or across theorists (compare Anderson, 1982 with Bybee, 1985). In the present study, it is assumed that aspect is a derivational process. It is restricted by its meaning to a particular semantic class of Serbian verbs (Partridge, 1964, in Bybee, 1985). Moreover, it was also always the case that two distinct verbal entries existed in the dictionary. Note however, that these formations do not change word class as is typical of derivational formations. In Experiment 2, aspect was marked by the addition of either a prefix or an infix to the base morpheme. Consequently, forms related by inflection shared both a base morpheme and a stem (base morpheme plus derivational affix) whereas forms related by derivation shared a base morpheme but differed with respect to stem. For example, the words OBARIM and BARIM are both formed from the base BAR and the inflectional affix IM. They differ with respect to the presence of a prefix. The prefix is part of the stem. Accordingly, the stems are OBAR and BAR, respectively.

The outcome of Experiment 1 indicated that with controls for orthographic overlap, the lexical representation of morphological relatedness by inflection and derivation differed. If this outcome reflects type of morphological relation as distinguished from effects of preserving or altering word class, then consistent with the results of Experiment 1, in Experiment 2 facilitation from primes that are inflectionally related to their targets should be greater than from primes that are derivationally related. Of course, the absence of a difference is ambiguous. It could indicate that the effect observed in Experiment 1 does reflect changes in word class between prime and target. Alternatively, it could indicate that aspect in Serbian is not a derivational relationship but rather, a less general inflectional relationship.

If, as sometimes claimed (e.g., Taft & Forster, 1975; Bergman, Hudson & Eling,

1988), prefixes but not other affixes are stripped from the base before lexical access is attempted, then the pattern for prefixed primes should differ from that of infixed primes. Alternatively, if activation in repetition priming is based on the stem (base plus derivational affix) rather than the base alone as sometimes claimed (Burani & Laudanna, 1992) then infixed forms should show a pattern similar to that of prefixed forms. Because inflections shared both base and stem whereas derivations shared a base morpheme only, derivations should produce weaker facilitation than inflections whenever the stem and base morpheme differ.

In summary, as in Experiment 1, patterns of facilitation for primes related by inflection and by derivation are examined in Experiment 2. Both inflectional and derivational primes always included the full base morpheme and their inflectional affixes were matched for letter length. In contrast to Experiment 1, in which orthographic and phonological overlap was perfectly matched but word class differed between derivational but not inflectional primes, in Experiment 2, the presence of a prefix or an infix rendered inflectional primes more similar to their targets than derivational primes (that included no affix) but all were verb forms.

Methods

Subjects. Thirty-six first year students similar in characteristics to those of Experiment 1, participated in Experiment 2. None had participated in Experiment 1.

Stimulus materials. Forty-eight Serbian word triples were selected. Each included three verb forms: a target verb, a prime that was inflectionally related and a prime that was derivationally related to the target. Targets consisted of present-tense verb forms in the third person plural. Each was composed of a base morpheme and an aspectual affix. Inflected forms were first person singular of those same verbs. Derived forms were first person singular of different verbs formed from the same base morpheme without an aspectual affix. (These forms are designated as derived because they are related by derivation to the target.) Inflectional and derivational primes were always presented in the same person and number. Items are listed in the Appendix.

Typically, the target and inflected prime were imperfective forms and the derived prime was perfective. They were all formed from the same base morpheme but, because of the addition of an affix, they differed with respect to their stems. Derivation was defined relative to the target rather than on an isolated word. Structurally, all members of a triple were composed of the same base morpheme but differed with respect to the presence of an affix, either prefix or infix. For example, perfective forms of the base morpheme BAR, meaning *cook,* included BARIM, BARIŠ, BARI . . . BARE, whereas imperfective forms such as OBARIM, OBARIŠ, OBARI . . . BARE include the prefix O. Other than the prefix or infix, the orthographic and phonemic overlap of primes and their morphologically related targets was perfectly controlled by selecting third person plural forms ending in E as targets and necessarily as identity primes (e.g., OBARE), forms ending in IM (e.g., OBARIM) as inflectionally related primes and verbs differing in aspect (e.g., BARIM) as the derivationally related primes. Perfective forms of the base morpheme GUR, meaning *push,* include GURAM, GURAŠ, GURA . . . GURAJU whereas imperfective forms such as GURNEM, GURNEŠ, GURNE . . . GURNU include the infix N. For infixed relatives, targets and identity primes ending in U (e.g., GURNU), inflectional primes ending in EM (e.g., GURNEM) and derivational primes ending in AM (e.g., GURAM) were presented where inflectional and derivational primes were always in the same person and number. In summary, the orthographic and phonological similarity of both inflectional and derivational primes was matched to the target so that both included the full base mor-

pheme although due to the prefix or infix, overall overlap for inflectional forms was slightly greater than that for derivational forms.

Pseudoword triples were created by substituting vowels or consonants within other base morphemes in order to create meaningless bases that were orthographically legal. To these, real inflected affixes were appended in order to create sets of pseudowords that differed only with respect to affix. The distribution of pseudoword affixes was matched to those for words. Pseudoword targets were preceded by identity, inflectionally (or derivationally) related pseudoword primes or by a real word prime. The value in including a word prime with a pseudoword target was to examine whether facilitation in repetition priming extends to strings without lexical status.

Three test orders were created. Each contained 200 items and included equal numbers of word and pseudoword targets preceded an average of ten items earlier in the list by a morphologically-related prime. In each test order, eight tokens for each of the three types of prime were presented. Across the three test orders, each word or pseudoword target was preceded by all three types of morphologically related primes. In contrast to previous repetition priming studies, here pseudoword targets were preceded 33% of the time by a word prime formed from the same base morpheme.

Procedure. The procedure was identical to that of Experiment 1.

Results and Discussion

Mean decision latencies (for responses less than 2 *SD* or greater than −2 *SD* from each subject's mean) and error rates in Experiment 2 are summarized in Table 3. Errors and outliers accounted for approximately 6% of all responses. An analysis of lexical decision latencies for words revealed a significant effect of type of prime [$F1(3,105) = 45.06$, $MS_e = 1726$, $p < .001$; $F2(3,138) = 27.73$, $MS_e = 2865$, $p < .0001$]. Effects of affix type were significant [$F1(1,35) = 46.51$, $MS_e = 1321$, $p < .001$; $F2(1,46) = 5.42$, $MS_e = 12712$, $p < .02$]. The interaction of type and overlap was significant in the subjects but not in the items analysis [$F1(3,105) = 4.59$, $MS_e = 2101$, $p < .005$]. Planned comparisons indicated that inflectional primes produced faster target latencies than did derivational primes both for prefixed targets [$F1(1,35) = 4.61$, $MS_e = 2596$, $p < .04$; $F2(1,23) = 3.88$, $MS_e = 12096$, $p < .053$] and for infixed targets, [$F1(1,35) = 8.79$, $MS_e = 1759$, $p < .005$; $F2(1,23) = 6.79$, $MS_e = 17749$, $p < .01$]. Target latencies following derivational primes were significantly faster than first presentations latencies in the prefixed [$F1(1,35) = 16.23$, $MS_e = 2660$, $p < .001$; $F2(1,23) = 11.26$, $MS_e = 35101$, $p < .001$] but not in the infixed condition [$F1(1,35) = 1.96$, $MS_e = 2883$, $p < .17$; $F2(1,23) = 4.74$, $MS_e = 12384$, $p < .03$]. Correlations between serial position of the prime and the magnitude of facilitation for targets (following derivational primes relative to the no prime condition) were not significant $r = -.154$, therefore it is unlikely that the magnitude of facilitation was significantly overestimated by the no prime baseline.

The analysis of error scores revealed a significant effect of type of prime [$F1(3,105) = 17.01$, $MS_e = 85$, $p < .001$; $F2(3,138) = 5.84$, $MS_e = 1.8$, $p < .001$]. Effects of affix type were significant in the subjects analysis only [$F1(1,35) = 32.89$, $MS_e = 79$, $p < .001$; $F2(1,46) = 2.99$, $MS_e = 8.2$, $p < .09$]. The interaction of type and overlap was significant in the analysis by subjects only [$F1(3,105) = 3.30$, $MS_e = 85$, $p < .023$; $F2(3,138) = 1.45$, $MS_e = 1.8$, $p < .23$]. Mean decision latencies and errors for pseudowords are included in Table 4. They indicate no effect of lexical status of the prime on pseudoword target latencies.

The magnitude of facilitation was significantly greater for prime-target pairs related by inflection than for pairs related by derivation. Thus, facilitation in repetition priming was once again sensitive to type of mor-

TABLE 4
MEAN LEXICAL DECISION LATENCIES (AND ERRORS) FOR TARGETS ON THEIR FIRST PRESENTATION, OR WHEN PRECEDED BY IDENTITY, INFLECTIONALLY AND DERIVATIONALLY RELATED PRIMES IN EXPERIMENT 2

	Type of prime							
	None		Identity		Inflectional		Derivational	
Prefixed words								
	OBARE		OBARE OBARE		OBARIM OBARE		BARIM OBARE	
	RT	ERR	RT	ERR	RT	ERR	RT	ERR
	675	(9)	573	(4)	600	(5)	626	(8)
Facilitation			102	(5)	75	(4)	49	(1)
Infixed words								
	GURNU		GURNU GURNU		GURNEM GURNU		GURAM GURNU	
	675	(21)	629	(8)	628	(7)	658	(14)
Facilitation			46	(13)	47	(14)	17	(7)
Pseudowords								
	678	(7)	672	(5)	668	(6)	665	(6)
Facilitation			6	(2)	10	(1)	13	(1)

phological relation when word class and formal properties of the affixes were controlled. Assuming an appropriate baseline, derivational primes produced significant facilitation relative to the no prime condition for prefixes although not (statistically) for infixes. More importantly, derivational primes produced significantly reduced facilitation relative to the inflectional primes. The present results replicate the general pattern of morphological relatedness in the repetition priming task including the different patterns of facilitation following inflectional and derivational primes that was observed in Experiment 1.

EXPERIMENT 3

The natural confound between inflections and derivations noted above was eliminated in the third experiment. Specifically, forms related by inflection tend to be more similar in terms of orthography and phonology than forms related by derivation. This is because derived forms share a base morpheme but differ with respect to derivational affix and therefore stem whereas inflected forms share both their base morpheme and their stem. The materials for Experiment 3 consisted of another set of verbs related by aspect. In each instance, two entries were formed around the same base morpheme; however, they differed with respect to the set of inflectional affixes each required. That is, many items shared both their base morpheme and their stem and they differed only with respect to their thematic vowel (Scalise, 1984). If differences between facilitation by inflection and derivation are observed with the materials of Experiment 3, they cannot be attributed to orthographic overlap or to repetition of the base morpheme but not the stem.

Methods

Subjects. Thirty-six first year students similar in characteristics to those of the first two experiments participated in Experiment 3. None had participated in Experiments 1 or 2.

Stimulus materials. Twenty-six word triples in Serbian were selected. Each included three verb forms: a target verb, a prime that was inflectionally related and a prime that was derivationally related to the target. Targets consisted of present tense verb forms in the first or third person plu-

ral. Inflected forms were first person singular of those same verbs. Derived forms were first person singular of different verbs formed from the same base morpheme that differed in the temporal qualities of the action they conveyed. Inflectional and derivational primes were always presented in the same person and number. Items are listed in the Appendix.

The orthographic and phonemic overlap of primes and their morphologically-related targets was carefully controlled and two patterns were included. Structurally, all members of a triple in the *matched* pattern were verbs constructed from the same base morpheme and stem but they differed with respect to the (thematic) vowel around which the inflectional affix was formed. For example, in one pattern, perfective forms of the base morpheme NOS, meaning *carry* are generally formed around the vowel I such as NOSIM, NOSIŠ, NOSI . . . (but) NOSE whereas imperfective forms are generally formed around A such as NOSAM, NOSAŠ, NOSA . . . NOSAJU. Forms ending in E served as targets and necessarily as identity primes (e.g., NOSE), forms ending in IM or EM (e.g., NOSIM) served as inflectionally related primes and verbs differing in aspect (e.g., NOSAM) served as the derivationally related primes. Thirteen such pairs were selected. Thirteen pairs followed a second *unmatched* pattern in which the inflectionally related prime overlapped by one or two letters more than did the derivationally related prime. For example, forms ending in AMO (e.g., NAZIVAMO) served as targets and as identity primes, forms ending in AM (e.g., NAZIVAM) served as inflectional primes and forms ending in EM (e.g., NAZOVEM) served as derivational primes. Note that for these triples, inflectional primes preserved both the I and A vowels of the target whereas the derivational primes did not.

Pseudoword triples were created by substituting vowels or consonants within other base morphemes in order to create meaningless bases that were orthographically legal. To these, real inflected affixes were appended in order to create sets of pseudowords that differed only with respect to affix. As with words, pseudoword targets were preceded by identity, inflected and derivationally related primes. Inflected and derived forms consisted of a nonsense base morpheme with a legal affix. The distribution of pseudoword affixes was matched to those for words.

In summary, as in Experiments 1 and 2, both inflectional and derivational primes always included the full base form and their affixes were matched for letter length. In contrast to Experiment 1, in which orthographic and phonological overlap was perfectly matched but word class differed between prime and target, derivational as well as inflectional primes in Experiments 2 and 3 preserved word class of the target. In contrast to Experiment 2, in which orthographic and phonological overlap between inflectional and derivations primes was not perfectly matched, in Experiment 3 matched and mismatched overlap was systematically manipulated. In the condition in which orthographic and phonological overlap were mismatched, inflectional primes were more similar to their targets than were derivational primes because the inflectional primes (i.e., those ending in AM) preserved the vowels of the target form whereas none of the derivational primes did. In the condition in which orthographic and phonological overlap were matched, inflectional and derivational primes were equally similar to their targets.

Three test orders were created. Each contained 114 items and included equal numbers of word and pseudoword targets preceded an average of ten items earlier in the list by a morphologically related prime. In each test order, four or five tokens of each of the three types of matched and unmatched primes were presented. Across the three test orders, each word or pseudoword was preceded by all three types of morphologically related primes.

Procedure. The procedures were identical to those of Experiments 1 and 2.

Results and Discussion

Mean decision latencies (for responses less than 2 *SD* greater than −2 *SD* from each subject's mean) and error rates in Experiment 3 are summarized in Table 5. Accordingly, approximately 5% of responses were eliminated. An analysis of lexical decision latencies for words revealed a significant effect of type of prime [$F1(3,105) = 23.40$, $MS_e = 2598$, $p < .001$; $F2(3,72) = 11.17$, $MS_e = 2396$, $p < .0001$]. Effects of orthographic and phonological overlap (match) were significant in the analysis by subjects [$F1(1,35) = 21.14$, $MS_e = 3607$, $p < .001$] but not in the analysis by items [$F2(1,24) = 2.54$, $MS_e = 86181$, $p < .12$]. Importantly, the interaction of type and match did not approach significance in either analysis. Nevertheless, comparisons between inflections and derivations were examined separately for matched and mismatched items. Target latencies following orthographically-matched inflectional primes were faster than target latencies following derivational primes [$F1(1,35) = 6.26$, $MS_e = 2197$, $p < .014$; $F2(1,12) = 4.73$, $MS_e = 1150$, $p < .05$]. However this pattern missed significance for mismatched primes [$F1(1,35) = 2.06$, $MS_e = 2197$, $p < .15$; $F2(1,12) = 1.23$]. Finally, latencies for targets following derivational primes were significantly faster than for first presentations when overlap was mismatched [$F1(1,105) = 28.58$, $MS_e = 2197$, $p < .001$; $F2(1,12) = 8.81$, $MS_e = 2814$, $p < .01$] and in the subjects analysis, when overlap was matched [$F1(1,105) = 6.97$, $MS_e = 2197$, $p < .01$; $F2(1,12) = 1.62$, $MS_e = 4240$, $p < .23$]. The correlation between serial position of the prime and magnitude of facilitation for targets following derivational primes relative to the no prime condition was positive and nonsignificant, $r = .11$. In conjunction with previous experiments, this finding supports the appropriateness of the no prime baseline.

The analysis of error scores revealed a significant effect of type of prime [$F1(3,105) = 4.60$, $MS_e = 78$, $p < .005$; $F2(3,75) = 3.74$, $MS_e = .61$, $p < .02$]. For pseudowords, neither decision latencies nor accuracy revealed an effect of prime. Mean decision latencies and errors for pseudowords are included in Table 5.

The pattern of target latencies indicated that identical repetition and inflectional primes both produced significant and

TABLE 5

MEAN DECISION AND NAMING LATENCIES (AND ERRORS) FOR TARGETS ON THEIR FIRST PRESENTATION, PRECEDED BY IDENTITY, INFLECTIONALLY AND DERIVATIONALLY RELATED PRIMES IN EXPERIMENT 3

	Type of prime							
	None		Identity		Inflectional		Derivational	
	NOSE		NOSE		NOSIM		NOSAM	
			NOSE		NOSE		NOSE	
	RT	ERR	RT	ERR	RT	ERR	RT	ERR
Matched words								
	630	(10)	577	(2)	573	(3)	600	(4)
Facilitation			53	(8)	57	(7)	30	(6)
Mismatched words								
	676	(4)	617	(2)	601	(3)	617	(2)
Facilitation			59	(2)	75	(1)	59	(2)
	None		Identity		Pseudoword		Word	
Pseudowords								
	674	(8)	671	(9)	665	(8)	663	(9)
Facilitation			3	(−1)	9	(0)	11	(−1)

equivalent facilitation. Matched derivational primes produced significantly reduced facilitation relative to the inflectional condition and significant facilitation relative to the no prime condition. The present results replicate previously observed effects of morphological relatedness in the repetition priming task and extend those results by revealing a significant distinction between the effect on targets of inflectional and derivational primes that share both their stem and their base morpheme.

Effects of orthographic and phonologic overlap between prime and target on the pattern of facilitation across prime types were systematically examined because inflectional relatives tend to be more similar than derivational relatives. Matched and mismatched overlap never interacted with type of prime although planned comparisons indicated that the difference between targets preceded by inflections and by derivations was statistically more reliable for matched pairs than for mismatched pairs. This pattern is not anticipated if differences in magnitude of facilitation between inflectionally and derivationally related primes reflects extent of orthographic overlap with the target. Moreover, because the semantic differences between inflectional and derivational relatives was small, it cannot readily be attributed to greater semantic overlap for inflections relative to derivations.

The materials selected for Experiment 3 are unique in that for many items inflectional and derivational relatives were both formed around the same base morpheme and differed only with respect to the vowel from which the inflectional affixes were formed. Because no derivational affix was introduced, relatives shared both their base morpheme and their stem. Thus, the results of Experiment 3 indicate that the difference between inflections and derivations in the repetition priming task cannot be attributed to greater facilitation for stems than for bases.

In the present study, morphological relatives produced facilitation to target decision latencies in the repetition priming task but the interpretation of these lexical decision results is not straightforward. It has been suggested that the results obtained with this task may reflect binary decision processes that are specific to this task (Balota & Chumbley, 1984) or alternatively that expectancy and post-lexical mechanisms are involved as well as lexical activation (Neely, 1991). Obviously, it is important to provide converging evidence from other experimental tasks for the contribution of morphology to word recognition. In the three remaining experiments, morphological effects are investigated in a new experimental task.

Experiment 4

The outcome of the first three experiments using the repetition priming paradigm suggested processing differences between inflectional and derivational formations. Another source of evidence for the role of morphology in lexical processing derives from the pattern of errors observed in the production of spontaneous speech (Cutler, 1980; Dell, 1986; Fromkin, 1973; Garrett, 1980, 1982; Stemberger, 1985). One prevalent type of error entails the reordering of morphemic elements so that the stem or affix of a word migrates from the intended word to another site. The pattern for stems and affixes tend to differ (Garrett, 1976). Although there are confounded prosodic differences, this observation has been interpreted as evidence that the base morpheme and inflectional components of a morphologically complex word are separable. Moreover, when word final elements are misordered, those that are morphemic are more likely to shift than are phonemically equivalent but nonmorphemic segments (Stemberger, 1984) and this difference cannot be attributed to frequency differences (Dell, 1990). Finally, inflectional affixes are more likely to migrate than are derivational affixes (Garrett, 1982). Collectively, these observations indicate that the constituent structure of morphologically complex words is available to the production mechanism and are consistent with the

claim that inflectional and derivational forms may be treated differently (see also Badecker & Caramazza, 1989; Miceli & Caramazza, 1988).

In Experiments 4, 5, and 6, an experimental task inspired by the pattern of speech errors in spontaneous speech was developed in order to provide converging evidence for the claim that the morphological constituents of a word can be available to a processing mechanism. The *segment shifting task* entails deliberately shifting segments from a source word to a target word and rapidly naming the product aloud. The experimental manipulation exploits the fact that the morphemic structure of many words is not wholly transparent and that the same sequence of letters (e.g., ER) can function morphemically in one context (e.g., DRUMMER) and nonmorphemically in another (e.g., SUMMER). Letter sequences which are morphological in the context of some source words and nonmorphological in the context of others were shifted onto the same target word. Pronunciation latencies for the same targets formed from morphemic and nonmorphemic source words are compared. The segment shifting procedure used in Experiment 4 is depicted in Fig. 1.

Methods

Subjects. Twenty-six students at the University of Belgrade participated in the experiment in partial fulfillment of the requirements for an Introductory Psychology course. All had experience with reaction time studies but none had participated in previous experiments in this study. The data from nine additional subjects were eliminated because their error rates exceeded 20%.

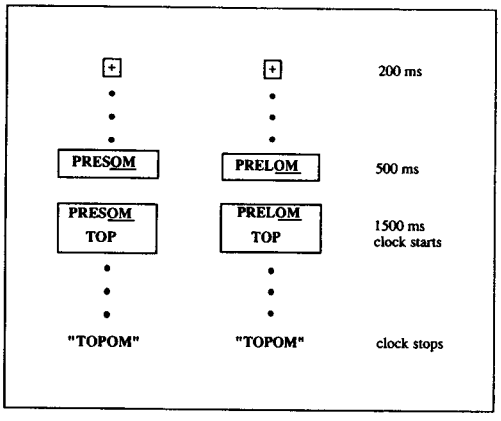

FIG. 1. The original segment shifting procedure.

Stimulus materials. Sixteen pairs of Serbian words were constructed for each of two morphological types and these constituted the source words for Experiment 4. Each pair of source words included a morphologically complex word composed of a base morpheme and a morphological suffix and a morphologically simple control word. The control word ended with the same sequence of letters that functioned morphemically in its pair. Morphemic and nonmorphemic endings were controlled for phonemic and syllabic structure (Tyler & Nagy, 1989). The Serbian analog of inflected words such as WINNING and matched morphologically simple words such as INNING constituted an inflectional type pair. For example, inflectional source words consisted of masculine singular instrumentals such as PRESOM, which means *press* and nonmorphemic controls consisted of morphologically simple words ending with the same sequence of letters without a morphemic function such as PRELOM, which means *fracture,* in nominative case. Note that the OM sequence appeared on morphemic and nonmorphemic source words of equal length and that source and target words were semantically unrelated.

A second morphological type consisted of homographic morpheme affixes. Pairs of source words consisted of morphologically complex source words with morphological affixes that were compatible with the target word (same syntactic category and gender) and morphologically complex source words that were not. That is, the Serbian analog of nominal or verbal S was shifted to another word of the same (consistent) or a different (inconsistent) word class. For example, the nominative plural I from CEVI, meaning

pipes, or the third person singular I from CEDI, meaning *he wrings,* was shifted to the target word RAD in order to form the word RADI, meaning *he works.* Note that in both source words the I is morphemic. What differs for homographic affixes is the consistency or inconsistency of the syntactic category of the source word and the target word. Source words for the segment shifting experiments are described in Table 1 and are listed in the Appendix.

Procedure. Following the presentation of a fixation point for 200 ms, a source word with a portion underlined appeared for 500 ms. Immediately afterwards, the target word appeared below the source word and a clock started. Both words remained visible for 1500 ms. A blank field followed the display and lasted for 2000 ms.

Subjects were instructed to segment and shift the designated segment from a source word onto a target word and to name the new result aloud as rapidly as possible. For example, the OM of the source word PRESOM was underlined and subjects were instructed to shift that sequence of letters to the target word TOP in nominative case in order to produce TOPOM, which means *cannon,* in instrumental case. Onset to vocalization was measured and errors were recorded. A sequence of 13 practice items preceded the experimental list which included eight tokens each in the morphemic-nonmorphemic and morphemic-incompatible conditions.

Results and Discussion

Means for Experiment 4 are summarized in Table 6. All correct scores less extreme than 3 *SD* from the mean for each subject were included in an analysis of variance (approximately 14% of all scores were eliminated) and revealed a significant effect of morphological type (inflection/homograph) [$F1(1,25) = 7.53$, $MS_e = 1278$, $p < .01$; $F2(1,30) = 4.85$, $MS_e = 1222$, $p < .04$]. The interaction of morphological status and morphological type was significant in the analysis by subjects [$F1(1,25) = 11.89$, $MS_e = 437$, $p < .003$] but was only marginally significant in the analysis by items [$F2(1,30) = 2.96$, $MS_e = 1550$, $p < .10$]. The effect of morphological status was not significant. A planned comparison between morphological and nonmorphological segments was significant for the inflectional type of affix [$F1(1,25) = 10.44$, $MS_e = 585$, $p < .001$; $F2(1,15) = 3.25$, $MS_e = 1115$, $p < .09$] but not for the homographic type. No effects were significant for errors.

TABLE 6
SEGMENT SHIFTING TIMES AND ERRORS FOR MORPHOLOGICAL AFFIXES AND THEIR NONMORPHOLOGICAL OR INCOMPATIBLE CONTROLS IN EXPERIMENT 4

	Shifted segment		
	Morphemic	Nonmorphemic or incompatible	Difference
Morphological type			
Inflection	PRESOM	PRELOM	
	582	604	22
	11%	12%	1
Homograph	CEDI	CEVI*	
	577	571	−6
	13%	13%	0

* Incompatible morpheme.

For the homographic morpheme type, where the consistency or inconsistency of the syntactic category of the source word and the target word was varied, no significant effects of consistency (−6 ms) were observed. Shifting rates for I segments derived from verbal and nominal source words were statistically equivalent.

The outcome of Experiment 4 was that morphological segments were shifted from source words to target words more rapidly than their phonologically-matched controls but that syntactically congruent and incongruent morphological affixes did not differ. This result suggests that the component structure of morphologically complex words is available to the language processing mechanism and that morphemes as contrasted with phonemes are the relevant units.

The observed effect could reflect the lexical representation of morphological structure such as the process of segmenting,

from the source, a sequence of letters that constitutes a morphemic component and of affixing that sequence to the target. That is, *segmentation* of morphological units could underlie the effect. Similarly, it is possible that the internal structure of words composed of multiple morphemes differ in their *coherence* relative to morphologically simple words. It should be pointed out that coherence defined in terms of sequential probabilities between letters, is a not plausible account, because the composition of morphemic and nonmorphemic sequences was well matched in this study (see also Rapp, 1992). Nevertheless, the representation of morphologically complex words may encompass their subword units, and morphological coherence may be relevant. In summary, morphemic affixes were more easily segmented from a source word than were nonmorphemic controls presumably because the availability of sublexical morphological components determined morphological coherence. In effect, the imposed shifting of letter sequences from morphologically simple words is difficult because it is arbitrary whereas the shifting of letter sequences from morphologically complex words is relatively easy because it is principled and follows morphological structure.

Experiment 5

The purpose of Experiment 5 was to replicate the results of the previous experiment and to allow a new comparison between inflectional and derivational morphological types. In an attempt to increase the magnitude of the effects observed in the previous experiments, the segment of the source word that subjects had to shift was not specified when the source word appeared. Instead, it was indicated 750 ms later and was simultaneous with the appearance of the target word. The comparison between inflectional and derivational affixes was again examined. If the constituent structure of inflections is more transparent than that of derivations then effects should be more systematic for inflections. Finally, if the segment shifting effect is sensitive to strategies imposed by the subject and if subjects anticipate segmenting morphological affixes then limiting preparation time before the onset of the target may increase the magnitude of the effect because the component structure of the morphemic source word but not its control will be available before it is visually specified.

Methods

Subjects. Twenty-four students at the University of Belgrade participated in Experiment 5 in partial fulfillment of the requirements for an Introductory Psychology course. All had experience with reaction time studies but none had participated in previous experiments in this study. No subject's data were eliminated because of error rates in excess of 20%.

Stimulus materials. Eighteen pairs of Serbian words were constructed for each of two morphological types and these constituted the source words. Each pair of source words included a morphologically complex word composed of a base morpheme and a morphological suffix and a morphologically simple control word. The control word ended with the same sequence of letters that functioned morphemically in its pair. Inflectional type source words consisted of first person singular verbs ending in EM such as KRADEM, which means *I steal,* and nonmorphemic controls consisted of morphologically simple words ending with the same sequence of letters without a morphemic function such as BADEM, which means *almond,* in the nominative case. Note that the EM sequence appeared on morphemic and nonmorphemic source words whose length differed by no more than one letter.

A second morphological type consisted of agentives which are derivational morphemes. These pairs of source words consisted of morphologically complex source words and morphologically simple source words ending in the sequence AR or AČ. For example, derivational source words

consisted of agents such as ČUVAR, meaning *guard,* in nominative case and nonmorphological controls consisted of morphologically simple words such as STVAR, meaning *thing,* in nominative. In both cases, the AR was shifted to the target word RAD in order to form the word RADAR meaning *worker.* Subjects were instructed to add the shifted segment from the source word to the target word and to name it aloud.

Procedure. In an attempt to increase the size of the effect observed in the previous experiment, the presentation conditions of Experiment 5 were modified. The segment of the source word that subjects had to shift was not indicated at the same time that the source word appeared. That is, the source word first appeared alone and without underlining. After 750 ms, the target word appeared below the source word, the segment of the source word that subjects had to shift was underlined, and a clock started. A blank field followed the display and lasted for 2000 ms.

Subjects were instructed to segment and shift the designated segment from a source word onto a target word and to name the new result aloud as rapidly as possible. For example, the EM of the source word JEDEM was underlined and subjects were instructed to shift that sequence of letters to the target word KUJE in order to produce KUJEM, which means *I hammer.* Onset to vocalization was measured and errors were recorded. A sequence of 13 practice items preceded the experimental list which included nine tokens of morphemic and nonmorphemic source words in the inflectional and derivational conditions.

Results and Discussion

An analysis of variance on correct latencies less extreme than 3 SD from the mean for each subject (approximately 6% of all responses were eliminated) revealed significant effects of morphological type (inflection/derivation) [$F1(1,23) = 13.78$, $MS_e = 2487$, $p < .002$] and morphological status (morpheme/nonmorpheme) [$F1(1,23) = 9.1$, $MS_e = 913$, $p < .007$] by the subjects' analysis, but only morphological type approached significance by the items' analysis [$F2(1,34) = 2.75$, $MS_e = 5139$, $p < .11$]. With the error measure, neither the main effect nor the interaction of affix by type approached significance. Means are summarized in Table 7.

Numerical differences for agentive derivational affixes were reduced and in the opposite direction relative to those of inflectional affixes although there was no significant interaction. Nevertheless, a planned comparison conducted on means for each subject indicated that inflectional affixes were shifted faster than their nonmorphological controls [$F1(1,23) = 8.15$, $MS_e = 1201$, $p < .009$] and a test conducted on means for each item showed the same trend [$F2(1,17) = 2.68$, $MS_e = 2393$, $p < .12$]. No effects were significant for derivational affixes, however.

The outcome of Experiment 5 was that inflectional but not derivational segments were shifted from source words to targets words more rapidly than from their phonologically matched controls. This result suggests that the component structure of morphologically complex words is sometimes available to the language processing mechanism and again, that base morphemes as contrasted with phonemes are the relevant units. Numerically, the effect was comparable to that of Experiment 4 suggesting that restricted preparation time did not alter the processes involved in this task. Times

TABLE 7
SEGMENT SHIFTING TIMES AND ERRORS FOR MORPHOLOGICAL AFFIXES AND THEIR NONMORPHOLOGICAL CONTROLS IN EXPERIMENT 5

	Shifted segment		
	Morphemic	Nonmorphemic	Difference
Morphological type			
Inflection	JEDEM	BEDEM	
	781	809	28
	5%	4%	−1
Derivation	ZIDAR	KADAR	
	753	761	8
	4%	5%	1

were longer overall but error rates decreased. Importantly, the relation between speed and accuracy across experiment did not differ by experimental condition.

The linguistic productivity and lexical structure of inflectional as contrasted with derivational formations noted above leads one to expect inflectional affixes to show enhanced effects relative to derivational affixes and the effect of morphological status was significant only for inflections in Experiment 5. The sixth experiment in this series also compares inflections and derivations in a more complex version of the segment shifting task.

Experiment 6

An attempt at replication of differences in inflectional and derivational processing with different materials necessitated a modification of the segment shifting procedure described above. In this experiment, as in the previous segment shifting experiments, subjects had to shift the affix from the source word to the target word. In contrast to the procedure of the previous experiments, in Experiment 6, subjects had to delete the original affix on the target word before substituting the shifted segment. As in Experiments 4 and 5, subjects had to name the resulting word aloud. The addition of this step whereby subjects had to delete the original affix (or its orthographically and phonemically matched control) rendered the task more difficult but it permitted the comparison of morphological constructions for inflectional and derivational formations to be expanded.

Methods

Subjects. Twenty-six students from the same population as those in previous experiments participated in Experiment 6. None had participated in previous experiments in this study.

Stimulus materials. Materials consisted of 36 Serbian word pairs including equal numbers of inflectional and derivational morphological types and their nonmorphemic controls. As in the previous experiment, the inflectional type consisted of first person singular verbs such as PROGONIM, meaning *I capture,* and their nonmorphemic controls such as SINONIM, meaning *synonym.* They were shifted to inflected targets such as DELE, meaning *they share.* In the present experiment, in order to respond DELIM, meaning *I share,* subjects had to delete the original affix (viz., E) and substitute the IM affix. The derivational type contrast consisted of singular diminutives ending in ICA such as BAŠTICA, meaning *little garden,* and their controls such as KOŠTICA, meaning *seed.* They were shifted to target such as BUBA, meaning *bug,* and subjects responded BUBICA, meaning *little bug.*

Procedure. The procedure of Experiment 6 was like that of Experiment 5 (but not 4), in that the segment of the source word that subjects had to shift was not specified at the same time that the source word appeared. Instead, it was indicated after 750 ms when the target word appeared. However, in both the inflectional and derivational conditions of Experiment 6, subjects had to drop the original (morphemic) affix on the target and to substitute the affix from the source word. That is, the final vowel on words such as BACE and BUBA was deleted before adding IM or ICA respectively. Finally, filler trials in which no portion was underlined were also included. In those cases, subjects were required to repeat the target word in its original form. Nine tokens in the morphemic and nonmorphemic conditions were included for both the inflectional and derivational conditions.

Results and Discussion

An analysis of variance on correct latencies less extreme than 3 *SD* from the mean (so that approximately 6% of all responses were eliminated) revealed a significant effect of morphological type (inflection/derivation) [$F1(1,25) = 60.03$, $MS_e = 3295$, $p < .001$; $F2(1,34) = 17.12$, $MS_e = 8177$, $p < .001$] and a marginally significant inter-

action of morphological status and morphological type [$F1(1,25) = 10.02$, $MS_e = 2960$, $p < .005$; $F2(1,34) = 2.77$, $MS_e = 7182$, $p < .10$]. The effect of morphological status just missed significance with subjects as a random variable [$F1(1,25) = 4.12$, $MS_e = 3250$, $p < .053$].

The effect of morphological status of affix (56 ms) was significant for inflectional type pairs [$F1(1,25) = 14.01$, $MS_e = 2960$, $p < .001$)] by subjects and was marginally significant by items [$F2(1,34) = 3.24$, $MS_e = 7182$, $p < .08$)]. For derivational pairs, the effect was in the opposite direction (−11 ms) and was not significant [$F1(1,25) = .54$]. The significant effect for inflections and the nonsignificant change in direction for derivations produced the marginally significant interaction of affix by morphological type. For errors, the effect of morphological type was significant by subjects [$F1(1,25) = 9.82$, $MS_e = 575$, $p < .005$; $F2(1,34) = 7.73$, $MS_e = 398$, $p < .09$] but the main effect of morphological status and the interaction of contrast by type did not approach significance. Because latency and error patterns for the targets following inflected primes in Experiment 6 suggested a speed accuracy tradeoff, correlations between measures were computed. Neither the correlations for morphemic and nonmorphemic conditions separately nor the pooled correlation approached significance. Evidently, latencies did not decrease as errors increased (Table 8).

The results of Experiment 6 are consistent with the segment shifting results of the previous experiments whereby morphological segments are shifted faster than their nonmorphemic controls. The pattern of errors goes in the opposite direction but it was not statistically significant nor was it produced by a speed-accuracy tradeoff. Although the results with items as a random factor are weak, the pattern was replicated with (a) the inflectional affixes for instrumental nouns in Experiment 4, (b) first person singular verbs in Experiments 5 and 6. The set of experimental materials for Experiment 6 required a modification to the experimental procedure whereby the original affix on the target word had to be deleted before the shifted segment could be appended and it allowed a valuable replication of the previous results. Specifically, the effect of segment shifting was significant for inflectional pairs but not for derivational pairs. These results are consistent with the linguistic distinction between morphological types noted above and with the pattern of production error whereby inflections enter into speech errors more frequently than do derivations (Garrett, 1980). This finding suggests that the morphological structure of inflectional and derivational formations does differ.

TABLE 8
SEGMENT SHIFTING TIMES AND ERRORS FOR MORPHOLOGICAL AFFIXES AND THEIR NONMORPHOLOGICAL CONTROLS IN EXPERIMENT 6

	Shifted segment		
	Morphemic	Nonmorphemic	Difference
Morphological type			
Inflection	BAJAM	SAJAM	
	829	886	57
	9%	6%	−3
Derivation	BAŠTICA	KOŠTICA	
	776	765	−9
	3%	3%	0

GENERAL DISCUSSION

In the repetition priming paradigm, the pattern of facilitation among lexical decision latencies for target words that were preceded by morphological relatives provided evidence that skilled readers of Serbian are sensitive to the constituent structure of morphologically complex words. It was not necessary for identical forms to be repeated in order to reduce target decision latencies. Repetition of the same base morpheme in a different but related morphologically-complex word also produced facilitation. Evidence of morphological relatedness in repetition priming is consistent with the results of similar studies conducted across a variety of languages and morphological contexts, and generally, it is inter-

preted as evidence that morphology is represented in the lexicon.

Similarly, the failure to find facilitation in lexical decision among target pseudowords that were preceded by other pseudowords constructed from the same meaningless base morpheme and real morphemic suffixes, or by words constructed from the same meaningful base morpheme in an illegal combination with a real affix, is consistent with the outcome of other studies that have used this experimental task. Although small facilitation effects for pseudoword targets sometimes have been reported in lexical decision with repetition priming (e.g., Bentin & Feldman, 1990), it is never the case that pseudoword effects are numerically larger than word effects and most typically they are smaller. It has been suggested that for pseudowords, under some encoding conditions, the advantage of repeating the same or a very similar orthographic and phonemic pattern is offset by the inappropriateness of responding "word" to a familiar pseudoword pattern (Balota & Chumbley, 1984; Duchek & Neely, 1989; Feustel, Shriffrin, & Salasoo, 1983). That is, familiarity offsets any advantage associated with repeating a "no" response.

The present experiments conducted with Serbian materials permitted a rigorous comparison of two types of morphological formations. When inflectionally- and derivationally-related prime-target pairs were compared, significantly greater facilitation was observed for inflectional relatives than for derivational relatives. This finding was observed in Experiment 1, in which derivational formations differed in word class from inflectional formations but were equally similar with respect to phonological and orthographic overlap, in Experiment 2, in which all formatives were verbs and targets following derivationally related primes differed with respect to the addition of either a prefix or a suffix, and in Experiment 3, in which one half of the primes were perfectly matched for overlap as well as word class with their targets and one half shared one letter more in the inflectional condition than in the derivational condition.

When derivationally related prime-target pairs were compared with first presentation, significant facilitation was observed for agentives in Experiment 1, for prefixed targets in Experiment 2, and for mismatched pairs in Experiment 3. Facilitation following derivational primes was not significant in the analysis by subjects for infixed items (Experiment 2). The planned comparison by items for matched items (Experiment 3) was not significant although the latency differences were consistent with a pattern of facilitation. The reliability of facilitation from derivationally related primes may be low and the no prime baseline may overestimate the magnitude of facilitation (but see discussion of results for Experiments 1–3). However, the same pattern was observed in three experiments. Moreover, when the planned comparisons for no prime and derivational conditions in the three experiments (five conditions) were combined into one statistical test (Winer, 1971, p. 49), results indicated that facilitation was significant $\chi^2.001\ (10) = 48.21$ for subjects and $\chi^2.001\ (10) = 38.97$ for items. In summary, although there is a tendency towards facilitation of targets following derivational primes, because targets always occurred slightly later in the session than their primes, the facilitation effects with derivational relatives should be interpreted with caution.

It is unlikely that the effect of morphological relatedness can be described in terms of the pattern of activation between the orthographic and perhaps phonological units that constitute a word. This claim is based on (a) the pattern of facilitation for morphologically related prime-target pairs in which the base morpheme does not always retain the same form, (b) the absence of facilitation among morphologically unrelated prime-target pairs that are similar in

form, (c) statistically significant differences in patterns of facilitation to targets primed by inflectional and derivational relatives that are matched or nearly matched to the target for similarity of form, and d) the effect of morphological status on segment shifting for inflectional affixes but not for derivational affixes. The separate bases for these claims will now be summarized.

In previous repetition priming studies, changes in spelling or pronunciation between morphologically related prime and target did not diminish the magnitude of facilitation to target decision latencies relative to morphologically related prime-target pairs with no change. For example, Serbian forms that undergo palatalization (e.g., NOZI), forms with letter deletion (e.g., PETKU) and regular forms (e.g., NOGOM) all produced equivalent target (e.g., NOGA, PETAK) facilitation (Feldman & Fowler, 1987). Similar results in repetition priming have been reported in English for moderately irregular forms such as SLEPT–SLEEP (Fowler et al., 1985; Napps, 1989; Stolz & Feldman, in press; cf. Stanners et al., 1979). In addition, recognition latency to inflected verb forms was sensitive to frequency of citation forms (and cumulative frequency for all regular forms) both when they differed in spelling (Kelliher & Henderson, 1990) and when spelling was preserved (Katz, Rexer, & Lukatela, 1991; Nagy, Anderson, Schommer, Scott, & Stallman, 1989). That is, a contribution of both citation frequency and cumulative frequency of morphologically related forms to recognition latency was observed even when the orthographic and phonological form of the base morpheme was not preserved. Equivalent patterns of influence for morphologically related words with differing orthographic and phonological form and for words with similar form are problematic for any model that assumes that the base morpheme alone or a pattern of activation over its letter or phoneme units underlies morphological effects. In summary, patterns of facilitation in repetition priming suggest that the underlying morphemic representation is abstract enough to tolerate at least moderate orthographic and phonological variation.

Whereas formal similarity of morphologically unrelated words can produce inhibition in some presentation formats when items are presented close in succession (Grainger Colé & Segui, 1990; Laudanna et al., 1992; Segui & Grainger, 1990; Stolz & Feldman, in press), at long lags it is the case that the formal similarity of morphologically unrelated primes and targets (e.g., pairs such as DIET and DIE) does not result in priming either in English (Hanson & Wilkenfeld, 1985; Napps & Fowler, 1987; Stolz & Feldman, in press) or in Serbian (Feldman & Andjelković, 1992; Feldman & Moskovljević, 1987). For example, for prime-target pairs formed from unrelated homographic base morphemes (e.g., BOR) such as BORAMA (dative plural of BORA, meaning *wrinkle*) and BOROVI (nominative plural of BOR, meaning *pine*), no effect of formal similarity was observed for inflectionally complex words at lags of ten items in repetition priming (Feldman & Andjelković, 1992). Stated generally, whereas orthographically similar form plays a role at short lags, at long lags as in the repetition priming task, there was neither a facilitative nor inhibitory effect on the target of orthographic and phonological similarity between morphologically-unrelated prime and target.

The primary finding of Experiments 1, 2, and 3 was that inflectional primes produced significantly greater facilitation than did derivational primes and that derivational primes produced facilitation relative to the no prime condition. This outcome was observed under experimental conditions that (a) perfectly matched formal overlap of prime and target but left word class free to vary (Exp. 1), (b) perfectly controlled word class by using only verb forms and manipulated position in which affix was added,

and (c) perfectly controlled word class by using only verb forms but matched letter overlap of inflectional and derivational relatives on only one half of the items (Exp. 3).

It is evident that the lexical representation of inflectional and derivational formations must differ. Several accounts have been proposed. It has been suggested that, in the lexicon, the linkage between whole word forms that share a base morpheme is stronger for inflectionally-related forms than for derivationally-related forms or that the connections between components must be stronger for inflectional than for derivational formations. This is consistent with the linguistic claim that the component structure of inflectionally related forms is more transparent than that of derivationally related forms. Alternatively, as noted above, inflectional formations tend to share a base morpheme and stem and differ with respect to inflectional affix whereas derivational formations tend to share a base morpheme and differ with respect to derivational affixes and stem. Accordingly, if both stems and bases are taken as units to be activated in repetition priming, then the difference between inflections and derivations could reflect redundant activation for inflections relative to derivations. Results of Experiment 3 indicate that this account is incomplete, at best. Inflectional relatives like NOSIM and derivational relatives like NOSAM share both base morpheme and stem but they did not produce equivalent target facilitation.

Results of the segment shifting task also provide compelling evidence that the morphological status of a word's constituents influences performance in recognition tasks. Although differences between inflectional and derivational affixes were weaker in this task, in that analyses by items tended to have significance levels around $p < .10$, a similar outcome was observed in three experiments with different manipulations on inflectional affixes. Importantly, the results were consistent with those obtained in repetition priming. In the segment shifting task, morphological effects were more reliable for inflectional affixes relative to their controls than for derivational affixes and their controls. Phonological and orthographic properties of a source word were matched in the experimental design and sequences that created morphological segments were manipulated more efficiently than nonmorphological controls over a variety of inflectional environments. The morphological origins of a segment were evident despite the fact that all of the responses articulated by subjects were frequent words and that responses were the same in the morphological and nonmorphological conditions.

In that the internal structure of words formed with inflectional affixation may be more transparent than that of words with derivational affixation, and effects were more reliable for inflections than for derivations, an account of the segment shifting experiments based on ease of segmentation is plausible. Similarly, the emphasis could be on coherence at the boundary between sublexical word units. In languages such as Serbian (and English) in which morphemes are concatenated to form complex forms, there is a temptation to describe morphemes in terms of boundaries between orthographic or phonological *sequences* of units. As should be obvious from the present discussion, however, these lexical representations must be sufficiently abstract to accommodate changes in form as well as the word context of which the sequence is a part. Admittedly, it is difficult to distinguish between segmentation of and coherence between morphemic components when morphology is concatenated.

An investigation of morphological effects in a nonconcatenative language such as Hebrew is less amenable to an account based on sequence, however. In Hebrew, the root or base morpheme of a word is represented by a discontinuous pattern of (usually) three consonants. Vowels carrying an inflectional function are infixed between

these units. Consequently the base morpheme is not realized as an uninterrupted unit within the word. It is necessarily abstract with respect to phonological (and sometimes orthographic) patterning and yet, effects of morphological relatedness have been demonstrated both in repetition priming (Bentin & Feldman, 1990; Feldman & Bentin, in press) and in segment shifting (Feldman, Frost, & Pnini, submitted for publication). In Hebrew, ease of segmentation rather than coherence may provide the more accurate account.

Alternatively, the locus of the segment shifting effect could reflect strategies that vary on a trial by trial basis and reflect compatibility between source and target word. Accordingly, word class compatibility effects for affixes from source and target words would be anticipated. The CEVI-CEDI comparison in Experiment 4 indicated that when affixes were shifted from a source word of the same or a different word class as the target, latencies were equivalent. Similarly, the results of segment shifting experiments in Hebrew (Feldman, Frost & Pnini, submitted) indicate that morphological effects can be observed when the affix is shifted to a meaningless target string. Segment shifting effects are not expected on pseudoword targets if the effect reflects compatibility. Evidently, the locus of the segment shifting effect is not yet well understood but, at this point, a lexical locus tied to morphemic as distinguished from orthographic components seems likely.

In summary, two very different experimental paradigms provide strong support for the psychological processing of the morpheme and for a distinction between the processing of inflectional and derivational formations. Similarity of form defined by orthographic and phonological overlap of morphologically-related primes and targets is not a necessary condition to produce facilitation. Similarity of form in the absence of morphological relatedness is not a sufficient condition to produce target facilitation or inhibition at long lags. Patterns of activation over orthographic or phonological units cannot describe morphological effects. Importantly, they cannot account for the differences between inflections and derivations when semantic similarity is controlled. Evidently, processing of a word is sensitive to that word's constituent morphemic structure.

APPENDIX

Experiment 1 Materials

Target	Identity	Inflection	Derivation
blud	blud	bludom	bludim
bol	bol	bolom	bolan
branim	branim	braniš	branik
brod	brod	brodu	brodi
broj	broj	broju	broji
bura	bura	burom	buran
čud	čud	čudom	čudim
cvet	cvet	cvetom	cvetan
deo	deo	delom	delim
doček	doček	dočekom	dočekan
govor	govor	govorom	govorim
grad	grad	gradom	gradim
hlad	hlad	hladom	hladan
igraš	igraš	igram	igrač
lom	lom	lomom	lomim
nosam	nosam	nosaš	nosaš
obaram	obaram	obaraš	obarač
peva	peva	pevam	pevač
plivam	plivam	plivaš	plivač
računa	računa	računam	računar
rad	rad	radom	radim
slikaš	slikaš	slikam	slikar
spava	spava	spavaš	spavač
tragaš	tragaš	tragam	tragač
vaja	vaja	vajam	vajar
vodiš	vodiš	vodim	vodič
zvoni	zvoni	zvonim	zvonik

Experiment 2 Materials

Target	Identity	Inflection	Derivation
		Prefixed	
obare	obare	obarim	barim
ocede	ocede	ocedim	cedim
očiste	očiste	očistim	čistim
obodre	obodre	obodrim	bodrim
oderu	oderu	oderem	derem
oljušte	oljušte	oljuštim	ljuštim
iseku	iseku	isečem	sečem
iskoče	iskoče	iskočim	skočim

APPENDIX —*Continued*

Target	Identity	Inflection	Derivation
isele	isele	iselim	selim
ulepe	ulepe	ulepim	lepim
urade	urade	uradim	radim
ubodu	ubodu	ubodem	bodem
zgrabe	zgrabe	zgrabim	grabim
zbroje	zbroje	zbrojim	brojim
zbace	zbace	zbacim	bacim
zdrobe	zdrobe	zdrobim	drobim
zgnjeće	zgnjeće	zgnjećim	gnjećim
zbrišu	zbrišu	zbrišem	brišem
slete	slete	sletim	letim
smute	smute	smutim	mutim
sprže	sprže	spržim	pržim
smrve	smrve	smrvim	mrvim
stresu	stresu	stresem	tresem
slome	slome	slomim	lomim
		Infixed	
birkaju	birkaju	birkam	biram
čarnu	čarnu	čarnem	čaram
dirnu	dirnu	dirnem	diram
džarnu	džarnu	džarnem	džaram
gurnu	gurnu	gurnem	guram
javnu	javnu	javnem	javim
jurnu	jurnu	jurnem	jurim
kidnu	kidnu	kidnem	kidam
kucnu	kucnu	kucnem	kucam
mere	mere	merkam	merim
mrdnu	mrdnu	mrdnem	mrdam
njuše	njuše	njuškam	njušim
padnu	padnu	padnem	padam
pirkaju	pirkaju	pirka	piri
sednu	sednu	sednem	sedam
sevnu	sevnu	sevnem	sevam
šušte	šušte	šuškam	šuštim
svirkaju	svirkaju	svirkam	sviram
turnu	turnu	turnem	turam
virkaju	virkaju	virkam	virim
virnu	virnu	virnem	virim
vrdnu	vrdnu	vrdnem	vrdam
živnu	živnu	zivnem	živim
zovnu	zovnu	zovnem	zovem

Experiment 3 Materials

Target	Identity	Inflection	Derivation
		Matched	
bace	bace	bacim	bacam
ciče	ciče	cičim	cičem
dobiju	dobiju	dobijam	dobijem
klize	klize	klizim	klizam
lupe	lupe	lupim	lupam
nose	nose	nosim	nosam
odbiju	odbiju	odbijam	odbijem
opuste	opuste	opustim	opuštam

APPENDIX —*Continued*

Target	Identity	Inflection	Derivation
sede	sede	sedim	sedam
speru	speru	speram	sperem
vode	vode	vodim	vodam
voze	voze	vozim	vozam
čuče	čuče	čučim	čučnem*
		Mismatched	
dirnemo	dirnemo	dirnem	diram
duvnemo	duvnemo	duvnem	duvam
napijamo	napijamo	napijam	napijem
natapamo	natapamo	natapam	natopim
nazivamo	nazivamo	nazivam	nazovem
naturamo	naturamo	naturam	naturnem
obaramo	obaramo	obaram	oborim
obijamo	obijamo	obijam	obijem
odvajamo	odvajamo	odvajam	odvojim
potapamo	potapamo	potapam	potopim
povijamo	povijamo	povijam	povijem
skidamo	skidamo	skidam	skinem
zovnemo	zovnemo	zovnem	zovem

* Not included in the analysis.

Experiment 4 Materials

Morphologically complex source word	Morphologically simple source word	Target
	Inflections	
slavom	slalom	rad
presom	prelom	top
prozom	prolom	grof
akcijom	aksiom	dan
maljem	melem	kraj
bojem	boem	muz
palcem	parfem	broj
hicem	harem	nož
prolećem	problem	čaj
tučem	totem	konj
adresom	agronom	kum
princem	prijem	koš
arkadom	astronom	lav
etikom	ekonom	zid
kafanom	karcinom	zet
antenom	anatom	sat
	Homographic morpheme	
cedi	cevi	jad
davi	dani	ćud
deli	dedi	gost
gadja	gara	rak
kida	kipa	lan
mrzi	mravi	gled
čami	čari	reč
košta	koša	nos
buja	buta	zec

APPENDIX —*Continued*

Morphologically complex source word	Morphologically simple source word	Target
crpi	crvi	čadj
krsti	kosti	zub
prska	prsta	luk
pada	poda	klub
mašta	mosta	dom
prašta	plasta	sir
gleda	gliba	sin

Experiment 5 Materials

Morphologically complex source word	Morphologically simple source word	Target
	Derivations	
berač	kolač	let
birač	vrač	ples
čuvar	stvar	red
kuvar	ajvar	mlin
limar	ormar	lug
merač	žarač	kov
orač	trač	voz
pekar	bakar	kalem
ribar	dabar	stan
rudar	sudar	dom
slikar	plakar	grob
šumar	šamar	brod
svirač	otirač	glas
trubač	korbač	kroj
vidar	radar	drug
vinar	bunar	zub
zidar	kadar	lek
zlatar	litar	put
	Inflections	
bajam	sajam	kida
biram	jaram	pita
derem	bagrem	bere
diktiram	dijagram	gadja
jedem	bedem	ljuje
kradem	badem	kaže
majam	zajam	dira
orem	harem	digne
pajam	pojam	buja
perem	melem	pase
pijem	prijem	dode
pletem	sistem	bakče
postim	kostim	davi
progonim	sinonim	deli
tonem	fonem	pišu
udaram	epigram	kupa
vajam	najam	pada
zidam	islam	peva

Experiment 6 Materials

Morphologically complex word	Morphologically simple word	Target
	Derivations	
vranica	stanica	kanta
spravica	zdravica	bunda
pelenica	vodenica	krpa
baštica	koštica	buba
savanica	tavanica	tabla
sobica	ubica	kuća
masnica	mašnica	priča
kadica	ladica	guma
najavica	kijavica	kasta
kravica	krivica	bara
bananica	pijanica	gužva
banjica	brnjica	kifla
pesmica	pesnica	korpa
rolnica	bolnica	basna
zabavica	bradavica	palma
tašnica	košnica	pošta
sarmica	samica	rana
saunica	sapunica	tegla
	Inflections	
bajam	sajam	kidaju
derem	bagrem	beru
diktiram	diagram	gadjaju
jedem	bedem	kluju
kradem	badem	kažu
majam	zajam	diraju
orem	harem	dignu
pajam	jaram	kupaju
perem	melem	pasu
pijem	prijem	dodju
pletem	sistem	podju
postim	kostim	dave
progonim	sinonim	dele
tonem	fonem	pišu
udaram	epigram	biraju
vajam	najam	pradaju
zajam	pojam	bubaju
zidam	islam	pevaju

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