

Grammatical Priming Effects Between Pronouns and Inflected Verb Forms

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Summary. Deciding on the lexical status of a word can be facilitated by a preceding, semantically related word. Three experiments are reported demonstrating a different kind of facilitation due to the grammatical relation between function words and content words in Serbo-Croatian. A pronoun facilitated or inhibited the lexical decision on a following verb depending on whether the person of the verb, as represented by its inflected ending, agreed with the person of the pronoun. Also, verbs primed subsequent pronouns but the pattern of results for the verbal priming of pronouns was markedly different from that for the pronominal priming of verbs. The results suggest that the organization of the internal lexicon is sensitive to grammatical relations as well as semantical relations between words.

Introduction

The facilitation of the perception of one word by the perception of another has been the subject of much recent experimental inquiry. Facilitation effects have been demonstrated largely, but not exclusively, in the context of word lists and primarily, but not exclusively, with words that are either associatively or semantically related. Almost without exception, however, these effects have been demonstrated in the lexical decision task where the subject is asked to decide, as rapidly as possible, whether or not a given letter string is a word. Thus the standard demonstration of facilitation effects is of the following form: Given two words, simultaneously or successively, the lexical decision latency to the pair (are they *both* words?) or just to the second of the two can be shown to depend on the semantic relation that exists between them (e.g., Fischler 1977; Meyer et al. 1975; Neely 1977). Recently, evidence was provided of a different facilitation effect, one that would appear to deserve the label 'grammatical' rather than 'semantic' (Lukatela et al. in

press), because the formal relation between prime and target words concerns the target's grammatical inflection. Inflection is the major grammatical device of Serbo-Croatian, Yugoslavia's principal language. Nouns are declined, the individual grammatical cases being formed by adding a suffix to a (quasi) root morpheme. In normal linguistic usage, a noun is often preceded by a preposition which signals the likelihood of a particular grammatical case for the noun. This redundancy stresses the noun's function in the sentence. The lexical decision task was adapted to the question of whether the processing of an inflected noun is facilitated by the prior presentation of a grammatically consistent preposition. The answer was positive. Lexical decision times to nouns were faster when the preceding preposition was appropriate to the case of the noun than when it was either inappropriate or simply a nonsense syllable. The present paper pursues a further possible instance of grammatical facilitation, one that is defined over the relation of pronoun to verb. The person of Serbo-Croatian verbs is specified by the inflected suffix that the verb assumes and by the pronoun that precedes or follows it. Insofar as a given pronoun and a given inflected form of the verb co-occur consistently in normal linguistic usage their individual perceivings may be mutually facilitating. In particular, a prior pronoun might facilitate lexical decision on a subsequent verb with which it is grammatically consistent, and vice versa.

The types of facilitation under consideration here — that of noun by preposition and of verb by pronoun may not succumb to the kind of interpretation applied to the more familiar instances of facilitation between semantically similar items. The notion of an automatic spread of activation, originally described by Quillian (1969) and elaborated recently (for example, Anderson 1976; Collins and Loftus 1975; Neely 1977; Posner and Snyder 1975), refers ultimately to a specific linkage between particular representations of particular words. The idea that there is a specific linkage between (certain) internal word-representations (so that the direct stimulation of one representation mechanically and eventually leads to the (indirect) stimulation of others) identifies a medium for the automatic accessing of word-meaning in long-term memory. Such automaticity is useful; it prunes degrees of freedom in the search process. Thus, *glass* leads mechanically and eventually to *ice*, *cave* to *mine*, *nurse* to *wife*, and so on (from the appendix of Fischler 1977).

There is, therefore, a certain intuitive appeal to the notion of automatic spreading activation. However, the relation of preposition to inflected noun in Serbo-Croatian cannot sensibly be portrayed as a linkage between *particular* internal word-representations. English is sufficient to make this point: What could possibly motivate or rationalize specific linkages between the lexical representations of *in* and *wall*, *from* and *chalk*, *below* and *jogger*? A potentially more sensible portrayal follows from the allowance that it is morphemes rather than words that are specifically linked. Thus, spreading activation might be defined over connections between the small set of Serbo-Croatian prepositions and the small set of inflected endings of Serbo-Croatian nouns. And the prepositional priming of lexical decision on an inflected noun could then be said to rest on the partial activation of the noun, namely, of its inflected ending (compare with, Stanners et al. 1979). Against this interpretation, however, is (i) evidence that the inflected Serbo-Croatian nouns are represented in the internal lexicon as singular units rather than as morphological concatenates (Lukatela et al. 1980); (ii) evidence that priming or facilitation does not occur between two semantically un-

related nouns that are in the same grammatical case (Lukatela and Popadić, Ref. Note 1); and (iii) the argument that the evidence for morphological decomposition reported for English materials (e.g., Stanners et al. 1979 b; Taft and Forster 1975) may be an artifact of over-representing multimorphemic stimuli in the experimental design (Rubin et al. 1979).

We have laboured the problem of applying an interpretation of semantic facilitation to grammatical facilitation in order to emphasize that an explanation which addresses relations among some word types may not address relations among all word types. For example, how relations are effected among words of the open class (e.g., adjectives, verbs, and nouns) may not be how relations are effected among words of the closed class (e.g., pronouns, prepositions, determiners, auxiliaries), nor how relations are effected across the two classes – such as the facilitation of an inflected noun by a grammatically consistent preposition. The distinction of open and closed classes is not just a formal distinction – readers of English relate to the two vocabulary types in qualitatively different ways suggesting, among other things, largely distinct recognition procedures (Bradley 1978; Friederici and Schoenle 1980; Garrett 1978; Zurif 1980). This division of the lexicon into two categories not only militates against a single account of facilitation effects but it argues, more generally and most obviously against a unitary view of the lexicon; on a pluralistic view, words would be expected to differ widely in the manner of their lexical organization and the means by which they are accessed. For example, it seems unlikely that, within the open class, nouns and verbs should be organized and retrieved along identical lines. The characterization of nouns as clusters of correlated attributes in a hierarchical organization contrasts with the characterization of verbs as clusters of uncorrelated attributes in a matrix-like organization (Huttenlocher and Lui 1979; Kintsch 1972; Miller and Johnson-Laird 1976). With regard to the inflected nouns of Serbo-Croatian, it appears that the grammatical cases of any given noun comprise a system of words with the more frequent nominative singular form as the nucleus around which the oblique cases cluster uniformly (Lukatela et al. 1980). Preliminary work on how the various forms of inflected Serbo-Croatian verbs relate among themselves suggests, however no prominent member in the verb system that is comparable to the nominative singular in a noun system even though there are large differences among the verb forms in their individual frequencies of usage (Mandić and Ognjenović, Ref. Note 2).

The upshot of the foregoing is that semantic facilitation and grammatical facilitation are probably best understood not as expressions of a single mechanism but rather as expressions of different mechanisms that stand in a complementary relation; and that it should not be surprising to find different species of facilitation if, as can be supposed, the organization of the lexicon is pluralistic rather than unitary.

Experiment 1

In Serbo-Croatian the inflectional forms of the verb identify voice (active or passive), mood, tense, number, and person; the pronouns agree – in normal usage – with the inflectional form in number and person. Most often the inflected verb forms are preceded by an appropriate personal pronoun. The first experiment examined the effect of

a preceding appropriate, inappropriate, or nonsense pronoun on a subsequent lexical decision to a Serbo-Croatian verb. Two inflectional forms were used: the first person singular present tense and second person singular present tense. Our expectation was that when the pronoun agreed with the inflected verb form, lexical decision time would be reduced in comparison to when the pronoun did not agree with the inflected form, and in comparison to when the 'pronoun' was, in fact, a nonsense syllable.

Method

Subjects. Sixty-five students from the Department of Psychology, University of Belgrade, received academic credit for participation in the experiment. A subject was assigned to one of four subgroups, according to the subject's appearance at the laboratory, to give a total of sixteen subjects per subgroup.

Materials. Letter strings, each consisting of five or six upper-case letters were typed with an IBM Selectric typewriter. The letter strings were used to prepare black on white slides.

Two types of slides were constructed. In one type, the letter string was arranged horizontally in the upper half of a 35 mm slide and, in the other type, letters of the same kind were arranged horizontally in the lower half of a 35 mm slide. Letter strings in the first type of slide were always pronouns (or their pseudoword analogues) and letter strings in the second type of the slide were always inflected verbs (or pseudoword analogues). All together, there were 320 'pronoun' slides and 320 'inflected verb' slides with each set evenly divided into words and pseudowords. The 160 inflected verb slides that were words consisted of two sets of 80 representing the same 80 verbs, respectively, in the first person singular present tense and second person singular present tense. The 80 verbs were selected from the middle frequency range of a body of one-million Serbo-Croatian words (Kostić, Ref. Note 1). A different set of 80 verbs of the same frequency and in the same person and in the same tense was used to generate the pseudowords. This was done by simply changing one letter in the root morpheme leaving the inflected ending unchanged. The replacement was an orthotactically and phonotactically legal letter. A second set of 80 pseudowords was created where the

Table 1. Examples of Serbo-Croatian verbs¹

Infinitive form	Present tense first person	Present tense second person
RADI-TI (to work)	RADI-M	RADI-S
ČITA-TI (to read)	ČITA-M	ČITA-S
PISA-TI (to write)	PISE-M	PISE-M
PUŠI-TI (to smoke)	PUŠI-M	PUŠI-S
PEVA-TI (to sing)	PEVA-M	PEVA-S
PI-TI (to drink)	PIJE-M	PIJE-S

¹The hyphens have been added to emphasize the inflections

Table 2. Pseudoverbs derived from the verbs in Table 1¹

Infinitive form	First person present tense	Second person present tense
KUSI-TI	KUSI-M	KUSI-S
JEVA-TI	JEVA-M	JEVA-S
DI-TI	DIJE-M	DIJE-S

¹The hyphens have been added to emphasize the inflections

words in this second set differed from those in the first set in their inflections for person, i.e., first person became second person and *vice versa*.

As an illustration of how the verb and pseudoverb slides were prepared, consider a typical mini-list of Serbo-Croatian verbs presented in Table 1. All these verbs are from the mid-frequency range and display the three typical final syllables in the first person (-IM, -AM, -EM) and in the second person (-IS, -AS, -ES) of the present tense. From the list of 160 verbs exemplified by the mini-list in Table 1, one half were used to produce the verb slides. The other half were transformed into pseudoverbs by changing the initial or second-to-initial consonant. In this manner the letter strings in Table 2 were obtained from the mini-list of Table 1. To reiterate, in deriving a pseudoverb from a verb the final syllable was never changed, and the final syllables (-IM, -AM, -EM, -IS, -AS, -ES) were balanced across all verbs and pseudoverbs.

The pronoun slides and the inflected verb slides were grouped into pairs such that (1) the inflected verb slides contained a word in one half of the pairs and a pseudoword in the other half; and (2) the pronoun slides contained the pronoun JA which is specific to verbs in the first person singular or the pronoun TI which is specific to verbs in the second person singular or a monosyllabic pseudoword (a pseudopronoun). Six monosyllabic pseudo words – JO, VA, DA, TR, ZI, KI – were derived from the pronouns JA and TI by changing the initial or final letter. Forty monosyllabic pseudoword slides were prepared with the letter string JO, twenty slides with VA, twenty slides with DA, forty slides with TR (R can function as a vowel in the language), twenty slides with ZI, and twenty slides with KI.

In total, there were 640 different pairs of slides of which a given subject saw 160 pairs. Forty other different pairs of slides were used for the preliminary training of subjects.

Design. As remarked, each verb and pseudoverb appeared in two persons. A constraint on the design of the experiment was that a given subject never experienced a given verb or pseudoverb in either inflected form more than once. Put differently, each subject saw the same verbs and pseudoverbs as every other subject but not necessarily in the same person nor necessarily preceded by the same pronoun or pseudopronoun type. In one half of the 160 trials the second stimulus in a pair was a verb and in the other half the second stimulus was a pseudoverb. The set of 80 verbs that was presented to a subject consisted of 40 verbs in first person singular and 40 other verbs in second person singular. These two groups of words were further divided into four subgroups of ten verbs each. Similarly, the set of 80 pseudoverbs that was presented to a given subject

consisted of 40 pseudoverbs in the first person singular and 40 other pseudoverbs in the second person singular. These two groups of pseudoverbs were further divided into four subgroups of ten pseudoverbs each.

Four subgroups, two of verbs and two of pseudoverbs, were preceded by the nominative first person pronoun JA. Four other subgroups, two of verbs and two of pseudoverbs, were preceded by the nominative second person pronoun TI. With respect to the pseudopronouns, two groups of verbs and two groups of pseudoverbs were preceded by the pseudopronouns JO, VA or DA. The other two groups of verbs and pseudoverbs were preceded by the pseudopronouns TR, ZI or KI.

There were four groups of 16 subjects each. All received the same experimental manipulation and differed only with regard to the particular stimuli they were presented. Each subject in each group of 16 subjects saw each pronoun-verb, pseudo-pronoun-verb, pronoun-pseudoverb, and pseudopronoun-pseudoverb combination. Put differently, each subject saw the same verbs and pseudoverbs as every other subject but not necessarily in the same person nor necessarily preceded by the same pronoun or pseudopronoun type.

Procedure. On each trial, two slides were presented. The subject's task was to decide as rapidly as possible whether the letter string contained in a slide was a word. Each slide was exposed in one channel of a three-channel tachistoscope (Scientific Prototype, Model GB) illuminated at 10.3 cd/m^2 . Both hands were used in responding to the stimuli. Both thumbs were placed on a telegraph key button close to the subject and both forefingers on another telegraph key button two inches further away. The closer button was depressed for a 'No' response (the string of letters was not a word); and the further button was depressed for a 'Yes' response (the string of letters was a word).

Latency was measured from the onset of a slide. The subject's response to the first slide terminated its duration and initiated the second slide unless the latency exceeded 1300 ms in which case the second slide was initiated automatically. The duration of the second slide, unlike that of the first, was fixed at 1300 ms.

Results

Analyses were performed only on those latencies to the second slide which were correct and less than 1300 ms. Total error rate was 1.3 per cent. Mean lexical decision reaction times for 'word' decisions and 'nonword' decisions are presented in Table 3.

An analysis of variance was performed on each subject's mean reaction times in each combination of prime lexicality (pronoun vs. pseudopronoun), target lexicality (verb vs. pseudoverb), and person (first vs. second). Because the results were essentially similar for both persons in this analysis as well as the subsequent one, the presentation and interpretation of the results have been simplified. When the person of the prime and target were the same, the combination has been labelled 'appropriate' and when different, the combination has been labelled 'inappropriate'. Thus for Table 3, data for both the first and second persons have been combined to give a mean for 'appropriate' priming of real verbs of 652 ms. Similarly, the mean of the inappropriate cell, 780 ms, is a combination of first person pronouns preceding second person verbs and second pronouns preceding first person verbs.

Table 3. Experiment 1: Reaction time in milliseconds to verbs and pseudoverbs when primed by grammatically appropriate or inappropriate pronouns or by pseudopronouns

Prime	Target	
	Verbs	Pseudoverbs
Appropriate pronoun	652	758
Inappropriate pronoun	780	731
Pseudopronoun	726	794

The analysis on word data showed that there were no significant differences between groups of subjects, $F(3, 60) = 0.93$, $MSe = 34,418$, $p < 0.50$. Also, the average latency of a verb when preceded by a pronoun did not differ from the average latency of a verb preceded by a pseudopronoun; $F(1,60) = 2.91$, $MSe = 4,026$, $p < 0.10$. However, the interaction of verb ending with pronoun person was significant; $F(1,60) = 118.91$, $MSe = 4,086$, $p < 0.001$, accounting for the non-significant main effect of pronoun versus pseudopronoun. Further, inflected verb ending, pronoun person, and pronoun lexical status (real or pseudo) formed a three-way interaction: $F(1,60) = 137.79$, $MSe = 3,993$, $p < 0.001$. This is to say that latencies to inflected verb forms varied as a function of whether (i) the prime was a pronoun or a pseudopronoun; and (ii) the pronoun was grammatically appropriate or inappropriate, that is, grammatically consistent or inconsistent with the verb ending. Inspection of Table 3 reveals that the decision time for verbs was shorter when the pronoun was grammatically appropriate.

The analysis of variance on pseudoverb data, showed no main effect due to subject group, $F(3,60) = 0.44$, $MSe = 47,985$, $p < 0.50$. However, there was a significant main effect of the pronoun's lexical status, $F(1,60) = 54.48$, $MSe = 5,267$, $p < 0.001$, such that pronouns (relative to pseudopronouns) reduced reaction times to pseudoverbs. There was a significant two-way interaction of verb ending with pronoun person, $F(1,60) = 13.42$, $MSe = 1,168$, $p < 0.001$, which must be interpreted relative to a three-way interaction of verb ending, pronoun person, and pronoun vs. pseudopronoun, $F(1,60) = 21.14$, $MSe = 1,061$, $p < 0.001$. This suggests that it was more difficult to reject pseudoverbs which were preceded by an appropriate pronoun than to reject the same inflected pseudoverbs preceded by an inappropriate pronoun. Finally, when a pseudoverb was preceded by a pseudopronoun, there were no significant differences among the inflected forms of the pseudoverb. To sum up, pseudoverb rejection latencies were faster when the preceding item was a pronoun as opposed to a pseudopronoun but, for these faster latencies, an appropriate pronoun slowed pseudoverb rejection more than an inappropriate pronoun.

Discussion

Facilitation of lexical decision by a preceding item is generally said to occur either by means of a process that is automatic or by means of a process that is conscious and attentional (Posner and Snyder 1975; Neely 1977). As an example of the latter, lexical decision on inflected verbs which were preceded by a grammatically appropriate pro-

noun may have been facilitated by the subjects consciously expecting to observe the inflected ending specific to the pronoun before the verb was displayed. If such was the case – that the facilitation we observed was due entirely to the allocation of selective attention – then there would be little reason to believe that the observed facilitation is characteristic of the process of lexical access during natural discourse. It is well known that attentional priming is slow relative to automatic priming (e.g., Stanovich and West 1981) and it is unlikely that attentional priming could play a useful role in the lexical access of verbs, given the normally close temporal contiguity between pronoun and verb.

First consider the pseudoverb results; these are consistent with the notion of automatic processing. To begin with, there was no general inhibition effect. Compared to pseudopronouns, inappropriate as well as appropriate pronouns expedited negative decisions on pseudoverbs. The overall reduction in rejection latencies induced by a preceding pronoun suggests that pronouns and verbs may stand in a special relation. One speculation is that pronouns trigger a verb processing mechanism which operates on the morphological structure of verbs. The pseudoverb data are consistent with the notion that verb processing begins with a decomposition of the verb into stem and suffix and that a preceding pronoun primes the mechanism that performs this morphological decomposition.

Assuming, therefore, that a pronoun quickened the decomposition of a following verb, argument can be given that this effect occurred automatically. Consider the contrary possibility, that the effect was due to an attentional mechanism. If the pseudopronoun-pseudoverb sequence is regarded as an instance of neutral priming, then the pronoun-pseudoverb sequence can be regarded as an instance of negative priming, misleading the subject to consciously expect a verb. Because of a pronoun, an attentional expectation of a verb is formed directing processing capacity to the verb region of the lexicon and reducing the processing capacity for the pseudoverb that follows. If the latter were the case then pseudoverb decision times should have been slowed by a pronoun relative to the pseudoverb decision times associated with a pseudopronoun. The fact that the opposite outcome was observed suggests that the grammatical relation between pronoun and verb facilitated rejection of the pseudoverb automatically rather than attentionally.

A further observation on pseudoverbs suggests the involvement of postlexical processes. Reaction time to a pseudoverb preceded by a pronoun appropriate to its inflected ending was slower than reaction time to a pseudoverb preceded by a pronoun inappropriate to its inflected ending (see Table 3). The congruency between a morpheme currently being processed (the inflected ending of the pseudoverb) and a recently processed pronoun may retard the decision to reject the rest of the target item (the pseudoverb stem) as nonsense.

In contrast to the pseudoverb data, the verb data are not consistent with the notion of automatic processing. The latencies to verbs preceded by inappropriate pronouns were slower than the latencies to verbs preceded by pseudopronouns. This fact is easy to understand in terms of attentional facilitation and difficult to understand in terms of automatic facilitation. Selective attention (but not automatic priming) uses conscious processing capacity and when it is directed to the wrong target (for example, by an

inappropriate pronoun) the subject has fewer resources to use in processing the actual target which is displayed.

Attentive rather than automatic processing is said to dominate at longer temporal separations between the priming stimulus and the target stimulus. With short temporal separations inhibition effects are negligible, becoming increasingly substantial as the separation is lengthened (Neely 1977). If the effects of pronouns on verbs are mediated by attentive processing then the latency of accepting as a word a verb that follows an inappropriate pronoun should be greater when the verb is separated from the pronoun by a long interval compared to when the separation interval is short. This hypothesis is evaluated in the second experiment which, in addition, seeks to replicate the pattern of results obtained in the first experiment.

Experiment 2

The design of Experiment 2 permitted a systematic study of the effect of the length of time permitted for pronoun processing before the appearance of the verb. Two stimulus onset asynchronies were used: 300 ms and 800 ms. These intervals bracket the average intervals subjects produced themselves in Experiment 1. In contrast to the first experiment, subjects in Experiment 2 were required to make a lexical decision only to the second stimulus (the verb or pseudoverb target). In further contrast, the first stimuli in the second experiment were always pronouns; there were no pseudopronouns. In all other respects the design and the stimuli were the same as Experiment 1. Verb and pseudoverb targets were preceded by pronouns that were either appropriately or inappropriately matched to the target's inflectional suffixes.

Method

Subjects. Eighty students from the Department of Psychology, University of Belgrade, received academic credit for participation in the experiment. None of the subjects previously took part in Experiment 1.

Materials. The stimuli were the same as in Experiment 1 with the exception of the pseudopronoun stimuli which were not used. In total there were 160 different pronoun-verb pairs and 160 pronoun-pseudoverb pairs.

Design. A subject was assigned to one of eight groups, to give a total of 10 subjects per group. Each subject saw 80 pairs of stimuli. The first stimulus in each pair was a pronoun. In half of the 80 trials the second stimulus in a pair was a verb and in the other half the second stimulus was a pseudoverb. Each subject in each odd-numbered group of 10 subjects (i.e. in Groups 1, 3, 5, 7) saw 40 different stimulus pairs in the pronoun-verb combination and 40 other different stimulus pairs in the pronoun-pseudoverb combination. Within each combination, the pronoun, verb, or pseudoverb appeared equally often in the first and the second person. The onset-onset interval between prime and target in these groups was 300 ms. Similarly, each subject in each even-numbered

group of 10 subjects (i.e., in Groups 2, 4, 6, 8) saw the same stimuli pairs as his/her counterpart in the oddnumbered groups. The onset-onset interval for these groups was 800 ms.

Procedure. The procedure was similar to that in Experiment 1 except for the fact that the subject gave a response only to the second stimulus in each trial. The first stimulus in each trial was always presented for 300 ms; the second stimulus was presented with no delay (for half the subjects) or with a delay of 500 ms (to the other half).

Latency was measured from the onset of the second slide. Display of the second slide was terminated by a key press.

Results and Discussion

An analysis of variance was performed on each subject's mean reaction time computed on all correct responses out of the ten trials in each experimental situation. All latencies shorter than 300 ms and longer than 1300 ms were considered as errors. The total error rate was 1.7 per cent.

Table 4 presents the mean reaction time data for verb targets primed by appropriate or inappropriate pronouns at stimulus onset asynchronies of 300 ms or 800 ms. Inspection of the results for real verbs suggests that appropriate pronouns facilitated verb recognition relative to inappropriate pronouns. There is also the suggestion that the relative priming facilitation increased as the interval between prime and target onsets increased. Inspection of the pseudoverb results suggests that the four pseudoverb conditions which were preceded by pronouns did not differ.

Analysis supported these suggestions. First, an analysis of variance was performed on the average verb and pseudoverb latencies in each experimental condition for each subject. There were several interactions which reflected effects due to counterbalancing the assignment of specific verbs and pseudoverbs to the various conditions. For the five-way interaction for counterbalanced subject groups with stimulus onset asynchrony, verb/pseudoverb, first person/second person pronoun, and appropriate/inappropriate suffix was significant, $F(3,72) = 3.39$, $MSe = 1,259.9$, $p < 0.03$. Inspection of this and other interactions involving groups indicated that the trends in the data were similar for all groups; the ordinal relationships in the data discussed below were true for all groups although the sizes of the differences changed.

Table 4. Experiment 2: Reaction time in milliseconds to verbs and pseudoverbs when primed by appropriate or inappropriate pronouns at 300 or 800 millisecond stimulus onset asynchronies

Prime	Target			
	Verbs		Pseudoverbs	
	300 ms	800 ms	300 ms	800 ms
Appropriate pronoun	666	643	731	722
Inappropriate pronoun	729	739	717	714

The interaction of verb/pseudoverb by appropriate/inappropriate inflection by stimulus onset asynchrony was significant, $F(1,72) = 6.01$, $MSe = 1,777.4$, $p < 0.02$. This three-way interaction was studied further by performing two analyses of variance, separately, on verbs and pseudoverbs. As Table 4 suggests, the two-way interaction between appropriate/inappropriate inflection and stimulus onset asynchrony was significant, $F(1,72) = 10.45$, $MSe = 1915.1$, $p < 0.002$. Inspection of the table shows that the large difference between appropriately and inappropriately primed verbs at the short 300 ms asynchrony (666 and 729 ms, respectively) is somewhat larger at the 800 ms asynchrony (643 and 739 ms, respectively). Thus, the increasing onset asynchrony between prime and target was effective in increasing the differential between appropriate and inappropriate primes. It is clear that there is a strong main effect for appropriateness over and above its interaction with onset asynchrony; the latency difference between verbs with inflected endings appropriate to the pronoun and verbs with inflected endings inappropriate to the pronoun was highly significant, $F(1,72) = 262.6$, $MSe = 1,915.1$, $p < 0.001$. This main effect of appropriateness was the most striking result of the verb analysis confirming the large effect which was found in Experiment 1. There were also reliable effects due to the person of the pronoun (not shown in Table 4); verb reaction times were faster following a first person pronoun prime than a second person pronoun prime $F(1,72) = 1,601$, $MSe = 949.8$, $p < 0.001$.

A different picture emerged from the analysis of pseudoverbs. There, the two-way interaction between appropriate/inappropriate inflection and onset asynchrony was not significant and, in fact, its mean square was small, $F(1,72) = 0.76$, $MSe = 507.7$. However, the main effect of appropriateness, although small, was very reliable, $F(1,72) = 16.1$, $MSe = 655.9$, $p < 0.001$. As Table 4 indicates, the pseudoverb with inflected endings which were appropriate to the preceding pronoun were rejected as words more slowly than inappropriate pseudoverbs. Finally, although not indicated in Table 4, the person of the preceding pronoun was again significant. The first person pronoun facilitated subsequent lexical decisions more than the second, $F(1,72) = 15.3$, $MSe = 1,017.6$, $p < 0.001$.

Thus, the pattern which was observed in Experiment 1 was replicated under the conditions of Experiment 2. Verb lexical decision was faster and pseudoverb lexical decision was slower in the presence of a grammatically appropriate pronoun relative to an inappropriate pronoun. Additional results from the present experiment suggested that the relative facilitation of verbs and inhibition of pseudoverbs was largely completed within the 300 ms onset asynchrony; only small increases occurred when the pronoun was displayed for 800 ms before the verb came on.

Although the significant interaction between appropriateness and temporal separation for the verb is in accordance with the attentional hypothesis nevertheless, the fact that the effect of appropriateness was largely established by the 300 ms interval implies that the pronominal influence is principally automatic and not attentional. And, as in Experiment 1, the data for pseudoverbs lend no support to an attentional source of the priming effect. When the latter result is considered together with the grammatical influence on verbs at a 300 ms separation of pronoun and verb an automatic view of the pronominal influence on verbs emerges as the most parsimonious.

Experiment 3

Verbs and pronouns are open and closed word classes, respectively. There is evidence, as noted in the introduction, that words of an open class and words of a closed class may not be processed in the same manner. It might also be the case that the effects on the processing of items of one class induced by items of the other class are not symmetrical. In particular, pronominal influences on verbs may not be identical to verbal influences on pronouns. A third experiment was conducted using the material from the first experiment and similar to the first experiment in all respects except for a reversal of the order of stimuli within each pair: the prime was a verb (or pseudoverb) and the target was a pronoun (or pseudopronoun).

Twenty-five students from the Department of Psychology, University of Belgrade, participated in the experiment. None of them had participated in the first experiment.

Results and Discussion

Mean decision times for the pronoun and pseudopronoun targets are presented in Table 5. Mean acceptance latency for pronouns was faster when preceded by grammatically appropriate verbs than by inappropriate verbs. Slowest were pronouns preceded by pseudoverbs. In contrast, mean rejection latencies for pseudopronouns were approximately equal whether preceded by appropriate verbs, inappropriate verbs, or pseudoverbs. With regard to the verb and pseudoverb targets which appeared as first stimuli in each trial the average acceptance latencies for verbs in first and second person in the present tense were 735 ms and 752 ms, respectively, whereas the mean rejection latencies for pseudoverbs in first and second person were 771 ms and 774 ms, respectively. The total error rate (wrong responses and slow responses) on first and second stimuli was respectively 1.8 % and 2.0 %.

The suggestion that the decision time to a pronoun was shorter when the pronoun was preceded by a verb as opposed to a pseudoverb and the suggestion that the latency to an appropriately primed pronoun was shorter than to an inappropriately primed pronoun were substantiated by the statistical analyses. An analysis of variance revealed that the legality of the prime (verb vs. pseudoverb) was significant, $F(1,24) = 48.33$, $MSe = 1,925$, $p < 0.001$. Grammatical person of the pronoun target (first vs. second) was not significant but a three-way interaction among legality of prime (verb or pseudoverb) inflected ending of prime (appropriate or inappropriate), and the person of the pronoun

Table 5. Experiment 3: Reaction time in milliseconds to pronouns and pseudopronouns when primed by appropriate and inappropriate verbs

Prime	Target	
	Pronouns	Pseudopronouns
Appropriate verb	550	645
Inappropriate verb	575	645
Pseudoverb	613	656

was significant, $F(1,24) = 5.54$, $MSe = 634$, $p < 0.05$. This significant interaction means that grammatical consistency between the inflected ending of the preceding verb or pseudoverb and the pronoun was an important factor only when the preceding item was a verb. With regard to pseudopronouns, inspection of Table 5 suggests that in all combinations the rejection latencies were about the same, a suggestion that was supported by the analysis of variance.

The average acceptance latency for a pronoun was shorter when it was preceded by a verb than when it was preceded by a pseudoverb. Importantly, this reduction occurred whether or not the ending of a priming verb was grammatically appropriate to the person of the pronoun. Clearly, the obtained data can not be explained in terms of priming the pronoun by the verb ending, since all the pseudoverbs that were used in this experiment had the same endings as the verbs (*m*, *s*) yet the lexical decision on pronouns was indifferent to the pseudoverbs that preceded them. The acceptance latencies to pronouns in the grammatical and non-grammatical pseudoverb-pronoun combinations were virtually identical.

A closer examination of verb-pronoun combinations reveals that the average decision latency for pronouns was statistically faster when the verb ending was appropriate to the pronoun than when it was not appropriate. This observation suggests that an appropriate inflected ending was able to enhance lexical decision on a pronoun over and above the enhancement produced by a preceding verb. Importantly, a differential effect of the appropriateness of the inflected ending to the pronoun was not found with pseudoverbs.

An interpretation of these data is that a verb preceding a pronoun primes the (small) set of pronouns, a pseudoverb does not. In addition, the verb primes the particular member in the pronoun set that is congruent with the verb's inflected ending. This priming would appear to be automatic. Inhibition effects were absent and the presence of a verb significantly affected the latencies for accepting pronouns as words even though throughout the experiment subjects could only rely on the fact pronouns and pronoun analogues would appear as second stimuli.

In summary, the most noticeable commonality between the first two experiments and the third is that the shortest acceptance latency for a word target was in the condition in which the word pair was grammatical. In short, pronouns and verbs are mutually facilitating. The most noticeable difference between the first two experiments and the third is that the data of the third experiment display no inhibition effect (pronouns preceded by grammatically inappropriate verbs were responded to faster, not slower, than pronouns preceded by pseudoverbs) and exhibit no differentiation within the group of decision latencies on pseudopronouns. In short, verbs affect the pronouns they precede in a way different from the way that pronouns affect the verbs that follow them.

Taken together, the results of the three experiments suggest that pronouns can automatically facilitate verbs and that verbs can automatically facilitate pronouns but that the mechanism of facilitation is not the same in the two cases.

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