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## Sensitivity to Inflectional Morphology in Agrammatism: Investigation of a Highly Inflected Language

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We present the results of a study with six Serbo-Croatian-speaking agrammatic patients on a test of inflectional morphology in which subjects judged whether spoken sentences were grammatical or ungrammatical. Sensitivity to two kinds of syntactic features was investigated in these aphasic patients: (1) subcategorization rules for transitive verbs (which must be followed by a noun in the accusative case; intransitive verbs can be followed by nouns in other noun cases); (2) sensitivity to the inflectional morphology marking noun case. The test items consisted of three-word sentences (noun-verb-noun) in which verb transitivity and appropriateness of the case inflection of the following noun were manipulated. Results of the grammaticality judgment task show that both syntactic properties are preserved in these patients. © 1988 Academic Press, Inc.

### INTRODUCTION

Recent research on Broca-type aphasia has suggested that syntactic deficits in speech production have parallels in speech comprehension. It has been argued that Broca patients with agrammatic output tend not only to omit many grammatical words and grammatical morphemes in their productions, but also that they fail to process these words properly in comprehension, although special tests were required to bring these problems to light. An important claim in this regard was made by Bradley, Garrett, and Zuriff (1980) who offered a unified account of Broca-type aphasia encompassing both production and comprehension, based on results obtained using lexical decision and picture verification tasks.

However, using a different experimental task, other researchers have

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found retained capacities of agrammatic aphasics to apprehend syntactic structures and to process the same closed-class items that are so often absent in their speech. Retained ability of English-speaking agrammatics to detect a variety of syntactic anomalies was uncovered by Linebarger, Schwartz, and Saffran (1983) using a grammaticality judgment task. They found that so-called agrammatics perform at much better than chance level in judging the acceptability of many syntactic structures, including ones that hinge on the availability of closed-class items (e.g., auxiliaries). Such evidence is clearly incompatible with any hypothesis that tries to explain agrammatism as loss of tacit knowledge necessary to compute syntactic structure.

Subsequent work by Crain, Shankweiler, and Tuller (1984) supported and extended the finding of preserved receptive processes in the context of severely limited production. Their agrammatic subjects showed retained ability to detect anomalies involving prepositions, determiners, particles, and auxiliary verbs—closed-class items which are often missing in the productions of Broca-type aphasics. Moreover, the agrammatic subjects in this study were pressed to make judgments of grammaticality “on-line,” a maneuver that forestalls the possibility that they might be adopting procedures for judging grammaticality that do not appropriately reflect their normal syntactic parsing routines.

The present study pursues the issue of receptive capabilities in agrammatism in patients who speak a language quite unlike English. If it is correct to characterize agrammatism in linguistic terms, then losses in language function that follow lesions in specific language zones will occur across all languages, making agrammatism a universal phenomenon. Still, the particular effects of lesions may vary with structural differences among languages, because languages sometimes employ different means to achieve the same grammatical ends. Thus the same neurological deficit could produce different patterns of symptoms in speakers of different languages. Naturally, the variation in expression of aphasia caused by cross-language differences cannot be without limit if grammatical devices are expressions of a Universal Grammar and subject to its constraints (Chomsky, 1981).

These considerations underscore the importance of cross-language studies of aphasia in evaluating theoretical hypotheses about the source of agrammatism. Among the criteria of theoretical adequacy is the requirement that we should be able to predict and account for the manifestations of agrammatism in different languages.

A recent account of agrammatism proposed by Grodzinsky (1984) gives due weight to such cross-linguistic considerations, and, indeed, makes detailed predictions about the manifestations of agrammatism in several languages. On his account, different languages will have associated with them different patterns of impairment, with the patterns reflecting a common principle: misselection of closed-class words (i.e., the class



which includes articles, auxiliary verbs, particles, and prepositions) within the same syntactic category. Other explicit predictions are made, including the prediction (i) that closed-class items will not be missing entirely in all languages, and (ii) distinctions between closed class items belonging to different syntactic categories should be preserved despite the loss of sensitivity to distinctions within a category.

As to the first point, Grodzinsky's theory contrasts free-standing grammatical morphemes, which are often missing entirely in the productions of English-speaking agrammatics, with bound morphemes (grammatical affixes). According to the theory, inflectional affixes will be neglected by agrammatics only when they are unessential to the "well-formedness" of the lexical item—if, in other words, the lexical item without the affix maintains its status as a word. The second prediction of the theory, that between-class sensitivity is preserved in agrammatism, follows from the proposal that what is lost in agrammatism is the lexical content normally present at the terminal nodes of closed-class categories. Information about "part-of-speech" is available, but the particular words are not.

The present study is designed to investigate Grodzinsky's hypotheses, taking advantage of a cross-language difference in use of closed-class morphology. Languages that have few word-order constraints are usually also highly inflected; they make heavy use of bound morphemes. On the other hand, fixed word-order languages commonly use word order to mark the same grammatical phenomena that are handled by inflectional morphology in nonconfigurational languages.

Pursuing this distinction, we note that in English the order of constituents is a fundamental device for indicating both semantic and syntactic relationships. German and Serbo-Croatian, in contrast to English, are relatively free-word-order languages. In Serbo-Croatian, morphological inflection is used to express grammatical relations that are expressed by word order in English. Unlike English, where case is conveyed either by word order (or by a free-standing preposition or pronoun), Serbo-Croatian marks case relations by noun inflections and imposes comparatively few restrictions on word order. In order to construct a grammatically correct structure, words have to match in gender, number, person, and noun case. This is accomplished by adding an appropriate suffix, an inflectional morpheme, to the word stem. The fact that the morphology of closed-class items plays such an important role in Serbo-Croatian, makes it an ideal language to contrast with English, in testing detailed theoretical claims like Grodzinsky's.

Previous research has shown that both German-speaking and Serbo-Croatian-speaking agrammatics show some degree of sensitivity to case inflection even when the test sentence departs from standard word order (Heeschen, 1980; Smith & Mimica, 1984; Friederici, 1982; Smith & Bates, 1985). Heeschen found that Broca's aphasics made 18% error in matching semantically reversible sentences to pictures when standard word order

was presented and 27% error when standard word order was violated. In an object-manipulation study with Serbo-Croat aphasics, Smith and Mimica showed that agrammatics are differentially sensitive to three types of cues: closed-class morphology, semantic constraints, and word order. Agrammatics were impaired relative to normals when forced to rely on case inflection cues alone. However, it was found that sentence understanding in agrammatic users of Serbo-Croatian was facilitated by a convergence of cues that, in combination, often led to successful processing of sentences.

The available data on agrammatism in different languages neither confirm nor disconfirm Grodzinsky's hypothesis that within-class sensitivity to bound morphemes should be impaired in agrammatics who speak a language with relatively free word order. Some impairment is evident, but in the use of convergent cues to assign noun case, there is also evidence of some sparing of function which does not sit well with Grodzinsky's account.

Problems associated with the choice of task to assess grammatical competence merit comment. The findings we have just discussed indicate that aphasic subjects perform better on some tasks than others. Tasks that minimize extraneous demands, e.g., the grammaticality judgment task, have proven more successful in uncovering retained syntactic ability than tasks like picture verification and object manipulation. The latter have been found to underestimate the extent of agrammatics' competence. Consequently, in much previous research, failures of agrammatics to use closed-class morphological items in analysis of sentences may have reflected a processing limitation and not a structural deficit per se. For these reasons it seems to us that past research does not provide the data needed for a definitive test of Grodzinsky's specific claims about the linguistic source of agrammatic comprehension errors.

The present study focuses specifically on the processing of bound morphemes marking noun case by Yugoslavian agrammatics, who were native speakers of Serbo-Croatian. We chose to use elicited grammaticality judgments as the task in order to avoid introducing extraneous processing factors that would otherwise be confounded with syntactic parsing in object-manipulation and picture-verification tasks. The Serbo-Croatian-speaking agrammatic aphasics were tested for retained sensitivity to noun inflections in the context of the contrast between transitive and intransitive verbs. This maneuver allows us to test Grodzinsky's hypothesis that distinctions within the same closed-class category should be lost in agrammatism.

In the Serbo-Croatian language, subcategorization is related not only to the meaning but also to the syntactic structure of a noun. Both transitive and intransitive verbs can be directly followed by a noun phrase. If the verb is transitive, however, it must be followed by a noun in the *accusative case*. This feature of Serbo-Croatian offers the opportunity to create

transitive vs. intransitive sentences that are minimal pairs. Sentences of both types can be constructed so as to be identical except for the terminal noun suffix. This suffix alone may differentiate a transitive from an intransitive sentence. In English it is impossible to create such minimal pairs since in English an intransitive verb *cannot* be directly followed by a noun phrase, whereas a transitive verb *must* be. (These differences between the two languages are diagrammed schematically in Fig. 1.) But of course these differences in subcategorization in English, but not in Serbo-Croatian, necessitate differences in prosody and length.

Some evidence has already been obtained, using the grammaticality judgment task, that English-speaking agrammatics are sensitive to the kind of strict subcategorization information that is conveyed by transitive vs. intransitive verbs. However, if Grodzinsky's hypothesis is correct, then Serbo-Croat agrammatics, unlike English-speaking agrammatics, should *not* be sensitive to this subcategorization property of verbs. This is expected because in Serbo-Croatian transitivity is captured by affixation and not by word order. Accordingly, Serbo-Croat aphasics should be unable to tell whether there is agreement between a specific verb and the case inflection on a following noun. This is just the kind of cross-language difference that is expected, on Grodzinsky's account, if agrammatism has a linguistic basis.

The ability of Serbo-Croat agrammatics to use subcategorization information was tested by manipulating the case endings of nouns that follow either transitive or intransitive verbs. We wanted to discover

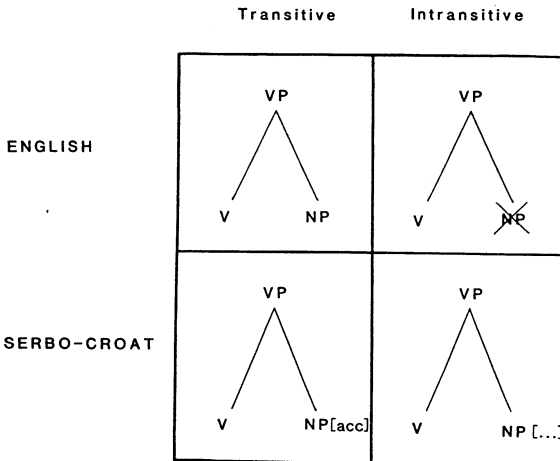


FIG. 1. The diagram compares the form of the verb phrase for transitive and intransitive verbs in English and Serbo-Croatian. Note that in Serbo-Croatian, unlike in English, a noun may follow the verb directly for either a transitive or an intransitive verb. Intransitivity is marked by some other case than the nominative or accusative.

whether the subcategorization facts associated with transitive verbs are more accessible to agrammatic aphasics than those associated with intransitive verbs for grammaticality decisions that turn on noun case. Clearly, Grodzinsky's hypothesis would predict that the two classes of verbs should be treated in the same way, so that performance on judgments of grammaticality would be roughly at chance for each. This question was put to an empirical test in our experiment.

To summarize, a much debated issue in neurolinguistics is whether the syntactic deficits of agrammatics in speech production have parallels in speech comprehension. The hypothesis implies that there is some central syntactic processing component that is impaired in agrammatism and that is a cause of both comprehension and production difficulties. Our research addresses this issue by focusing on receptive processes in agrammatism from a cross-language point of view. The study had two purposes: first, to identify universal, cross-language characteristics of agrammatism, and second, to exploit special characteristics of the Serbo-Croatian language in order to test Grodzinsky's challenging hypothesis that distinctions within the same closed-class category should be lost in agrammatism.

### SUBJECTS

The subjects, who ranged in age from 30–57 years, were six nonfluent aphasics, two females and four males, all right-handed. Their characteristics are summarized in Table 1. In each case, the lesion was confined to the left hemisphere. All had completed at least the secondary school. All were outpatients of the Clinic for Neurophysiology and Speech Pathology in Belgrade, Yugoslavia.

Four patients carried the diagnosis of stroke, one was a victim of traumatic insult, and one had a surgically removed tumor. Time since onset of the disorder was at least 6 months. Three patients (B.S., D.M., and R.N.) were initially mute. CT scans, available for the trauma patient, the tumor patient, and one stroke patient revealed a lesion predominantly

TABLE 1  
CHARACTERISTICS OF THE APHASIC SUBJECTS

Subject	Age	Sex	Education	Etiology	Time postonset
B.S.	31	M	14	Trauma	3 years
D. K.	36	M	14	CVA	6 months
D. M.	33	F	16	Tumor	4 years
R. N.	57	F	16	CVA	3 years
S. P.	53	M	16	CVA	5 years
N. M.	57	M	16	CVA	1 year

in the inferior posterior region of the left frontal lobe. In addition to the general neurological examination, diagnostic criteria included performance on the Boston Diagnostic Aphasia Examination, which was translated and adapted for Serbo-Croat speakers. Comprehension was relatively good in social contexts, but, as may be seen from the BDAE scores (Table 2), each subject had significant impairment in comprehension.

In their speech production, all the subjects demonstrated severe-to-moderate agrammatic speech. That is, their speech was effortful, dysprosodic, and telegraphic. Each of the patients made notable production errors on case endings, often using the nominative case in linguistic contexts in which this case was inappropriate. However, none of these errors resulted in nonwords. Representative examples of speech production are given in Table 2.

A group of normal subjects, matched in age and education was also included in the experiment.

### MATERIALS

The experimental materials consisted of 64 grammatical and 64 ungrammatical sentences, each containing three words (noun-verb-noun). Half of the grammatical sentences incorporated a transitive verb followed by the accusative object noun and half incorporated an intransitive verb followed by an adverbial noun usually in the instrumental case.

All the words in the sentence were balanced for length and frequency of occurrence. By varying transitivity, four forms of each sentence were generated as shown in the example:

- (1) Seljak obradjuje polje.  
(The farmer is cultivating the field.)
- (2) Seljak trci poljem.  
(The farmer is running through the field.)
- (\*3) Seljak obradjuje poljem.  
(The farmer is cultivating through the field.)
- (\*4) Seljak trci polje.  
(The farmer is running the field.)

It will be noted that in each of the above sentences, the correct grammatical form depends just on the last (unstressed) phoneme of the last word in the sentence. It should be noted also that some of the critical nouns preserve their lexical well-formedness even when they appear in unmarked forms (i.e., nominative and accusative).

### DESIGN AND PROCEDURE

The sentences were tape recorded and systematically distributed in four groups. Each sentence was read once, with normal speed and intonation. Ungrammatical sentences were read with the intonation appropriate for the corresponding grammatical sentence (i.e., with a correct

TABLE 2  
PERFORMANCE ON SELECTED PORTIONS OF THE BDAE

Subject	BDAE comprehension				Speech production <sup>a</sup>
	A	B	C	D	
B.S.	16/20	4/5	9/12	8/10	Pa . . . mama brise tanjir. De . . . dečko . . . kolači . . . devojčica uzmi uz . . . uzima. . . . Voda curi . . . Well . . . mama is drying the plate. The b . . . boy . . . cookies . . . the girl take ta . . . is taking. . . . The water is leaking.
D.K.	20/20	5/15	6/12	6/10	Voda. Devojčica. Sudove pere. Voda teče. Dete i devojčica se . . . ne znam da kažem. Kolače. Devojčica se okliže i pala. Gotovo. The water. The girl. Washing the dishes. Water is leaking. The kid and the girl . . . I don't know how to say. Cookies. The girl is slipping and fallen. End.
D.M.	18.5/20	12/15	8/12	7/10	Brat i sestra. Hoće kolače. Mama pere. Ta . . . tanjir. Voda . . . Ne mogu da kažem. Brother and the sister. Want the cookies. Mama is washing. The pla . . . plate. Water. I can not say. Mama i tata . . . ne, briše sudove. Ne mogu da kažem. Ne mogu da kažem. Vidi kako ovde drži . . . Ne mogu da kažem.

R.N.	19/20	10/15	6/12	2/10	Mama and daddy . . . no, drying dishes. I can not say. I can not say. Look how is holding. . . . I can not say. Kujna. Mama pere . . . ovaj tanjir. A ovaj dečak i devojčica. To je . . . Daje sestri kolače. Ova je voda pri . . . pri . . . E, voda je pr-li-la. Voda je preliła u sudoperu. Šolja.
S.P.	18.5/20	14/15	6/12	7/10	Kitchen. Mama is washing . . . this plate. boy and girl. This is . . . Is giving cookies to the sister. This water . . . is li . . . li . . . Water is lea-king. Water is leaking into the sink. The cup.
N.M.	12.5/20	8/15	6/12	6/10	Ovaj . . . dete je ustalo da pojedje pekmez a ova žena je prosula vodu što je htela da pere. Pa je sve oprala. This . . . child got up to eat the jam and this woman has spilled the water cause she wanted to wash. She washed everything.

Note. A, Body part identification; B, commands; C, complex ideational material; D, reading sentences and paragraphs.  
<sup>a</sup> Patient's description of "Cookie theft" picture, BDAE.

case inflection). The subjects listened to the sentences over headphones. Their task was to indicate for each sentence whether it was grammatically correct or not. The subjects responded by pressing one of two keys, marked YES and NO. Each subject participated in four individual sessions, one session per week for 4 consecutive weeks. Each new session started with 10 practice sentences to familiarize the subject with the task.

## RESULTS

First, we present an analysis of the error data by subjects. Percentage of errors for each sentence type is given in Table 3.

The table shows that the error percentage scores of the individual subjects covaried with the severity of their aphasia, as measured by neurologists' ratings. It is important to note, however, that all of the subjects were well above chance level in responding correctly to the inflections of the terminal word in the target sentences. The same pattern of errors is apparent for all subjects despite differences in etiology, age, and severity.

Also shown in Table 3 is the analysis of errors by sentence type. Sentences of Type 4 evoked the most errors (i.e., grammatically incorrect sentences with an intransitive verb), and those of Type 1 evoked the fewest errors (i.e., grammatically correct sentences with a transitive verb).

The error data were subjected to analysis of variance by subjects and by items, comparing the factors of *group*, *grammaticality*, and *transitivity*. In both the analyses by subjects and by items there was a significant effect of *grammaticality* ( $F(1, 5) = 16.74, p < .01$ ;  $F(1, 31) = 8.73, p < .01$ ). This means that grammatically correct and grammatically incorrect sentences were not equally difficult for the subjects. It proved to be easier for the subjects to give a correct judgment when the correct inflections were presented.

TABLE 3  
PERCENTAGE OF ERRORS FOR APHASIC SUBJECTS BY SENTENCE TYPE

Subject	Grammatical sentences		Ungrammatical sentences	
	Transitive verb	Intransitive verb	Transitive verb	Intransitive verb
B.S.	10.8	14.0	16.0	24.0
D.K.	4.0	6.0	4.0	10.8
D.M.	0.0	8.0	12.0	6.4
R.N.	10.8	10.8	9.2	14.0
S.P.	6.0	9.2	14.0	16.0
N.M.	1.6	4.0	8.0	10.8
Mean	5.5	8.7	10.5	13.7



Analysis of the false alarms indicates that this effect is not due to the tendency for Broca-type aphasics to be "overaccepting." The fact that they correctly rejected ungrammatical sentences 88% of the time is clear evidence of their retained sensitivity to the closed-class morphology, both in accepting grammatically correct sentences and in rejecting ungrammatical sentences.

The effect of *transitivity* was also significant both by subjects and by items ( $F(1, 5) = 10.00, p < .025$ ;  $F(1, 31) = 7.41, p < .01$ ). This indicates that these agrammatic subjects were sensitive to subcategorization requirements which, as we saw, require them to attend to noun inflections. We interpret this result to mean that Broca-type aphasics have preserved information in their lexicons about the complements of verbs, retaining whether or not they obligatorily require a direct object. Presumably, such stored information serves to "prime" the correct noun inflections, by generating a syntactic expectancy for a particular case ending.

A comparison of the accuracy of judgments by aphasic patients with those of control subjects demonstrated that although the patient's performance was relatively successful, it was clearly depressed compared to the nearly error-free performance of control subjects. Detection of ungrammatical sentences occurred with an average accuracy of 99.2%, whereas grammatical sentences were accepted 98.6% of the time.

An interesting post hoc observation was made concerning the lexical items that preserve their lexical well-formedness even in the unmarked form. It should be noted that for some nouns the unmarked nominative case is identical to the word stem. For these nouns the other case-inflections are simply appended to the stem (as in Table 4, Column 1). These nouns keep their lexical well-formedness even when the case inflections are neglected. For all other nouns (as in Table 4, Column 2) the nominative form and other case forms are different from the word stem. For the latter class of nouns, the stem needs a case inflection in order to be a word.

Grodzinsky (1984) has proposed that agrammatics should have difficulty processing inflections of the first class of nouns but not the second class. In the case at hand, this hypothesis would predict that aphasics should

TABLE 4  
CASE INFLECTIONS FOR TWO CLASSES OF NOUNS IN SERBO-CROATION

	Class 1		Class 2	
Nominative	sto-	(table)	farb-a	(color)
Genitive	sto-la		farb-e	
Dative	sto-lu		farb-i	
Accusative	sto-		farb-u	
Instrumental	stom-lom		farb-om	

make more mistakes when they are processing a sentence in which the critical noun-item belongs to the first class of nouns (nouns in the unmarked nominative case). For example, an aphasic subject should reject a grammatically correct sentence in which the critical noun is inflected with some case other than the nominative or accusative case. This would happen if the subjects were capable of processing the noun only by treating it as if it were in the nominative (unmarked) case. On the other hand, whenever the critical noun is in the nominative case, a subject should have a tendency to accept the sentence even if ungrammatical. However, it was found that nouns in the marked cases were not significantly more difficult than those in the unmarked for our subjects. This finding counts as disconfirming Grodzinsky's prediction.

### DISCUSSION

The main result was that agrammatics in this study proved to be capable of using bound closed-class morphemes in sentence processing. Each of the six Serbo-Croat-speaking agrammatic patients showed evidence of retained ability to respond selectively to noun inflections marking noun case and verb transitivity. The finding of retained syntactic competence is consistent with earlier findings of Smith and Mimica (1984) in Serbo-Croatian and of Heeschen (1980) in German.

The findings are also consistent with recent work with English-speaking agrammatics who showed a retained ability to perform judgments of sentence grammaticality (Linebarger et al., 1983). Further, the results are consistent with the indications that agrammatic aphasics are capable of carrying out syntactic analyses *on line* (Crain et al., 1984; Tyler, 1986). The subjects of the present study, like their English-speaking counterparts, demonstrated retained sensitivity to syntactic category even when the category is marked by affixation and not by word order or by free-standing grammatical morphemes.

As noted in the introduction, this result could not have been presupposed. It is conceivable that agrammatics would be capable of exploiting one indicator of syntactic category, but not another. Given the indications that agrammatics are deficient in use of closed-class vocabulary items, one might be led to suppose that some ability to use word order is retained while ability to use the closed-class morphology is lost. The structure of English does not permit us to distinguish between these possibilities, because word order and the introduction of prepositions such as *to* and *by* are the only devices available for marking noun case. But, as we noted, the Serbo-Croatian language, by virtue of its rich inflectional system, enables us to test the effect of relying solely on inflectional morphemes for marking case. Both transitive and intransitive verbs can be directly followed by a noun phrase. This feature of Serbo-

Croatian made possible the creation of transitive and intransitive sentences that are minimal pairs, differing solely in one noun suffix.

In summary, our Serbo-Croat-speaking agrammatic patients showed retained sensitivity to noun inflections marking the transitive/intransitive verb within the context of the sentence judgment task. The error rate was remarkably low, averaging only 12% for aphasic subjects across conditions. The finding of preserved sensitivity to case in this context clearly fails to support Grodzinsky's (1984) hypothesis that distinctions within the same closed-class category should be lost in agrammatism.

The questions we raise about ability of agrammatics to use the closed class morphology in sentence processing were also addressed in the recent research of Smith and Mimica (1984), to which we have referred. In that study, also, Serbo-Croatian-speaking agrammatics showed better than chance ability to use case inflection in the assignment of agent-object relations, but the error rate was much higher than in the present study. The large differences in rate of correct responding may be attributable to the task. Smith and Mimica used an object manipulation task, which is known to impose a considerable burden on short-term memory processes (Hamburger & Crain, 1984).

An explanation of agrammatics' performance failures in terms of processing limitations rather than loss of syntactic competence is fully in line with the other findings of the Smith and Mimica study. These investigators explored the effects on the acting out task of association or dissociation of three variables, word order, animacy, and case inflection. When all three factors were concordant, Broca's aphasics performed with only 10% of error, whereas when two factors were in competition, performance fell to near-chance level (42% errors). In their terms, situations of conflict, such as that created by use of a nonpreferred word order, create "cognitive overload."

Taken together, the findings of the present study are consistent with other research both on richly inflected languages and on fixed word-order languages like English. The weight of the evidence supports the view that comprehension deficits in agrammatism do not reflect loss of either the knowledge or ability to access members of the closed-class lexicon in extracting the syntactic structure of a sentence. Access to grammatical knowledge is impaired, to be sure, but access can often be attained successfully in circumstances that minimize the processing load.

A comparison of agrammatics' performance across tasks shows that subjects who standardly fail in an object-manipulation task may succeed in a grammaticality judgment task that tests comprehension of the same linguistic structures. This implies that all necessary syntactic structures may be preserved in the so-called agrammatism of Broca's aphasia, and that problems in some other part of the language apparatus are responsible

for failures of comprehension. There is increasing support for the view that complex behaviors are products of interaction between many different and independent subsystems, each performing a unique and special role. In agrammatism, a likely source of comprehension problems is a verbal working memory limitation. There is evidence that the phonological processing system, on which the verbal working memory depends, is often damaged in the nonfluent aphasia (Caramazza, Berndt, & Basili, 1983; Martin, 1985).

In sum, the findings of the present study are consistent with the main body of research on sentence processing in Broca's aphasia in suggesting that the link between linguistic competence and linguistic performance is not fully preserved. Tacit knowledge of syntax is seen to be intact under circumstances that tax working memory as little as possible. However, linguistic knowledge is less accessible in contexts, including many everyday contexts, that place heavy demands on working memory. Thus, the data we have reviewed implicate disturbances of language subsystems other than the syntactic component, and suggest that studies investigating the role of such processing components as working memory will be important in the future.

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