SOME WORD-ORDER EFFECTS IN SERBO-CROAT*

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In the Serbo-Croatian language, the relative order of subject (S), verb (V), and object (O) is flexible. All six of the permutations of those elements have identical words, meaning, and voice, and all six are grammatically acceptable. Nonetheless, SVO is the dominant form. The psychological reality of this dominance was assessed in three tasks. SVO was associated with the shortest latencies (and SO forms in general were faster than OS forms) when subjects were asked to evaluate the plausibility of a sentence (Experiment 1) or to initiate an utterance (Experiment 2). This advantage did not obtain in lexical decision (Experiments 3 and 4). Results are discussed in the context of linguistic universals of word order and Forster's (1979) model of the language processor.

Keywords: word order, universals, lexical access

INTRODUCTION

The relative order of subject, verb, and object is fairly flexible in Serbo-Croat, the major language of Yugoslavia. Of the six possible orders (SVO, SOV, VSO, VOS, OSV, and OVS), all have the same referential meaning and all are considered to be grammatically acceptable (Belić, 1933). Relevant grammatical information is carried by case inflections on nouns rather than word order. For example, in *Granata pogađa palatu, Granata palatu pogađa,* etc. 'the grenade strikes the palace,' the nominative (*grenade*) and accusative (*palace*) are distinct and the direction of action is clear.

With respect to what we might term word order "preferences" demonstrated by the world's languages, Greenberg (1966) has noted that the vast majority have several variants but one dominant order. Of the six possibilities, however, all are not equally likely to dominate. In fact, orders in which the object precedes the subject (VOS, OSV, and OVS) are quite rare. Of the three so-called common types, SVO is the most frequent and it is this order that dominates in the Serbo-Croatian language (Greenberg, 1966). The issue

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to be addressed is whether or not the universal rarity of OS constructions relative to SO constructions has a parallel in word-order preferences of readers of a language in which both constructions are equally acceptable and equally meaningful. In other words, does the bias against OS orders in languages in general surface in a processing bias against OS orders in Serbo-Croat?

Among Yugoslavian children, at least, the answer appears to be yes. On a task in which 2-4 year-olds were required to act out sentences with toy animals, Slobin and Bever (1982) reported that performance on OS sentences was worse than performance on SVO sentences (where 67% was considered above chance, they averaged 63% and 73% correct, respectively). In contrast, young speakers of Turkish, also an inflected language, were equally facile with both orderings (83% and 81%). This suggests that there is not an inherent difficulty of OS sentences. Slobin and Bever maintain that the difference between the two groups lies in the reliability of inflections in the two languages. In Turkish, they are always regular and explicit but in Serbo-Croat there are many irregular declensions and many instances in which cases are indistinct (e.g., the declension for *stvar* 'thing' is *stvar, stvari, stvari, stvar, stvar, stvari, stvari* for nominative, genitive, dative, accusative, vocative, instrumental, and locative, respectively). In such cases, and in the absence of logical constraints, word order is necessary to understand the sentence. Slobin and Bever argue that the convention is to follow the SVO order in ambiguous sentences and that this tendency seems to spill over to inappropriate circumstances (i.e., when inflections are explicit) resulting in poorer performance by the Yugoslavian children.

Whether or not the canonical form continues to enjoy an advantage in adult linguistic performance is the focus of the present investigation. Broadening the comparison to SO vs. OS sentences will allow us to disentangle word-order effects from frequency effects. Advantages for the canonical form might be attributable to the fact that SVO is the most frequently occurring word order. But an advantage of, say, VSO over OSV would provide a stronger case for the influence of word order given that OSV is the next most frequent order in speech after SVO while verb-initial orders are the least frequent.

We will evaluate psychological consequences of varying word order in terms of three questions. First, is the speed of recovery of meaning from a printed sentence influenced by the order in which the words appear? This is addressed with a sentence verification task in Experiment 1. Second, is the speed with which an utterance is assembled affected by the ordering of the words that comprise it? A modified naming task is used to address this question in Experiment 2. And, finally, is the speed with which one lexically evaluates the last word of a sentence affected by altering the order of the two words that precede it? This will be assessed with standard lexical decision tasks in Experiments 3 and 4. One way in which to understand the differences among these tasks is in the context of Forster's (1979, 1981, 1985) characterization of the language processor. Briefly, this model posits that three relatively independent, hierarchically arranged operations are necessary for normal language comprehension: (1) The lexical processor accesses the representations of words in the lexicon; (2) the syntactic processor assigns a grammatical structure to the arrangement of words (stem with attached affixes); and (3) the message processor assigns meaning to the arrangement of words. Each operates automatically, and autonomously, accepting inputs from no source other than the next lowest level. A general problem solver integrates the outputs of these operations.

It can be supposed that in order to accommodate the variety of experimental tasks, the general problem solver can be reorganized into a variety of special-purpose devices. That is to say, although the general problems to be solved in normal language are not limited to, say, binary decisions as to lexicality or plausibility, such decisions can be made. Discerning the influences on those special purposes may elucidate the organization that underlies ordinary language comprehension. For example, if a special purpose device is influenced by information that is not directly relevant to its decision, then we might suppose that the processes responsible for evaluating that information are unavoidable, automatic aspects of normal language comprehension that cannot be disengaged simply because a contrived task does not require them. We will discuss each of our tasks, in turn, in light of this strategy.

The sentence-verification procedure used in Experiment 1 requires consideration of knowledge not explicitly stated in a given sentence in order to decide whether or not the situation described is semantically plausible (e.g., "father shaves beard" vs. "boy eats concrete"). Insofar as the relevant attributes are available in the lexicon,[1] the message processor could provide the requisite information to a special-purpose sentence verification device. In this fashion, plausibility evaluations might be accomplished on the basis of the language processor alone, that is, without reference to general conceptual knowledge.[2] Outputs from the other processors, though not directly relevant to the decision, might be expected to speed or slow the decision as a function of whether or not they are consistent with the output of the message processor.

In assembling an utterance (Experiment 2), readers were forced to consider entire utterances: They were instructed to read the word triads smoothly, as an entity, rather than word by word. The task can be considered as somewhat akin to naming experiments

[1] Forster (1979) points out that "the tailor made uniforms" can be assessed on the basis of information provided by the lexical entries but "the fireman sprayed the stadium" requires background knowledge (being on fire is not a typical characteristic of a stadium). Kostić (1983) offers verb valence (Starchuk and Chanal, 1963) and animateness mode requirements as lexical markers that could similarly permit the message processor to perform pragmatic evaluations in inflected languages. For example, a verb such as *govoriti* (to speak) requires, by and large, an animate noun in the dative case (*Govori bratu* 'He speaks to the brother'). Either type of animateness violation (*Govori brata* 'He speaks the brother' and *Govori magli* 'He speaks to the fog,' respectively) is pragmatically infeasible.

[2] This construal of the message processor should be distinguished from what Fodor (1983) has described as a Quinean process, one which considers information from a variety of sources, using background knowledge not provided by the immediate circumstances. Fodor contrasts this with modular processes which are fast, mandatory, and cannot be influenced by information from sources outside their domain. In Forster's model, however, the message processor is supposed to be a module just as the lexical and syntactic processors are modules; it operates quickly and inexorably. Its domain happens to include information about real-world possibility to the extent that some information useful to that designation is to be found in the lexicon.

in which subjects simply read a target word. Latencies to initiate pronunciation are slowed for nonwords relative to words (Theios and Muise, 1977) and, at least for English, are hastened by an associatively related prime. But they seem to be unaffected by syntactic relatedness (Seidenberg, Waters, Sanders and Langer, 1984). A special-purpose naming device, therefore, seems able to ignore the signal from the syntactic processor.

In the lexical decision task, positive output from the lexical processor indicates that a lexical entry has been found and so the decision device issues a "yes." Access occurs more quickly if a lexical entry of interest has been "primed" by an associatively related one (e.g., Lupker, 1984; Meyer, Schvaneveldt and Ruddy, 1975). It has also been shown, however, that in this task, which seems to require information from the lexical processor alone, the special-purpose decision making device cannot ignore information from the syntactic and message processors. For example, violations of the prescribed case, gender, or number agreement between context and target pairs in Serbo-Croat are revealed by the syntactic processor (which does so by paying attention to, rather than stripping, inflections), yet they slow lexical decision time relative to grammatically congruent pairs (see Gurjanov, G. Lukatela, K. Lukatela, Savić and Turvey, in press, for a summary of such results). Violations of pragmatic event structure have similarly been found to lengthen lexical decision (Kostić, 1983). Such effects are not on the lexical processor itself but on the post-lexical special-purpose decision making device.

The direction to be taken here considers that just as the variety of special-purpose devices appear to be differentially sensitive to lexical, syntactic, and semantic aspects of language, so, too, might they be differentially sensitive to word order. While none of them requires an explicit evaluation of word order, verification and reading are somewhat global in requiring subjects to consider all three words at once. Lexical decision, in contrast, is more local because the actual decision is concerned only with the last word. It is expected that the globally oriented special-purpose devices – verification and reading – will be more sensitive to word order than the locally focused lexical-decision device.

To be redundant, some word-order effects are expected even though changing word order does not change semantic or syntactic structure, nor does it entail a change from active to passive voice. Even though the nouns are in the same order as those in the English passive voice sentence "The man(O) was bitten(V) by the dog(S)," "*Coveka*(O) *je ujeo*(V) *pas*(S)" is in active voice and means "The dog bit the man" (Javarek and Sudjić, 1963). Any differences that might be obtained, therefore, can be attributed fairly confidently to the relative efficacy of putatively equivalent word orders.

EXPERIMENT 1

In classical sentence verification tasks, a reader is presented with a sentence of the type "A cat is an animal" (vs. "A cat is a mammal") or "All animals are cats" (vs. "Some animals are cats") and must decide whether it is true or false. Latency is found to be a function of semantic relatedness (Smith, 1967; Wilkins, 1971), the number of shared features (Ripps, Shoben and Smith, 1973; Smith, Shoben and Ripps, 1974) or set overlap of the subject and predicate (Meyer, 1970). More recently, investigators have looked at the implications of propositions that require one to refer to general knowledge – that is, information that is not explicitly stated – in order to verify an assertion (Hayes-Roth and Thorndyke, 1979; Singer, 1981). For example, in the context of "The woman drove downtown to work," "The woman drove a car" is implied (Singer, 1981).

Our first experiment was of this type but did not require participants to remember information from contexts. Simple three-word sentences were semantically evaluated on their own merits. Subjects and objects were chosen to be unrelated associatively or semantically while verbs were chosen to depict a semantically plausible or implausible situation (e.g., "grenade strikes palace" vs. "boy eats concrete"). Plausible sentences were constructed so that referential constraints on a given string of words permitted no ambiguity as to the direction of the action. That is to say, in a sentence such as "grenade strikes palace" distinctive case markings provide redundant information; it is clear that "palace" is not a thing that effects striking. In contrast, for a sentence such as "girl strikes boy," either noun could, in principle, do the striking and case markings would be critical to understanding the sentence. Sentences of the "grenade . . ." type provide a more conservative test of the relative merits of the various word orders because there is no need (or temptation or opportunity) to resort to the dominant word order as a default interpretation. Word order should be superfluous to verification which simply requires understanding the possible events into which the constituents could enter. The usual concerns of verification experiments for whether or not words are ambiguous (e.g., Oden and Spira, 1983; Seidenberg, Tanenhaus, Leiman and Bienkowski, 1982) or whether the properties with which the sentences are concerned are the dominant properties for those words (Ashcraft, 1976; Barclay, Bransford, Franks, McCarrell and Nitsch, 1974) do not matter here because they are constant across word orders.

The experiment was designed to focus on the contrast between the dominant or canonical form in Serbo-Croat, SVO, and the noncanonical forms. Each of five groups of participants saw SVO type sentences and one other form. It was hypothesized that the semantic relationship implicit in these sentences would be recovered most quickly from the canonical form specifically, and from SO constructions in general.

Method

Subjects. Eighty high school seniors from the Fifth Belgrade Gymnasium served voluntarily as subjects. None had had previous experience with visual processing experiments. There were 16 subjects in each of five experimental groups. Each experimental group was further subdivided into two counterbalancing groups of eight subjects each.

Materials. Target sentences were variants of a basic set of 46 semantically plausible and 46 semantically implausible three-word sentences. In order to generate a large enough pool with the appropriate properties (e.g., CVCV . . . structure, midfrequency range, unambiguous case markings), two word lengths were necessary: Twenty-four sentences of each plausibility set were fashioned from six-letter words and twenty-two of each set comprised words of four letters each. All words were singular in number. Verbs were transitive in the third person present tense. Subjects were nouns in the nominative case, while objects were nouns in the accusative case. Nouns were chosen so that these case inflections were distinct. Otherwise, nouns were not restricted as to gender or animateness. The subject and object of a given sentence simply were chosen so as to exhibit no obvious semantic or associative link. Each of the 92 sentences was typed in upper-case Roman letters in each of the six word orders to prepare a total of 552 black on white slides. Each letter string was centered on a slide.

Design. The six word-order comparisons were distributed over five experimental groups, the SVO always compared with one other order. Two experimental lists were composed for each counterbalancing group (A and B) in each experimental group (1, 2, 3, 4, and 5). Group 1A saw half of the sentences (11 four-letter plausible, 11 four-letter implausible, 12 six-letter plausible, and 12 six-letter implausible) ordered SVO and the other half ordered SOV. Group 1B saw the same 92 sentences with the SVO and SOV now applied to the counterbalancing halves. This was true of groups 2 (SVO vs. VSO), 3 (SVO vs. OSV), 4 (SVO vs. VOS), and 5 (SVO vs. OVS). In sum, each subject saw the same sentences as every other subject but not necessarily in the same word order; no subject ever experienced the same sentence more than once (not even in a different word order); and each sentence appeared in every word order.

Procedure. On each trial, a single sentence was exposed for 2500 msec (with a 5000 msec intertrial interval) in one channel of a three-channel Scientific Prototype Model GB tachistoscope, illuminated at 10.3 cd/m^2. The subject's task was to decide as rapidly as possible whether or not the sentence described a meaningful, possible event. Subjects were instructed not to assume a poetic or philosophical attitude toward the nature of possibility but to adopt a common sense criterion. Decisions were indicated by depressing a telegraph key with both thumbs for a "No" response or by depressing a slightly further key with both forefingers for a "Yes" response. Latencies were measured from the onset of a slide. The experimental sequence was preceded by a practice sequence of 20 different sentences which were the same for all experimental groups.

Results and discussion

Error rates are summarized in Table 1. It can be seen that subjects were in fairly high agreement with the experimenters' categorization of plausible and implausible sentences, particularly when one considers that some proportion of the errors is due to the speeded classification task itself.

Average verification latencies are shown in Table 2. Because the six-letter-word sentences contained 50% more letters than the four-letter-word sentences, word length was included as a factor in the analysis to see if this extra load made a difference. A 5 (Group) × 2 (Canonical vs. Noncanonical) × 2 (Semantic Plausibility) × 2 (Word Length) analysis of variance revealed significant main effects of Group, $F(4, 75) = 4.88$; MSerr = 374956.06, $p < 0.005$, Canonical/Noncanonical, $F(1, 75) = 28.56$, MSerr = 9002.50, $p < 0.001$, Plausibility, $F(1, 75) = 76.74$, MSerr = 49377.39, $p < 0.001$, and Word Length, $F(1, 75) = 66.22$, MSerr = 47547.10, $p < 0.001$. Significant interactions

TABLE 1

Proportion of errors as a function of word order and plausibility

Word Order	Semantically Plausible	Semantically Implausible
Canonical	.11	.07
Noncanonical	.14	.08

TABLE 2

Average verification latencies (in msec) for canonical and noncanonical forms as a function of word length and semantic plausibility

Group	Word Order	Semantically Plausible 4-Letter Words	Semantically Plausible 6-Letter Words	Semantically Implausible 4-Letter Words	Semantically Implausible 6-Letter Words
1	SVO	1525	1707	1734	1824
	SOV	1554	1754	1755	1826
2	SVO	1579	1766	1725	1894
	VSO	1642	1766	1715	1869
3	SVO	1704	1907	2008	2091
	OSV	1846	2035	2057	2169
4	SVO	1616	1718	1836	1914
	VOS	1690	1778	1812	1941
5	SVO	1748	1960	1941	2042
	OVS	1777	2028	1972	2052

were found for Group × Canonical/Noncanonical, $F(4, 75) = 4.34$, MSerr = 9002.50, $p < 0.005$, Plausibility × Canonical/Noncanonical, $F(1, 75) = 10.18$, MSerr = 9016.78, $p < 0.005$, and Plausibility × Word Length, $F(1, 75) = 10.61$, MSerr = 16998.49, $p < 0.005$. All other F values were less than one except Group × Plausibility × Word Length, $F(4, 75) = 2.29$, MSerr = 16998.49, which failed to meet significance at the 0.05 level ($p = 0.07$).

The effect of Group indicates that the various groups differed in how quickly they responded overall, averaging 1710, 1745, 1788, 1940, and 1977 for SOV, VSO, VOS, OVS, and OSV, respectively. The Canonical/Noncanonical effect reflects a faster response time to the SVO type (1812 msec) than to non-SVO types (1852 msec). Sentences comprising four-letter words were verified more quickly than sentences comprising six-letter words (1762 msec and 1902 msec, respectively). And semantically plausible sentences were accepted more quickly (1755 msec) than semantically implausible sentences were rejected (1909 msec).

With respect to the interactions, Word Length × Plausibility indicates that the advantage for sentences of four-letter words over those of six-letter words was more pronounced in semantically plausible (a 174 msec difference) than semantically implausible (106 msec) sentences. (The three way interaction with Group approached significance because for two of the groups, the size of the advantage for four-letter words did not differ with plausibility.) The advantage of canonical over noncanonical forms was greater in semantically plausible (64 msec) than semantically implausible (16 msec) sentences. Finally, the Group × Canonical/Noncanonical interaction suggests that the degree of difference between SVO and the noncanonical forms varied for the five comparison forms (VSO–SVO = 7 msec, SOV–SVO = 24 msec, OVS–SVO = 34 msec, VOS–SVO = 34 msec, and OSV–SVO = 99 msec).

These last differences provide an indication that among noncanonical forms, SO constructions have an advantage over OS constructions. In order to permit a comparison of all permutations, each order was scaled in units of SVO. In Group 1, for example, a given subject's average response to SOV sentences was divided by that subject's average response to SVO sentences. (It should be noted that, for counterbalancing purposes, half of the subjects saw one set of SVO sentences and half saw a different set. Nonetheless, SVO is a legitimate normalizer since each subject in Group 1 had a counterpart in Groups 2, 3, 4, and 5.) A 4 (Word Order) × 2 (Word Length) × 2 (Semantic Plausibility) analysis of variance was performed on these ratios and their means (collapsed over word length) are shown in Figure 1. The main effects of Word Order, $F(4, 75) = 3.66$, MS = 0.02001, $p < 0.01$, and Plausibility, $F(1, 75) = 15.48$, MS = 0.09474, $p < 0.001$, were significant. No other effect or interaction reached significance as all yielded an $F < 1$.

The effect of Semantic Plausibility suggests that, as in the latency analysis, the various orders of implausible sentences were less different from their SVO form than were the plausible sentences, averaging 1.010 and 1.044, respectively. The effect of Word Order again suggests that there were differences among the permutations. To further assess the effect of order with respect to the SO/OS contrast, a second analysis was conducted on the ratios, this time limited to the semantically plausible sentences. This analysis

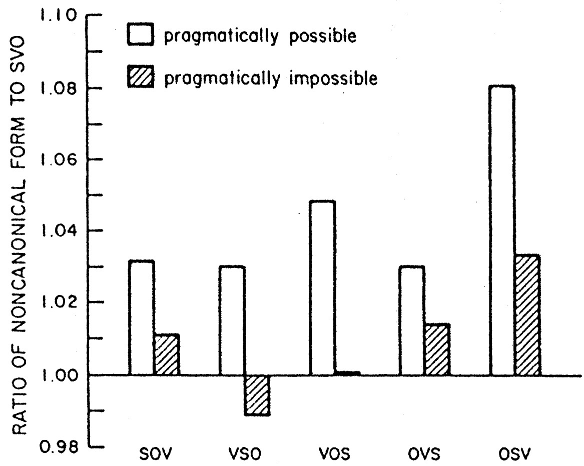

Fig. 1. Verification latencies for pragmatically possible and impossible sentences scaled in units of the canonical form.

looked at four sentence types: VSO, VOS, SOV, and OSV. The first two contrast SO and OS when the verb is the first word of the sentence, while the second two set up the contrast when the verb is the last word. The SO/OS contrast with V in the middle could not be included, since SVO, as the standard, would enter only ones into the analysis. A 2 (Verb Location) X 2 (SO/OS) X 2 (Word Length) analysis of variance revealed one significant effect: SO/OS, $F(1, 60) = 4.18$, MS = 0.00839, $p < 0.04$. That is, SO constructions differ from OS constructions. All other Fs were less than 1 except Verb Location, $F(1, 60) = 1.14$, MS = 0.00839, $p > 0.25$.

All analyses showed that word order influences the speed with which speakers/readers of Serbo-Croat can semantically evaluate a three-word sentence. This was true when the canonical SVO form was contrasted with all others as well as in the general contrast between SO and OS forms. Other standard influences on verification – typicality, relatedness, ambiguity – do not differ from one word order to the next. Typicality might be relevant if it is construed as structural typicality, but it should be noted that the SO/OS contrast overrode the frequency differences among the various word orders. That is to say, even though OSV is second to SVO in frequency of occurrence, it was evaluated slowly relative to SO sentences. Similarly, VSO (as a V-initial order) is infrequent, but it was evaluated quickly, relative to OS orders. These differences were consistent with the prediction motivated by observations of linguistic universals of word order.

Experiment 2

While ordinary naming tasks seem to be immune to influences of syntactic and message levels of processing, assembling an utterance so that it can be spoken as a unit may be sensitive to such influences insofar as they affect something like prearticulation planning (e.g., Cooper and Ehrlich, 1981) or articulatory routines for stress groups (Sternberg, Monsell, Knoll and Wright, 1978). For example, one of the uses of word-order variants in Serbo-Croat is to emphasize points of interest about the sentence ("The dog (not the child) ate the slipper," "The dog ate (rather than buried) the slipper," "The dog ate the slipper (not its dinner)"). To the extent that different stress patterns require different articulatory planning or work, word order ought to matter. These differences may themselves be linked to the canonical/noncanonical distinction with the dominant form being easier or faster.

A number of investigations of sentence production have hinted at an influence from structural variables. But, as observed by Fodor, Bever, and Garrett (1974), "What is needed is a paradigm in which structural variables are manipulated independent of content variables in a production task" (p. 404). They suggest that the data of Tannenbaum and Williams (1968), who found faster response times for active voice than passive voice descriptions of a line drawing, might be interpreted this way. Their measure was not latency to initiate a response but, rather, complete response time so the finding is inconclusive (e.g., passivization introduces extra syllables). Johnson (1966) reported longer initiation latencies for sentences whose beginning segments had higher depth (cf. Yngve, 1960) than shallower sentences matched for lexical content. These responses were to a paired-associate prompt, though; as the deeper sentences were more awkward, they may have been learned less well. More recently, Cooper and Ehrlich (1981) found no effect of early versus late clause boundaries (e.g., "I jog with the pitcher, and the umpire and Pete work out in the gym" vs. "I jog with the pitcher and the umpire, and Pete works out in the gym"). But, in addition to the reliance on memory, these sentences introduced a difference in the meaning of the contrasted sentences.

Experiment 2 does not demand that subjects learn or remember anything. Nor does the structural manipulation change the number of words to be uttered or the voice or the meaning. So, to reiterate, word-order change in Serbo-Croat is a clean manipulation of structural properties and its influence is expected to be felt in the globally oriented reading task.

Method

Subjects. Forty-two students from the Faculty of Philosophy at the University of Belgrade participated in the experiment in partial fulfillment of a course requirement. All had participated previously in reaction time experiments. There were 42 subjects in each of three experimental groups. Each experimental group was further subdivided into three counterbalancing groups with 14 subjects each.

Materials. Target sentences were variants of a basic set of 27 three-word sentences, largely the same as the six-letter-word plausible sentences of Experiment 1. Again, all words were singular in number, verbs were transitive third person present tense, subjects were nouns in the nominative case, and objects were nouns in the accusative case; gender and animacy were not restricted. Each of the 27 sentences was typed in uppercase Roman in each of the six word orders, to prepare a total of 162 black on white slides, and each was centered on a slide. All words were checked in a naming study to ensure that they were not associated with differential pronunciation latencies. Subjects (788 msec), Verbs (787 msec), and Objects (794 msec) did not differ, $F < 1$.

Design. In order to limit the burden on a given subject, the six word-order comparisons were distributed over three experimental groups, with SVO always compared with two other orders. Three experimental lists were composed for each counterbalancing group (A, B, and C) in each experimental group (1, 2, and 3). Group 1A saw nine of the sentences as SVO, nine as VSO, and nine as OSV. Groups 1B and 1C saw the same 27 sentences but with the word orders applied to different sets of nine. The same was true of groups 2 (SVO, SOV, and VOS) and 3 (SVO, OVS, and SOV, which was repeated so that the groups would be equated with respect to how many sentences a subject saw). In sum, each subject saw the same sentences as every other subject but not necessarily in the same word order; no subject ever experienced the same sentence more than once (not even in a different word order); and each sentence appeared in every word order.

Procedure. On each trial, a single sentence was exposed for 1500 msec (with a 5000 msec intertrial interval) in one channel of a three-channel Scientific Prototype Model GB tachistoscope, illuminated at 10.3 cd/m^2. The subject's task was to name this sentence aloud as rapidly as possible but necessarily "in one breath." That is, once pronunciation had commenced, it had to proceed without any stammering or stuttering. Naming latency was measured from the onset of the slide by a voice-operated trigger relay constructed by Dr. M. Gurjanov of the Faculty of Electrical Engineering at the University of Belgrade. The experimental procedure was preceded by a practice sequence of 27 different sentences which were the same for all experimental groups. Considerable feedback was provided on these practice trials to ensure that the utterances were produced smoothly.

Results and discussion

Each group of comparisons was analyzed separately. Because the means and variances of the treatment levels were related, a square root transformation was performed on the latency data. For Group 1, the SVO/VSO/OSV comparison was significant, $F(2, 82) = 11.73$, MSerr = 0.597, $p < 0.001$. The Group 2 SVO/SOV/VOS comparison was also significant, $F(2, 82) = 4.59$, MSerr = 0.920, $p < 0.01$. The Group 3 comparison of SVO/SOV/OVS was not significant, $F(2, 82) = 2.55$, MSerr = 0.638, $p < 0.08$. Protected *t*-tests (Cohen and Cohen, 1975) performed on Groups 1 and 2 revealed that the SVO (897 msec)/VSO (899 msec) contrast was not significant, $t(42) = 0.02$, $p > 0.50$, but SVO (897 msec)/OSV (941 msec), $t(42) = 4.05$, $p < 0.001$, SVO (922 msec)/SOV (947 msec), $t(42) = 2.14$, $p < 0.05$, and SVO (922 msec)/VOS (961 msec), $t(42) = 3.33$, $p < 0.01$, were significant. For ease of comparison with the verification data presented in Figure 1, each noncanonical order was scaled by the appropriate SVO latency and these ratios are shown in Figure 2. Again, it is apparent that the SO constructions differ less

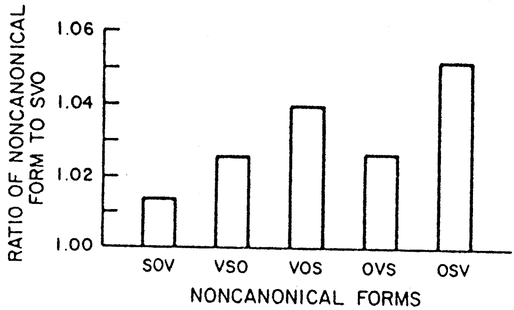

Fig. 2. Naming latencies scaled in units of the canonical form.

from the canonical form than do the OS constructions.

Word-order influences on initiating an utterance were generally consistent with those from sentence verification. SVO was always the fastest order, significantly different from one SO and two OS orders. Group 3 differences, though not significant, were in the same direction, with SVO being 4 msec faster than the SO and 21 msec faster than the OS in that group. Once again, the SO/OS contrast and not the frequency of occurrence of a given type of order governed the pattern of results. The reading task is really a hybrid of naming and sentence production tasks. As with naming, it requires no task-specific learning or memory but, as with sentence production, more than one word is uttered on a given trial. A number of manipulations that influence initiation latencies in these two types of tasks, however, do not seem to be a factor here, again because word order changes in Serbo-Croat leave so many properties unchanged. Even articulatory differences do not seem to be straightforward. Although Sternberg and his colleagues (Sternberg *et al.*, 1978; Sternberg, Wright, Knoll and Monsell, 1980) find that response latency is affected by the number of words with primary stress, this number does not vary with word order. The stress *pattern* changes but, given the finding that latency is not affected by the insertion of words with little or no stress (Sternberg *et al.*, 1978), this should not matter. Moreover, simply changing from a standard or more frequent word order does not, in and of itself, influence response latency. No latency differences were found among utterances of days of the week ordered normally, randomly, or limited to the repetition of one day (Sternberg *et al.*, 1978). Rather, our word-order differences seem to reflect something about the structure of sentences.

EXPERIMENT 3

We mentioned earlier that lexical decision is hastened by a variety of contexts, including associative (relative to neutral or unrelated), syntactic (relative to agrammatic), and semantic (relative to anomalous). An advantage is found for words in sentence contexts over words in isolation (i.e., preceded by a neutral context, Schuberth and Eimas, 1977; West and Stanovich, 1982). It would seem, then, that lexical decision is a particularly sensitive task. Nonetheless, we have already remarked that, in contrast to sentence verification and sentence reading, it is a locally focused task. While this fact has not precluded grammatic and semantic influences on the decision-making device, there are already hints that word-order processing does not enjoy the same status. An investigation of the grammatical congruency effect in noun-verb pairs and verb-noun pairs found no difference between the two word orders (Kostić, 1983). Those one-word contexts obviously did not explore the salience of SO constructions or the canonical form which provide the focus of Experiments 3 and 4. Experiment 3 was limited to verb targets in SO or OS contexts (which produced semantically plausible sentences) or in isolation (preceded by a row of asterisks). An advantage of meaningful contexts over isolation was expected in SV, VS, or asterisk contexts.

Method

Subjects. Seventy-five high school seniors from the Fifth Belgrade Gymnasium served voluntarily as subjects. None had previous experience with visual processing experiments.

Materials. Target words were 30 third person singular verbs in the present tense. The length of target words varied from four to seven letters. Thirty pseudoverbs were generated from the real verbs by changing one letter but maintaining the verb affix. Vowels were substituted for vowels and consonants were substituted for consonants. Twenty SO/OS contexts were constructed as before, with singular subjects in the nominative case and singular objects in the accusative case. Again, subjects and objects bore no obvious associative or semantic link. All sentences with word targets described semantically plausible situations. Word strings with pseudoverb targets were necessarily meaningless.

Design. Each subject saw ten (SO)V, ten (OS)V, and ten (***)V situations with verbs as targets and the same number with pseudoverbs as targets. Whether a given target was seen with an asterisk, SO or OS context was counterbalanced over subjects. Each subject saw the same sentences (or, for the asterisk context, same targets) as every other subject but not necessarily in the same word order; no subject ever experienced the same sentence more than once although pseudoword targets were repeated with different contexts; every target appeared with SO, OS, and asterisk contexts. The type of context was randomized over trials.

Procedure. A subject was seated before the CRT of an Apple IIe computer in a dimly lit room. A fixation cross was centered on the screen. On each trial, the fixation point disappeared and a centered context (SO, OS, or asterisks) appeared for 900 msec followed by an interstimulus interval of 100 msec before the target was presented, also in the center of the screen, for a maximum of 1500 msec. All letter strings appeared in uppercase Roman. Subjects were informed that some contexts would consist of words and others of asterisks. They were instructed to read the contexts where appropriate and, for all cases, decide as rapidly as possible whether or not the target was a word (periodic checks were made to ensure that subjects were reading the contexts). Decisions were again indicated by depressing a telegraph key as in Experiment 1, and latencies were measured from the onset of the target. In the event of an error, a message appeared on the screen and that trial was repeated (but its decision time was discounted). The experimental sequence was preceded by a practice session in which subjects had to achieve an error rate of less than 10% over 40 trials.

Results

Minimum and maximum acceptable latencies were set at 400 msec and 1500 msec, respectively. Average lexical decision latencies to word and nonword verb targets in SO, OS, and asterisk contexts are shown in Table 3. Because the nonword targets were filler items and not counterbalanced across groups, the analysis of variance was limited

TABLE 3

Average lexical decision latencies (in msec) to verb and pseudoverb targets as a function of context

Lexicality	Context		
	(SO)V	(OS)V	(**)V
Verbs	737	728	771
Pseudoverbs	827	845	830

to the word data. The effect of context was significant, $F(2, 148) = 16.38$, MSerr = 2361.13, $p < 0.001$. Significant protected *t*s were found for the SO/asterisk contrast, $t(150) = 6.18$, $p < 0.001$, and the OS/asterisk contrast, $t(150) = 7.62$, $p < 0.001$. Importantly, there was no significant difference between SO and OS, $t(150) = 1.44$, $p > 0.10$.

EXPERIMENT 4

Subjects. Seventy-five high school seniors from the Fifth Belgrade Gymnasium served voluntarily as subjects. None had previous experience with visual processing experiments.

Materials. Target words were 30 feminine singular nouns in the accusative case. The length of the target words varied from four to eight letters. Thirty pseudonouns were generated from real nouns by changing one or two letters but maintaining the accusative inflection. Twenty SV/VS contexts were constructed as before, with singular subjects in the nominative case and singular verbs in the present tense.

Design and procedure. The remainder of the method was the same as Experiment 3, with the appropriate exchanges of O and V.

Results and discussion

Minimum and maximum acceptable latencies were set at 400 msec and 1500 msec, respectively. Average lexical decision latencies to word and nonword object targets in SV, VS, and asterisk contexts are shown in Table 4. Because the nonword targets were filler items and not counterbalanced across groups, the analysis of variance was limited to the word data. The results were exactly the same as Experiment 3: The effect of context was significant, $F(2, 148) = 10.62$, MSerr = 1607.36, $p < 0.001$, with significant protected *t*s for the SV/asterisk contrast, $t(150) = 4.70$, $p < 0.001$, and the VS/asterisk contrast, $t(150) = 6.26$, $p < 0.001$, but not the SV/VS contrast, $t(150) = 1.56$, $p > 0.10$.

TABLE 4

Average lexical decision latencies (in msec) to noun and pseudonoun targets as a function of context

Lexicality	Context		
	(SV)O	(VS)O	(**)O
Nouns	682	675	704
Pseudonouns	800	783	791

Both Experiments 3 and 4 replicate the common finding that a sentence context hastens lexical decision relative to a neutral context. This was true for the four word orders that were investigated. Neither experiment found the sentence contexts to differ, however, not even SO and OS. These findings contradict the expectations from the perspective of word-order universals but are consistent with the results of Kostić (1983) on grammatical congruency of noun-verb pairs.

General Discussion

Three classes of experiments have been conducted whose focus is the contribution of word order to aspects of linguistic processing of Serbo-Croatian sentences of the subject-verb-object sort. Experiment 1 addressed the comprehension of the events to which the sentences referred: Were they semantically plausible? The experiment sought to determine whether reversals of the universally preferred subject-object ordering (Greenberg, 1966) in general, and departures from the canonical form (SVO) in particular, affected the latency with which evaluations of semantic plausibility could be made. Both the particular and the general perturbations of the canonical form retarded such decisions relative to the canonical SVO form and the SO ordering. The second experiment looked at printed three-word sentences and the time elapsing between their presentation and the initiation of their reading. Similar to the first experiment, it sought to determine the extent to which perturbations of the canonical word order made a difference. The outcome closely parallels that of the first experiment. Orders other than SVO were associated with generally longer latencies and OS orderings were generally slower than SO orderings. The goal of Experiments 3 and 4 was to see whether or not the time needed to decide about a printed word's lexical status was sensitive to the ordering of the subject, verb, and object. Experiment 3 posed the question by investigating lexical decisions on verb targets following either an OS or SO ordering; in Experiment 4 the investigation focused on object targets following either a VS or SV ordering. The outcome of both experiments was the same: With meaning and grammar held constant, a change in word order did not differentially affect lexical decision times although lexical decision times benefitted markedly from the sentential contexts.

The weight of the evidence favors the conclusion that word order does have psychological consequences for adult speakers of Serbo-Croat. The conclusion, however, must be qualified by noting that word-order effects were not manifest in all three classes of experiments. This "inconsistency" is to be expected. Effects of linguistic variables on linguistic processing depend on the kind of processing under inquiry. This reduces, by and large, to the kind of experimental task used to embody the linguistic process of interest. Before addressing the differences among the three experimental tasks, however, it will serve us well to conjecture about how word-order influences arise in the linguistic subsystems proposed in the construal of the language processor due to Forster (1979) but found in closely similar forms elsewhere (e.g., Fodor, 1983).

We remarked in the introduction that, although the various orderings of subject, verb, and object have the same referential meanings, in actual usage the variants may have specifiable contextual meanings related, for example, to intended points of emphasis in the sentence. This suggests the possibility that certain word orders might be perceptually more complex than others. In those cases where SO and OS expressions are, in fact, equivalent, the former may be evaluated faster than the latter because the latter allows or signals the possibility that normal precedence relations may not hold. So, although the resulting representation is the same, the paths taken to reach that result may not be. The syntactic parser may employ two different routines for processing OS and SO sentences: One routine is used for those sentences in which the first noun phrase is marked as subject and another is used for those in which the first noun phrase is marked as object.

Does the failure of the lexical decision task to yield word-order effects invalidate this argument? Perhaps not. As we have pointed out, the lexical decision task – unlike the reading and sentence verification tasks – is explicitly aimed at single-word rather than sentence-size units. Response times for lexical decision are measured from the onset of the last word, whereas in the other tasks, time to process the entire sentence is included. This allows the possibility that word order controls sentential processing time but this is not being measured by the lexical decision task. But, then, why were clear sentence-context effects found with the lexical decision task? The growing consensus is that this task involves more than the mere checking of a presented letter string against representations in the internal lexicon. The decision part of the task is influenced by other sources of evidential support (e.g., in the form of grammatic and semantic coherency checks [e.g., Gurjanov *et al.*, in press; Kostić, 1983; West and Stanovich, 1982]). If lexical-decision effects are really only decision effects, then responses will be delayed by any property of the target word that does not fit the context and will be hastened by any property that does fit the context. Implausible or ungrammatical combinations, therefore, both increase decision time. Variations in SO order do not affect decision time because, in all cases, the target word fits the context perfectly well. Sentence contexts facilitate lexical decision relative to asterisk contexts because in the latter, contextual appropriateness is irrelevant.

If a modified lexical decision task requiring the consideration of whole sentences (e.g., the scanning technique advocated by Sanocki, Goldman, Waltz, Cook, Epstein and Oden 1985) was similarly insensitive to word-order influences, then the foregoing line of argument would be supported. If, instead, the whole-sentence technique revealed word-order effects, then the presentation technique would be implicated. This last possibility suggests caution in drawing conclusions from research conducted at some remove from the communicative function of language. That is to say, lexical decision is a rather vacuous task relative to normal language comprehension. Nonetheless, providing a context (however meager) exerts an influence on decision time, presumably due to the functional integrity of the language processor. If enriching the lexical decision task even a little seems to reveal organizational properties of the language processor as it normally functions, then we can only speculate that enriching that and other tasks more in the direction of normal language use will reveal a great deal about the functional role of a variety of linguistic structures. Although we have argued that word-order effects in Serbo-Croat appear to reflect some seemingly fundamental linguistic universals, this does not preclude the possibility that "preferences" for the canonical SVO form and SO orderings might be overridden in a contextual niche that favors OS orderings. In the present series of experiments, with all things being equal, some word orders were more equal than others. But in normal language use, all things need not be equal and the special fit of a particular linguistic form to a communicative function may, in fact, overcome the SO advantage. It must be remembered, however, that in the experiments reported here performance reflected the SO/OS contrast indifferent to the frequency of use of the various word orders in normal speech. This suggests that even dominance in linguistic usage cannot deny the constraining role of linguistic universals.

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