

Comprehension of Nonlexical Categories in Agrammatism

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The focus of the paper is a proposal advanced by Grodzinsky (1984, 1986, 1990) concerning a possible syntactic deficit in agrammatism with respect to nonlexical categories. Eight native speakers of Serbo-Croatian, who presented a clinical picture of Broca's aphasia with agrammatism, were tested. Subjects' sensitivity to traces and their knowledge of the inflectional and determiner system was investigated using a grammaticality judgment paradigm. The processing load was further minimized by use of short sentences that unequivocally exemplified different syntactic violations. These steps led to significant improvement in the performance of agrammatic aphasics, a result that is incompatible with the claim that the content of nonlexical elements is lost in agrammatism.

Research findings of the past two decades indicate that agrammatic Broca's aphasics have deficits in both sentence production and comprehension. However, there are still lingering questions as to the origin of the deficit. Broadly speaking, one can attribute the difficulties either to loss of relevant

A partial account of the findings was presented at the 31st Meeting of the Academy of Aphasia, October 24–26, 1993, Tucson, Arizona. The authors gratefully acknowledge help in data collection from Mile Vuković, Faculty of Defectology, University of Belgrade, and from Jovanka Jezdimirović and Veronika Ispanović-Radojković, the Institute for Mental Health in Belgrade. This research was supported in part by a grant (HD-01994) to Haskins Laboratories from the National Institute of Child Health and Human Development.

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grammatical structures or to inability to access these structures due to limitations in language processing. Each view has spurred several research efforts.

The proposal that loss of syntactic structures is the cause of comprehension deficit in agrammatism is the common factor in several proposals which range from claims of complete breakdown of syntax (Caramazza & Zurif, 1976) to the claim that agrammatics have incurred very circumscribed syntactic deficits (Grodzinsky, 1990). The different versions of this proposal will be referred to as the *syntactic deficit hypothesis*. In this study, the version of the syntactic deficit hypothesis that we will consider stems from a proposal advanced by Grodzinsky (1984, 1986, 1990), who argued for a partial loss of syntactic knowledge. We focus on Grodzinsky's proposal because we regard it as the most precise and most clearly testable proposal in the literature concerning the nature of the comprehension deficit in agrammatism.

Specifically, Grodzinsky asserted that agrammatic aphasia is characterized by omission of nonlexical terminal elements from a particular level of syntactic representation, namely, S-structure. As a result, agrammatic aphasia results in the loss of traces and the content present at the terminal nodes of such nonlexical elements as determiners, auxiliaries, and inflections.

The alternative view will be referred to as the processing limitation hypothesis (PLH). This hypothesis supposes that agrammatics have retained their syntactic knowledge but have special difficulties in accessing and processing it. This proposal is supported by research findings showing that agrammatics have retained, to a considerable degree, the ability to detect violations of grammaticality (Linebarger, Schwartz, & Saffran, 1983). Confirming results were obtained by Shankweiler, Crain, Gorrell, and Tuller (1989) and by Bates, Friederici, and Wulfeck (1987), Kolk and van Grunsven (1985), Lukatela, Crain, and Shankweiler (1988), Lukatela, Shankweiler, and Crain (1995), and Milekić (1993) for languages other than English.

The intent of the present study was to investigate the role that variations in processing load play in the performance of agrammatic subjects who are native speakers of Serbo-Croatian. Serbo-Croatian was chosen because of its rich inflectional system, which offers the possibility of creating natural sounding stimuli with the targeted syntactic structures.

An earlier study with Serbo-Croatian speakers by Milekić, Shankweiler, and Crain (1992) demonstrated that increases in processing load had a detrimental effect on the performance of both agrammatic and normal subjects. In this study the syntactic complexity of the test sentences was held constant. To determine if extrasyntactic processing demands may play a major role in comprehension deficits of agrammatic subjects, we attempted to reduce them to the bare minimum. In the present study we accomplished this in

two ways. One way was to use short sentences with simple, high-frequency structures. The other was to make the task as easy as possible. This was accomplished by simplifying the decision process; our subjects were asked to make a response only when they detected an ungrammatical sentence.

The test sentences were designed to probe Grodzinsky's claims regarding missing nonlexical categories as the possible cause of agrammatism. Accordingly, we tested agrammatics' knowledge of traces and their knowledge of the inflectional (INFL) and determiner (Det) systems.⁵ Grodzinsky's proposals focused on the contents under INFL. According to Grodzinsky, these contents, which ordinarily indicate agreement features and tense specification, are deleted in agrammatism. Grodzinsky argued that the deletion of agreement features should lead to acceptance both of structures obeying subject-verb (SV) agreement and those not obeying SV agreement. Based on this prediction and the standard assumption that finite tense in INFL assigns nominative case to subjects, we would expect deletion of tense spec-

⁵ Grodzinsky's proposals also make one interesting prediction that we have not tested in the experiment reported here. Grodzinsky (1990) proposed an account of agrammatics' comprehension of passives that rests on the assumption that NP-t left by movement of the NP assigned object theta role in passive constructions is deleted.

- (i) a. John was killed t SS-structure for normals
 b. John was killed SS-structure for aphasics

NP-trace in (ib) being deleted, John cannot receive a theta-role from the trace in object position, as is generally assumed for surface subjects in passive constructions. Grodzinsky argued that the moved NP is theta-marked through the application of heuristic strategies, which, Grodzinsky argued, assign agent theta-role to initial NPs. This in turn leads to failure to comprehend passive sentences. Given this line of reasoning, we would expect the same problem with other constructions involving NP movement. Like the NP in subject position of passives, the NP in subject position of raising verbs such as *seem* cannot receive a theta-role. The heuristic strategies Grodzinsky posited would then apply and incorrectly assign John in (ii) the agent theta-role.

- (ii) John seems t to like Mary

Similar problems arise with respect to ergative, psych-verb, and *there* constructions, which are also assumed to involve NP movement. In fact, given the widely accepted VP internal subject hypothesis, even constructions such as (iii) involve NP movement.

- (iii) John heard a story

Under the VP internal subject hypothesis, John in (iii) is generated in Spec, VP and then raises to Spec, IP to be Case-marked. Given Grodzinsky's proposals, the trace left by movement of John to Spec, IP is deleted in agrammatism.

- (iv) [_{IP} John [_{VP} t heard a story]] SS

As a result, John in (iv) cannot receive a theta-role from the verb. Notice now that the heuristic strategies Grodzinsky posited, which assign the agent theta-role to initial NPs, make an interesting prediction. According to these strategies, John would be assigned the agent theta-role in (iv). Given this, we would expect aphasics to interpret "John heard a story" roughly as "John listened to a story." Similarly, we would expect "John seems to have heard a story" to be interpreted roughly as "John seems to have listened to a story."

ification to lead both to acceptance of structures with nominative subjects and ones with nonnominative subjects. To test the predictions of Grodzinsky's version of the syntactic deficit hypothesis that concern the inflectional system, we tested agrammatics' ability to detect ungrammatical constructions involving lack of subject-verb agreement (1a) and nonnominative subjects (1b).

- (1) a. *Direktor kažnjavaju učenike
principal (III p.sing.) are punishing (III p.pl.) pupils
b. *Mušteriju je udarila prodavačicu
customer (acc.) hit saleswoman (acc.)

Another of Grodzinsky's proposals is that agrammatic aphasics omit traces from their S-structure representations. To examine this proposal, we tested agrammatics' sensitivity to wh-traces using constructions involving vacuous quantification, i.e., operators binding no variables, and grammatical wh-questions.

- (2) a. *Ko doktor leči pacijenta
who doctor is treating patient
b. Koga doktor leči t
whom doctor is treating t

If subjects show the ability to detect sentences involving vacuous quantification, this can be taken to indicate that they know that a wh-phrase has to bind a variable. Given this, subjects' acceptance of grammatical wh-constructions could be interpreted as indicating that in these constructions they are linking the proposed wh-phrase with a variable, namely, wh-trace.

Agrammatics' sensitivity to NP-trace was also tested, using constructions involving agreement mediated with NP-traces. It is well known that traces have agreement features. Thus (3) is ruled out because agreement features of the trace, which is the only potential antecedent for the anaphor, and the anaphor do not match.

- (3) *John seems to t like herself

The agrammatics in our study were presented with constructions involving an agreement relation holding between an NP-trace and a predicative adjective, as in (4).

- (4) *Komšija_i moraju t_i biti dobri
The neighbor_i (III p.sing.) must t_i be good (III p.plu.)

Given Grodzinsky's proposal that traces are deleted from S-structure representations, agrammatics would be expected to exhibit chance level performance on constructions involving agreement processes mediated by

NP-traces. On the other hand, if agrammatics turn out to be sensitive to agreement features of NP-traces, this would provide evidence that NP-traces are not lost in agrammatism.

Turning now to the Det system, our way of testing agrammatics' knowledge of the system was to ask them to detect ungrammatical constructions involving incorrect forms of demonstratives.

(5) *Doktor leči taj pacijenta

The doctor is treating that (nom.) patient (acc.)

Agrammatics ability to detect the ungrammatically of constructions such as (5) would testify to their knowledge of the Det system.

METHOD

Subjects

The aphasic group consisted of eight right-handed stroke patients (three female, five male), each presenting stabilized, nonfluent aphasia of the Broca type. All subjects were outpatients of the Neurological Clinic or the Institute for Psychophysiological Disorders and Speech Pathology, both in Belgrade, Yugoslavia. All subjects had some education beyond high school and were native speakers of Serbo-Croatian. All had a stabilized lesion of vascular origin confined to the left cerebral hemisphere. In each case, the symptoms originated from an episode which occurred at least 6 months prior to testing. The subjects' ages ranged from 41 to 63 years (mean 53.8 years). All subjects passed an audiometric screening test with results within normal limits for their age group. The profile of the experimental group is presented in Table I.

All experimental subjects presented a clinical picture of Broca's aphasia with agrammatism. The diagnosis was made on the basis of neurologic examination, CT-scan findings, and the results on the Serbo-Croatian version of the Boston Diagnostic Aphasia Examination (BDAE; Goodglass & Kaplan, 1972). A control group of six normal adults was also tested using the same materials. This group was roughly matched for age and level of education with subjects in the aphasic group. None of the subjects in the control group had any pathological condition that could interfere with their linguistic performance.

Stimuli

As noted earlier, the test sentences were constructed with Grodzinsky's (1984, 1986, 1990) claims in mind concerning possible syntactic deficits in

agrammatism. In particular, the present study examined his claim that non-lexical terminal elements are deleted from the S-structure representations of agrammatic aphasics. In the experiment reported here, we tested subjects' sensitivity to traces and their knowledge of the inflectional and determiner systems using a set of ungrammatical sentences. Each sentence contained only a single grammatical violation. There were six types of ungrammatical sentences. Examples of each type are shown in Table II. The first type was represented by sentences involving vacuous quantification, i.e., operators binding no variables (vacuous quantification). The second and third types involved incorrect applications of the syntactic mechanism of spec-head agreement with INFL, resulting in the lack of either subject-verb agreement (SV agreement) or a subject bearing nonnominative case (nonnominative

Table I. Experimental Subjects Profile

Subject	Sex	Age (years)	Education (years)	Months from onset
G.B.	Male	52	8	21
K.S.	Female	45	16	8
C.R.	Male	55	14	12
D.V.	Male	63	16	6
J.L.	Male	57	16	22
R.J.	Female	56	14	36
L.Z.	Male	62	16	14
T.N.	Female	41	14	8
<i>M</i>		53.8	14.2	15.8
<i>SD</i>		7.2	2.5	9.4

Table II. Examples of the Stimulus Materials^a

Example sentence	Violation
Who the doctor treats patient?	Vacuous quantification
Who the student hits Marco?	
Principal are punishing pupils.	SV agreement
The cook (III p. sing.) kiss (II p. sing.) the teacher.	
The hunter (gen./acc.) buys gunpowder (gen.).	Nonnominative subject
The customer (acc.) hits the saleswoman (acc.).	
The neighbor _i (III p. sing.) must _t be good (III p. plu.).	NP-trace
The doctor treats that (nom.) patient (acc.).	Case 1 percolation
The student watches one (acc.) man (dat.).	Case 2 percolation

^a SV = subject-verb; III p. sing. = third-person singular; II p. sing. = second-person singular; gen. = genitive; acc. = accusative; III p. plu. = third-person plural; nom. = nominative; dat. = dative.

subject). The fourth type involved incorrect applications of agreement mediated by NP-trace (NP-trace).⁶ Finally, the last two types of ungrammatical sentences involve case violations where either a determiner (Case 1) or a noun (Case 2) was inflected for a "wrong" case.

The test sentences were short (two to six words, mean four words) and were designed to unequivocally exemplify the different syntactic violations described above. Each structure was represented in 10 ungrammatical and 10 control sentences, making a total of 120 sentences. The sentences were recorded on audio tape in pseudorandom order and at a normal conversational rate by a native speaker of Serbo-Croatian. Care was taken to preserve the natural prosodic structure of the spoken sentences.

Procedure

The subjects were tested in a quiet room. They were familiarized with the procedure of detecting ungrammatical sentences using practice materials, until the experimenter was convinced that they understood the task. The experimental sentences were presented via headphones, and the subjects were instructed to raise their hands whenever they detected an anomaly. The subjects were told that, if in doubt, they could request to have a sentence repeated. Subjects' responses and the number of times each sentence was presented were recorded by the experimenter.

RESULTS

Table III indicates the error rate for grammatical and ungrammatical sentences for both groups—agrammatic subjects erroneously identified 4.8%

⁶ Since it is not clear whether passive sentences in Serbo-Croatian involve movement, we used constructions involving modals to test subjects' sensitivity to NP-trace. Serbo-Croat modals essentially exhibit the same syntactic behavior as Romance modals, which have been extensively discussed in the literature (see Zubizaretta, 1982). They pass all traditional tests for NP-raising. Thus, as (i) shows, they can take idiom chunks as their subject.

- (i) *Brda i doline mu moraju biti obećani prije nego on išta uradi*
Heaven and Earth must be promised to him before he does anything

Table III. Mean Percent Correct Responses for Different Sentence Types

	Sentence type		
	Ungrammatical	Grammatical	All sentences
Aphasics	81.4	95.2	88.4
Normals	96.7	99.2	97.9

of the grammatical sentences as ungrammatical, whereas they failed to detect 18.6% of the ungrammatical sentences. Requests for repetition of test sentences occurred only twice out of 960 presentations for the aphasic group and never for the control group.

The results by type of syntactic violation are presented in Table IV. It can be seen that both aphasics and normals made the highest number of mistakes in detecting the violation which involved NP-traces (72.5% correct for aphasics and 91.6% correct for normals). The overall pattern of performance was similar for both groups. The main difference between the groups was that aphasics' performance was consistently lower than that of normals

Table IV. Percent Correct Responses for Ungrammatical Sentences Across Different Anomalous Structures

	Anomalous structure ^a					
	NS	SV	TR	VC	C1	C2
Aphasics	81.25	81.25	72.5	73.75	85	95
Normals	100	100	91.66	93.33	95	100

^a NS = nonnominative subject; SV = subject-verb agreement; TR = NP-trace; VC = vacuous quantification; C1 = Case 1 percolation; C2 = Case 2 percolation.

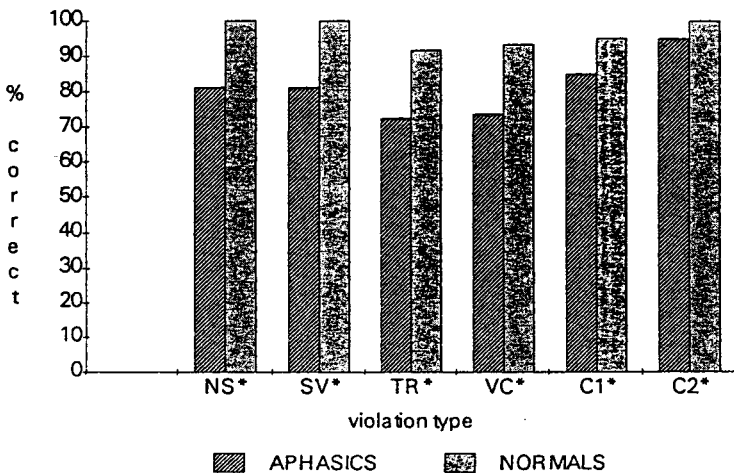


Fig. 1. Comparison of performance on ungrammatical sentences containing different syntactic structures. NS = nonnominative subject; SV = subject-verb agreement; TR = NP-trace; VC = vacuous quantification; C1 = Case 1 percolation; C2 = Case 2 percolation.

(see Table III, Fig. 1). The same pattern of responses was found in the performance of both groups on control (grammatical) sentences (see Table V, Fig. 2).

Statistical Analysis

Group means were tested for significance using a conservative version of the *t*-test which does not assume equal variances between the different groups.⁷ Overall performance of agrammatics and normals differed signifi-

⁷ A discussion of such a test is given in Snedecor and Cochran (1980, pp. 96-98). Note that the degrees of freedom for unequal variances are expressed as a decimal number computed using Satterthwaite's approximation, also described in Snedecor and Cochran.

Table V. Percent Correct Responses for Grammatical Sentences (Each Group Served as Control for Anomalous Syntactic Structure)

	Syntactic structure ^a					
	NS	SV	TR	VC	C1	C2
Aphasics	98.75	98.75	93.75	96.25	91.25	92.5
Normals	98.33	98.33	100	100	98.33	100

^a NS = nonnominative subject; SV = subject-verb agreement; TR = NP-trace; VC = vacuous quantification; C1 = Case 1 percolation; C2 = Case 2 percolation.

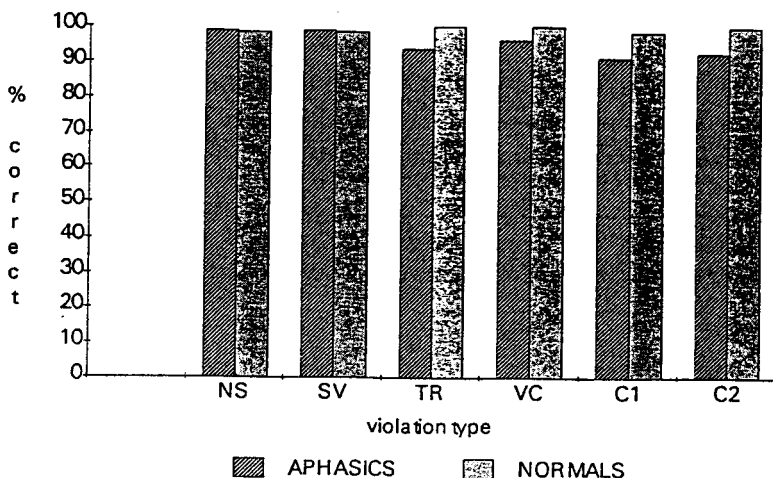


Fig. 2. Comparison of performance on grammatical sentences containing different syntactic structures. NS = nonnominative subject; SV = subject-verb agreement; TR = NP-trace; VC = vacuous quantification; C1 = Case 1 percolation; C2 = Case 2 percolation.

Table VI. Mean Percent Correct Responses for Individual Subjects

Subject	Sentence type		
	Ungrammatical	Grammatical	All sentences
G.B.	80.0	95.0	87.5
K.S.	88.3	100.0	94.16
C.R.	76.7	100.0	88.33
D.V.	51.7 ^a	90.0	70.83
J.L.	86.7	80.0	83.33
R.J.	88.3	100.0	94.16
L.Z.	91.7	100.0	95.83
T.N.	88.3	96.7	92.5
<i>M</i>	81.5	95.2	88.33
<i>SD</i>	12.2	6.6	7.7

^a Chance performance.

cantly [$t(122.1) = 5.52, p < .001$]. The group difference was significant on both ungrammatical [$t(63.6) = 5.40, p < .001$] and grammatical sentences [$t(57.2) = 2.69, p < .001$]. However, analyses of the results for each sentence type revealed that there were no significant differences between aphasics and normals for vacuous quantification (VC) and case agreement (C1) violations. Because the normal group performed consistently at the 100% level for those violations, it was not possible to meaningfully compare the performance of the two groups on these structures.

A second goal of the study was to determine if the agrammatics were able to perform at above-chance levels. For this purpose, we compared the difference between the observed performance and the expected chance levels using a chi-square test. The overall performance of all the agrammatic subjects was well above-chance level, as indicated in Table VI. (A further analysis by sentence type revealed that one agrammatic subject performed only at chance level on the ungrammatical sentences, while each of the others performed significantly above chance.)

DISCUSSION

With the exception of one subject, the agrammatics tested in the present experiment exhibited above-chance level performance on each of the constructions we tested. Consider first the constructions involving the inflectional (INFL) system. Recall that Grodzinsky claimed that agreement features and tense specification are deleted in agrammatism. Deletion of

agreement features is expected to lead to acceptance both of sentences with SV agreement and of those without it. Our agrammatic subjects, however, exhibited above-chance performance on detection of violations of SV agreement and they consistently accepted constructions with proper SV agreement.

As noted earlier, granting the standard assumption that finite tense in INFL assigns nominative case to subjects, we would expect that the deletion of tense specification would lead agrammatics to accept sentences regardless of whether the subject is assigned nominative or nonnominative case. However, the agrammatic individuals in this experiment exhibited above-chance performance in detecting ungrammatical constructions and accepting grammatical constructions. Our results, therefore, do not support Grodzinsky's claim that agreement features and tense specification are missing in agrammatism.

Next, we consider the constructions involving *wh*-trace. The aphasic subjects detected 73.75% of ungrammatical constructions involving vacuous quantification, indicating that they know that a *wh*-phrase has to bind a variable. Given this, their acceptance of grammatical constructions suggests that in these constructions they were linking the *wh*-phrase in the Comp position with a variable. The variable can only be a *wh*-trace. If the *wh*-phrase in Comp could be linked to any overt NP, we would expect agrammatics to accept both grammatical *wh*-constructions and constructions with vacuous quantification. However, this was not the case.⁸

Consider now the constructions involving NP-traces. The agrammatics in the present study responded to constructions in which an agreement relation holds between an NP-trace and a predicative adjective. Agrammatic subjects exhibited above-chance performance both on grammatical and on ungrammatical constructions involving adjective-trace agreement. This indicated their sensitivity to the agreement features of NP-traces, which would not be possible if these traces were deleted in agrammatism, as argued by Grodzinsky.

Finally, the agrammatics tested in the experiment performed at above-chance level in detecting constructions in which either a noun or a determiner bears the "wrong" case. Constructions involving the wrong forms of determiners are particularly important in light of the fact that agrammatic subjects studied by Shankweiler et al. (1989) exhibited chance performance

⁸ Notice that there was a possibility of agrammatics interpreting vacuous quantification constructions such as "Ko doktor leči pacijenta?" ("Who the doctor treats the patient?") as "Koji doktor leči pacijenta?" ("Which doctor treats the patient?"). The fact that the agrammatics correctly rejected vacuous quantification constructions indicates that they are sensitive to the nominal versus adjectival *wh*-word distinction. (Actually, it is not clear whether *which* in "which doctor . . ." has adjectival or determiner status in Serbo-Croatian.)

on constructions with incorrect determiners even though they were well above chance in detecting violations involving other closed-class items.⁹ In conclusion, the results of the experiment show that minimizing processing load may lead to significantly improved performance of aphasics, thereby providing a more accurate assessment of the syntactic component of their grammars.¹⁰ Our findings provide additional evidence in support of the processing limitation hypothesis and are incompatible with one version of the syntactic deficit hypothesis, namely, Grodzinsky's claim that the content of nonlexical elements is lost in agrammatism.

⁹ However, one must bear in mind that in the Shankweiler et al. (1989) study, the subjects were urged to make their decisions as quickly as possible, because of the on-line character of the data collection procedure. The speeded-up nature of the task may well have affected their performance detrimentally.

¹⁰ The fact that the aphasics exhibited better performance on grammatical than ungrammatical constructions can be taken to indicate that the very detection of ungrammatical sentences affects processing demands.

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