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Grammaticality Judgment of Article Use in Aphasic Speakers of Bulgarian

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Abstract

In recent years, research on aphasia has benefited from cross-linguistic comparisons. This is the first (online) study of grammaticality judgment of Bulgarian aphasics in comparison with age-matched controls. Two groups of aphasics (11 non-fluent and 8 fluent) judged sentences which varied in terms of positional constraints on bound morphemes, i.e., grammatically correct vs. incorrect placement of the postpositional definite article. Bulgarian aphasics were able to perform the task with smaller, yet comparable, speed and success as controls. While the performance profiles of the aphasic groups and the controls were similar, aphasic patients made more errors on the ungrammatical conditions and differed in the following way: compared with controls, non-fluent participants had problems with the article misplacement condition and fluent aphasics experienced difficulties in detecting violations in the over-marking (double article placement) condition. However, misplacement of the article was a weak point for the fluent patients as well. In general, Bulgarian-speaking aphasics show considerable similarities with the performance of controls, and differences which are mostly quantitative rather than qualitative.

Keywords: aphasia; grammaticality judgment; article use; Bulgarian.

Introduction

To understand and produce spoken language, one needs to be able to process rapidly a variety of information coming from sources commonly seen as different kinds of constraints on sound-meaning mappings. Syntactic constraints operate on the level of combining words and morphemes in strings that are acceptable to the speakers of a language as well-formed (grammatical) utterances. Aphasic patients, especially non-fluent (Broca) patients, have been shown to be impaired on their ability to use such constraints due to lesions in the language-dominant hemisphere.

However, differences have been reported both with respect to the kind of grammatical structure impaired and specificity in cross-language comparisons. Indeed, cross-linguistic studies of the profiles of symptoms and performance of aphasics have uncovered that against the general backdrop of deficits exhibited, a large degree of language-based specificity remains: the same aphasic syndromes often look very different from one language to another, with language-specific knowledge largely preserved in aphasics speaking, for example, English, Italian, and German (Bates, Friederici, & Wulfeck, 1987). Because of that Bates et al. have argued that the traditional distinction between agrammatism and paragrammatism does not work well for richly-inflected languages, as language-specific ratios of closed class morphology were preserved even among non-fluent patients. Thus, an important research goal nowadays is to contribute to our understanding of aphasia in diverse language environments, including less researched languages such as Bulgarian.

Although until recently it was widely believed that agrammatic aphasics have lost the ability to assign complete syntactic representations, as in tests showing their failure to comprehend complex syntactic structures in relative clauses, this does not necessarily hold for all syntax. Studies have shown that agrammatic (non-fluent) patients may retain their syntactic ability which is seen in their above-chance performance (Lukatela, Shankweiler & Crain, 1995). The now classic findings of Linebarger, Schwartz, and Saffran (1983) that agrammatic patients are sensitive to grammaticality despite their poor ability to use syntactic cues in comprehension tasks have been replicated and extended (Berndt, Salasoo, Mitchum & Blumstein, 1988, for example). Such findings have provided arguments in favor of the current view that grammatical knowledge is *relatively* preserved in agrammatic aphasia. A recent investigation into the abilities of aphasic patients to make grammaticality judgments on a variety of syntactic structures in English by

Wilson and Saygin (2004) has led them to argue that the pattern of performance they obtain does not result from any particular component of the grammar, or any particular brain region, being selectively compromised.

Indeed, theoretical accounts have tried to explain such diverse findings by either narrowing down the perimeter of impairment to ever more specific language structures (Grodzinsky & Finkel, 1998), on the one hand, or by searching for explanations in the deficiencies of more general cognitive mechanisms, e.g., working memory, disrupted timing (Kolk, 1995), or allocation of attention, especially inhibitory mechanisms (Wiener, Connor & Obler, 2004).

Furthermore, numerous studies have revealed highly similar profiles in the performance of *fluent and non-fluent aphasics* on certain tasks in a number of languages. Akhutina et al. (2001), for example, found context effects to be unrelated to specific aphasic symptoms or subtypes in a gender priming experiment with Russian-speaking aphasics. In Chinese, the performance of the fluent and non-fluent groups differed quantitatively rather than qualitatively, with better performance on all categories by the fluent group on a cloze test of production of grammatical morphemes (Law & Cheng, 2002). In a recent study of Dutch and English Broca's and Wernicke's aphasia, Bastiaanse & Edwards (2004) established that the proportions and types of errors made by each group were similar on their sentence comprehension and sentence anagram tasks. Bates et al. (1987) discovered that within each language of the three languages they studied (English, Italian, German), error patterns were quite similar for Broca's and Wernicke's aphasics. In sum, the extent of similarity of the profiles of the non-fluent and fluent aphasics remains an open issue to explore.

What theory can account for these results? The main line of explanation follows the notion of "agrammatism", however, there are many versions of this theoretical stand, ranging from central agrammatism, a rather disreputed theory nowadays, to Grodzinsky and Finkel's (1998) claim that agrammatic aphasics are selectively impaired in their ability to process structures involving traces of maximal projections (the Trace Deletion Hypothesis). This theoretical account has come under fire from Caramazza, Capitani, Rey, and Berndt (2001) and Wilson and Saygin (2004), among others. The importance of cross-linguistic research is only highlighted with respect to Grodzinsky's claim, however, as there is no evidence for the psychological reality of such traces in Bulgarian, even in non-aphasic Bulgarian speakers (controls) (Stamenov & Andonova, 1998), i.e., the claim cannot be put to the test in this language, or worse, casts doubts on the performance of all Bulgarian speakers.

Closed-class morphology or functional morphemes are a special interest in aphasia research, mainly in relation to agrammatism. Omission and substitution of articles are typically seen as features of agrammatic speech (Bastiaanse, Jonkers, Ruigendijk & Van Zonneveld, 2003). For example, Grossman, Carey, Zurif & Diller (1986) came to the

conclusion that agrammatic Broca's aphasics are particularly impaired in the use of articles to construct and/or interpret phrasal constituents. Hungarian Broca's patients also showed a very high level of article omission (MacWhinney & Osman-Sagi, 1991).

While the lack of articles (determiners) has traditionally been viewed as a major characteristic of the telegraphic speech of individuals with Broca's aphasia, recent studies have produced contradictory and ambivalent results. Not all closed class morphology is equally and uniformly impaired, and, for example, in a study of French-speaking agrammatic patients, articles were much less difficult to process than pronouns and the ability to process gender marked articles was generally well preserved in these agrammatic patients (Jarema & Friederici, 1994). In seven Broca's and three Wernicke's Romanian-speaking aphasics, articles showed a similar use with that of normals (Mihailescu, 1992). German and Italian patients were also much more likely to furnish the article before nouns than English-speaking aphasics, "despite or perhaps because of the fact that articles are more complex and informative in those languages," (Bates et al., 1987).

Thus, the picture of article use by aphasics is not uniform across languages or tasks. Furthermore, while many studies see Broca's aphasics as impaired in this respect, they typically focus on article *omission* as an error type. This is an inevitable limitation when studying languages with articles functioning as free-standing morphemes and it can only be overcome by extending studies to languages where the article is a bound morpheme (usually attached at the end of the noun and/or its modifiers). Such is the case of Bulgarian which we will present here. This is also the case in Swedish where the indefinite article is a free morpheme and the definite article is a suffix to the noun. In a recent study of the use of articles in the spontaneous speech of agrammatic speakers with Broca's aphasia in Swedish, Havik & Bastiaanse (2004) conclude that the definite article is easier to produce probably because it is a bound morpheme which is less prone to error than the freestanding indefinite article.

What is characteristic of the Bulgarian determiner system? It places a special emphasis on the use of the definite article, a bound (postpositional) morpheme. Morphological and structural rules govern its proper usage: (a) as a bound morpheme, the definite article agrees with the respective noun (and its modifiers) in number and gender; (b) the structural constraints require the article to be affixed postpositionally to the head noun or its first modifier. In Bulgarian, as in other languages, the definite article is one of the most frequently used markers of *given* information – it is affixed to nouns that are contextually known entities. Its use, however, is much wider than that of its counterpart in English, possibly also because of a lack of an indefinite article in the Bulgarian system. The opposition is in fact between the definite article and its absence, rather than between two types of articles (definite vs. indefinite, as in English). Furthermore, the use of the definite article is optional in a variety of contexts.

In our study, we set out to examine the real-time sensitivity to article use and its violations in Bulgarian-speaking aphasics and controls in an on-line task of grammaticality judgment. In this way, we aim to add to the growing cross-linguistic literature on aphasia, and especially to throw light on a specific part of the grammatical system related to definiteness and its marking via articles. The performance of non-fluent aphasics was compared with that of fluent ones, and with two groups of control subjects (college age and older age-matched controls). We chose grammaticality judgment as a task, as it is commonly used as a way of probing into the linguistic competence of speakers and estimating the degree of preservation of this competence in patients with neurolinguistic deficits. The results from previous studies involving grammaticality judgments in a number of languages, e.g., English, Italian, Chinese, Russian, German, etc. (Bates et al., 1987; Akhutina et al., 2001; Lu et al., 2000) have shown that this judgment is an unstable and probabilistic process, and the ability to perform such judgment is preserved in at least some aphasics, e.g., studies of aphasia in German have shown that the system of subject-verb agreement (inflection) is in principle intact in German Broca's (Janssen & Penke, 2002). Some studies with the grammaticality judgment task have shown that grammatical morphology is more impaired than word order, i.e., more sensitivity is preserved to violations of word order (Wulfeck, Bates, & Capasso, 1991). In grammaticality judgment studies, movement (word order, or structural) violations have been studied extensively. Bulgarian word order is highly flexible. In article usage, however, we have a case where positional constraints and their violations can be studied systematically. Note that here we examine the positional constraints of a *bound* morpheme.

Aphasics have been shown to be able to make online judgments in English and other languages (Wulfeck et al., 1991; Lu et al., 2002) using a violation detection task where they are asked to discriminate between grammatical and ungrammatical strings. This gives us sufficient confidence to expect a similar ability in Bulgarian aphasics. As in the Chinese study cited above, "grammaticality" as an intuitive notion in everyday discourse is rather dubious; thus, in our instruction, subjects were asked to judge which sentences were "right/correct" vs. "wrong/incorrect."

The research questions we ask in our study are: (a) can Bulgarian-speaking aphasics make grammaticality judgments in general, and on the placement of the definite article, in particular; (b) how do Bulgarian aphasics differ from controls in this task; (c) can the two groups of Bulgarian aphasics (non-fluent vs. fluent) be differentiated on the basis of their performance in terms of accuracy or speed of judgment? In other words, what are the specific features of Broca's aphasia?

Method

Participants 19 patients (8 fluent and 11 non-fluent aphasics) participated in this study, as well as two groups of controls: (a) 19 college students; and (b) 19 older controls matched with the patients on age, gender, and education level. All were native speakers of Bulgarian. These patients exhibited no difference in severity as demonstrated by a *t*-test, (*p*>.6); they also did not differ on mean age or mean education level.

Stimuli and Design The stimuli were 72 narrative sentences in Bulgarian stringing together a subject noun phrase (adjective + noun), a finite verb, and an object noun phrase (with the postpositional definite article present on the object noun). The finite verb was marked for the past tense and the respective gender suffix (the subject and predicate agree in gender in these constructions in Bulgarian). In effect, the 72 stimuli were 4 variations each of 18 master sentences in which article use in the subject noun phrase differed as follows: (i) condition A (grammatical) – article is correctly placed on the adjective only, e.g., "*krasivata zhena razhozhdala kucheto*" ('beautiful_Det woman walked dog_Det'); (ii) condition O (grammatical) – the noun phrase contains no article, which is permitted by Bulgarian grammar and resembles English constructions with the use of the indefinite article, e.g., "*krasiva zhena razhozhdala kucheto*" ('beautiful woman walked dog_Det'); (iii) condition AN (ungrammatical) – both the adjective and the noun are followed by the definite article, not permitted in the grammar, e.g., "*krasivata zhenata razhozhdala kucheto*" ('beautiful_Det woman_Det walked dog_Det'); (iv) condition N (ungrammatical) – the definite article is placed on the noun only, not permitted in the grammar, either, e.g., "*krasiva zhenata razhozhdala kucheto*" ('beautiful woman_Det walked dog_Det').

The average auditory length of grammatical (4145 ms) and ungrammatical (4170 ms) stimuli did not differ as shown by a *t*-test (*t*=0.44, *p*<0.66).

Procedure Stimuli were presented auditorily in a randomized order preceded by a 10-trial practice session. The experimenter read the instruction asking subjects to press the "YES" button in response to "correct" sentences and the "NO" button in response to "incorrect" sentences. In addition, they were instructed to press a middle "?" button when they had difficulty or uncertainty about the response. The assignment of YES and NO buttons on the button box was counterbalanced across subjects. Reaction times were measured from the offset of each sentence. A Carnegie Mellon button box recorded reaction times and button choice. A Power Macintosh 6400/200 equipped with the PsyScope software (Cohen, MacWhinney, Flatt & Provost, 1993) controlled stimuli presentation. For controls, the inter-trial interval was a random number between 1200 and 2000 ms. For aphasics, a mouse click by the experimenter after the subject's response prompted an inter-trial interval that was a random number between 2000 and 3200 ms.

Results and Discussion

Analyses were run on percent errors and percent of choice of YES button as the measures of accuracy of judgment. The reaction time measure (from the end of sentences) was

based on correct responses only. Prior to reaction time analyses, all trials with incorrect responses, RTs longer than 3000 ms for controls and 5000 ms for aphasics were removed from the data set, as well as trials falling outside the range of subjects' individual mean RT ± 2SD. These procedures resulted in three kinds of data removal, i.e., errors, time window violations, and individual outliers. In total, 84.3% of the data were accepted for RT analysis in the college controls group, 84.4% for the age-matched controls, and 76.8% for the aphasics.

The analyses of the performance of the two groups of controls (college-aged vs. older age-matched controls) did not lead to important differences, with the predictable exception of an overall disadvantage in older controls' speed. Comparative analyses will be presented here using the data from the age-matched controls.

Accuracy

First, we present the analysis of error rates in the control and aphasic groups. Overall, controls made fewer errors, as expected (8.9%) than aphasics (14.30% for non-fluent and 20.0% for fluent patients). One-way ANOVAs were conducted for overall grammaticality (grammatical vs. ungrammatical sentences) for each group of participants on error rates. Controls' data yielded no effect of grammaticality on error rates ($p<.9$), i.e., there was no difference in the error rate for the grammatical vs. the ungrammatical sentences. Neither did it have an effect on the performance of either group of aphasics ($p<.2$). This does not mean that our subjects did not understand the task, however, or that they reacted in a random manner, as our analysis showed a clear effect of grammaticality on the percent 'YES' choices across all groups. Ungrammatical items prompted significantly fewer 'YES' responses than grammatical ones (10% vs. 93%) in college controls ($F(1,70)=490.57$, $p<.00$), and 9% vs. 91% in age-matched controls ($F(1,74)=441.97$, $p<.00$). The two aphasic groups also accepted ungrammatical items as correct less than grammatical items, i.e., 21% vs. 92% for non-fluent aphasics ($F(1,42)=101.89$, $p<.00$) and 26% vs. 86% for fluent aphasics ($F(1,30)=42.98$, $p<.00$).

This study was designed to answer questions concerning article use and its violations in more detail. We now turn to the analysis of performance on the four article usage conditions for each of the aphasic groups. As a reminder, two of these are ungrammatical (conditions N and AN when the article is placed on the second item in the noun phrase), and two are grammatical (conditions A and O when the article is either placed on the modifier or is absent from the noun phrase).

Non-fluent aphasics In order to understand better the specificity of aphasics' performance, we ran separate comparative analyses of each of the two aphasics' groups with age-matched controls. These analyses revealed similarities but also intriguing differences across the abilities of fluent and non-fluent aphasics to detect grammatically unacceptable syntactic strings. To begin

with, non-fluent aphasics' overall accuracy was worse than that of the age-matched controls, i.e., they made an average of 14.3% errors on all four conditions, whereas controls made 8.9% errors. However, their performance was far from being at a chance level, i.e., they demonstrated sensitivity to the grammaticality of these sentences. Furthermore, though being much greater, non-fluents' error rate was not significantly different from that of controls on three out of the four article placement conditions in this experiment (the two grammatical conditions, A and O, and the ungrammatical AN). Their performance was significantly different, however, as seen in a Duncan posthoc test, on the ungrammatical condition N where the article is misplaced, or moved away, from the correct adjective-final to the incorrect noun-final position in the noun phrase ("*krasiva zhenata razhozhdala kucheto,*" Eng.'beautiful woman_Det walked dog_Det'). In this condition, non-fluent aphasics made 30.8% errors in comparison with controls' 16.4%. Importantly, the error rate difference between the non-fluent patients and age-matched controls did not reach significance on the other ungrammatical condition AN where the violation consists not of misplacement of the article but of over-marking the noun phrase by adding a second (unsanctioned) article on the noun (error rate: 10.3% non-fluent aphasics vs. 3.2% controls). What this means essentially is that Bulgarian non-fluent aphasics showed an impaired ability to detect misplacement and a statistically non-significant (though numerically present) disadvantage at detecting over-marking.

Fluent aphasics The comparative analysis of the accuracy (error rate) between fluent aphasics and age-matched controls revealed a somewhat different picture. First, however, similarly with non-fluent aphasics, their reactions were not at a chance level, i.e., they had not lost their ability to make grammaticality judgments while the overall accuracy of fluent aphasics was generally lower than that of age-matched controls (20.0% vs. 8.9%). Their performance differed significantly from that of controls on only one of the ungrammatical conditions, a finding that at first glance may seem familiar from the results on the non-fluent group. However, importantly, while non-fluent patients had an impaired ability to detect misplacement as in condition N, fluent aphasics had difficulty with the other ungrammatical condition, AN, which is a case of over-marking the noun phrase with two articles instead of one (e.g., "*krasivata zhenata razhozhdala kucheto,*" Eng. 'beautiful_Det woman_Det walked dog_Det'), as revealed by a Duncan post hoc test, with a difference between 23% for fluent aphasics and 2.1% for controls; their error rate was not significantly different from that of controls on the misplacement condition (29.5% vs. 16.4% in fluent and control groups, respectively). Thus, Bulgarian fluent aphasics found it particularly difficult to detect over-marking and seemed closer to controls in their detection of misplacement, although still worse than them. In effect, this shows a differential picture of impairment in the two aphasic groups, in that while non-fluent patients had specific

problems with misplacement, fluent patients were experiencing their own specific difficulties with over-marking.

This general conclusion on the differential nature of their performance needs to be modulated, however, as a direct comparison between the two groups of patients, i.e., fluent vs. non-fluent aphasics, independent of a comparison with controls, revealed that the error rates of the two groups were not significantly different on any of the four article usage conditions, although fluent aphasics had an overall worse performance (20.0%) than non-fluent aphasics (14.3%). Furthermore, while their error rates differed by almost 13% (23% in fluent vs. 10.3% in non-fluent) on condition AN (over-marking), it was extremely small on the other ungrammatical condition N (misplacement), i.e., both groups had quantitatively similar difficulties with the misplacement of the article (30.8% non-fluent vs. 29.5% fluent error rate).

Reaction Times

Non-fluent aphasics Non-fluent aphasics and age-matched controls differed in their speed of processing the four article placement conditions. A two-way interaction between group and condition ($F(3,110)=3.14$, $p<.05$) revealed that although both groups responded similarly to the grammatical conditions (with almost identical values for reaction times), non-fluent aphasics were markedly and significantly faster than controls on both ungrammatical conditions in a Duncan post-hoc test. The reaction time difference in correctly rejecting the ungrammatical AN and N conditions was not significant. Furthermore, both of these ungrammatical conditions yielded RTs around or below zero, i.e., correct rejection took place very soon after the occurrence of the violation (i.e., judgment was rather localistic). This was not the case with the age-matched controls who appeared to respond after processing the sentence as a whole, taking a more globalistic approach.

Fluent aphasics Unlike the non-fluent aphasics, the fluent ones were much slower than controls, and there was no interaction between the variables of group (fluent vs. controls) and article condition (p<.8). A Duncan post-hoc test revealed that fluent aphasics were significantly slower on only one of the two grammatical conditions, condition O, i.e., no article in the noun phrase (a legitimate construction in Bulgarian). Fluent aphasics were generally slower and more cautious, waiting well until and beyond the end of the sentence before they committed to a judgment on the acceptability of the string. A direct comparison of the reaction times of the two aphasic groups revealed that their speed was similar on the grammatical conditions but the non-fluent patients were much faster at detecting violations on the ungrammatical conditions and committing to a negative judgment, i.e., in terms of speed, they seemed to show greater sensitivity to these local structural violations, as pointed out above.

Conclusion

We present here the first online study of aphasia in Bulgaria which asks a number of research questions in a language which is under-researched and which offers an opportunity to explore positional constraints on the use of the article system. We first asked whether Bulgarian-speaking aphasics can make (online) grammaticality judgments in general, and on the placement of the definite article, in particular. Our findings indicate that, although less successful than the control groups, both non-fluent and fluent aphasics were able to perform this task, as evidenced by their well-above chance performance, and in the case of the non-fluent group, by their processing speed. In fact, non-fluent patients appeared to be using a rather 'local' strategy in reaching their judgments by rejecting ungrammatical stimuli almost immediately after the violation point. Fluent aphasics as well as most controls, especially the age-matched control group, were taking a more 'global' approach deferring judgment until they have processed the entire stimulus.

Our second question concerned the different profiles of aphasics and controls. While their overall performance was similar to that of controls (e.g., comparable overall error rates and error patterns, as well as speed of processing pattern), the two aphasic groups differed from controls on processing the two ungrammatical conditions of article placement. Furthermore, in answer to the third research question on distinctive cross-aphasic profiles, these differences appeared to be group-specific: while both non-fluent and fluent aphasics experienced difficulties with the ungrammatical article-misplacement condition, the fluent group had a specific disadvantage in under-detecting violations in the condition where the noun phrase constituents were over-marked with two instead of one article. The specific underlying mechanisms for this variation need to be explored further in the future, i.e., would the two aphasic groups differ in the same way on grammaticality judgments of structural constraints other than article use, would their productive performance mirror that differentiation in their receptive one, could there be a more general cognitive dichotomy at work here, e.g., weakened sensitivity to over-marking (in fluent) vs. mis-marking (in non-fluent), etc. In general, however, Bulgarian-speaking aphasics exhibit the kind of performance already established in some other languages: considerable similarities with the performance of controls, and differences which are mostly quantitative, rather than qualitative.

Finally, considerable variation and relatively high error rates were also obtained in the responses of non-aphasic participants in this study, pointing out the limitations of researching a grammatical category such as definiteness in syntactic strings isolated from a discourse-based context. This consideration, in combination with the high structural flexibility in the Bulgarian language, contribute to our understanding that: (a) it may be particularly difficult to create strings which would be judged as unambiguously ungrammatical, and (b) non-aphasic as well as aphasic speakers of Bulgarian utilize a number of additional

information cues besides grammatical structure in the process of comprehension.

Acknowledgments

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