

Sentence Interpretation in Bulgarian: The Contribution of Animacy

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Abstract

There is growing interest in exploring the interaction of semantics with other information sources in sentence processing. This study explores the role of noun animacy in these processes in combination with syntactic (word order) and morphological (number marking) factors by means of an on-line agency assignment task in Bulgarian. Unlike similar studies, the preparation of the stimuli follows a rigorous series of pre-tests which reveal the gradable nature of animacy and attempt to account for the interaction of verb semantics (agency reversibility) with noun semantics (animacy contrast). Results confirm expectations of the high significance of agreement in Bulgarian and present a challenge to the binary view of animacy. Some of the predictions on cue interaction within the Competition Model are put to the test and generally confirmed.

Introduction

In recent years there has been growing interest in the interaction of syntax and semantics. It has become clear that sentence processing is sensitive to various lexical influences in addition to syntax-related phenomena. This line of research requires a better understanding of the semantic aspects involved in interpreting sentences and many studies nowadays include such semantic variables as noun animacy, noun concreteness, etc. (Den, & Inoue, 1997; McDonald, Bock, & Kelly, 1993).

Studies have shown the involvement of animacy in sentence processing in English, French, Italian, Chinese, etc. It has been demonstrated that the use of animacy cues in sentence interpretation depends on the language being acquired (Kail, 1989).

This is particularly important for the examination of the validity of major tenets of interactionist models of language performance. If indeed, as has been proposed, sentence processing draws information from a variety of typologically different sources, or cues, then we should be able to demonstrate the interaction of semantic, morphological, and syntactic cues which is the goal of the present study.

It appears that our conceptual system frequently uses subtle distinctions of categories such as that between the living and non-living, the active and the passive, the moving and the stationary, the animate and the inanimate. Such distinctions may find explicit manifestation in the system of a language. They may also, however, be part of an implicit, underlying conceptual system which exerts its influence in indirect ways. Whorf (1956) introduced a distinction between overt and covert classes, or categories, in languages. Animacy appears to be one such covert category across a range of languages.

The extent to which animacy finds explicit expression across languages varies. In Slavic languages, animacy is often combined with gender to form a single category. Unlike Russian with its explicit marking for animacy in the accusative case, Bulgarian, having lost its case system, relies on other cues instead. Generally speaking, in modern Bulgarian, as in English and French, the animate/inanimate distinction is not morphologically marked on nouns but is rather a lexical-semantic property of the noun itself.

This study aims at identifying those processing strategies which are used most typically by Bulgarian listeners. In addition, the validity of some of the predictions within the framework of the Competition Model (Bates, Wulfeck, Hernandez, & Andonova, 1996) is examined in relation to cue convergence, cue competition and cue coalitions. Methodological issues are tackled as well, such as designing appropriate stimuli with animacy contrast.

Experimental Method

Stimuli Selection and Pre-tests

The experiment was intended to examine the interaction of a semantic factor (noun animacy) with syntax (word order) and morphological marking agreement during sentence interpretation. Our approach overcomes some of the inadequacies of previous studies of animacy in which noun and verb stimuli are selected on the basis of researchers' judgments with the underlying assumption that animacy is a binary category. Noun animacy is treated here as a gradable category for which rating scores are obtained from subjects. Another methodological difference in the preparation of the stimuli and the design consists in the attempt to control for the variation in the interaction of the semantics of the verb with the semantics of the two nouns.

Three animacy subsets of nouns were obtained after a series of selection procedures and pre-tests. First, a master list of 110 nouns was generated from which nouns that are difficult in terms of non-imageability and non-concreteness were excluded, e.g., abstract nouns, kinship terms, proper nouns, etc. The remaining 80 nouns were presented to 10 subjects in a classification-by-animacy task. This allowed the selection of nouns which typically co-occur in a group. Subjects in the pre-test were volunteer university students.

The resulting 60 nouns were presented to another group of subjects with instructions to assign a rating score from 1 to 7 (highest) to each noun according to frequency of occurrence in Bulgarian. Similarly, subjects were asked to give a rating of the same 60 nouns on a scale from 1 to 7 in terms of their degree of animacy (7-most animate). The former was necessary because of the absence of reliable frequency counts for Bulgarian. The second rating pre-test was carried out

separately and yielded measures for the subjectively perceived degree of animacy of the 60 nouns. 20 subjects (all psychology students of the same age group) participated in the two pre-tests as part of their course requirements

Nouns were then ranked according to their frequency and their animacy rating scores. Three subsets of 6 nouns each were formed according to their degree of animacy—High (H), Medium (M), and Low (L) with similar mean frequency scores (i.e., 4.94, 4.98, and 4.94 for Subsets H, M, and L, respectively) and with significantly different mean animacy scores (6.36, 3.83, and 1.67 for Subsets H, M, and L, respectively).

As pointed out earlier in this paper, another assumption of researchers which goes without preliminary testing in similar experimental work concerns the transitive verbs which are used in the sentence stimuli. The semantics of these verbs may frequently be a confounding factor not examined separately for its contribution to sentence comprehension.

For the purposes of this study, it was necessary to eliminate the influence of this potentially confounding factor. A panel of 5 native speakers of Bulgarian (university students of psychology) participated in generating and selecting semantically reversible verbs in terms of agency potential. In other words, transitive verbs were elicited which allow reversibility of the agent's role applied across animacy subsets, i.e., both 'The car hit the man' (LH) and 'The man hit the car' (HL) are equally plausible. As a result, six verbs were selected for use in all sentences: *hutna* ("pushed"), *udari* ("hit"), *zakri* ("covered/hid"), *iztsapa* ("soiled/stained"), *zastigna* ("caught up with") and *nadzhivia* ("outlived").

Finally, 30 master sentences were created incorporating two nouns from the animacy subsets and one of the 6 selected verbs balancing sentences across conditions. Similarly, a balance of the number of occurrences of each noun and of each verb in the total set of sentences as well as in each of the animacy contrast conditions was insured.

Design

The experiment was intended to study the impact of a semantic cue, noun animacy, on sentence comprehension and its interaction with syntax, namely verb position, which ultimately yields word order, and agreement on morphological marking between the verb and the nouns. In the experimental task, subjects were asked to identify the agent/doer in simple sentences consisting of a verb and two nouns. In effect, this type of task amounts to agency assignment.

The design of the experiment includes three independent variables and two dependent measures. The independent variables are position of the verb, agreement in number and contrast in animacy. For the structural factor position of the verb, there are three levels—verb in first position, verb in second position and verb in third position (VNN, NVN, NNV).

The second independent variable is a combination of two groups of morphological markers for number (on nouns and on verbs) which in Bulgarian are obligatory. In the sentence stimuli for this experiment, the verb agrees in number with

either only one of the nouns or with both nouns. Agrammatical strings (where the verb agrees with neither of the two nouns) were excluded. Thus, the design distinguishes among AgN1, i.e., the verb agrees with the first occurring noun; AgN2, i.e., the verb agrees with the second occurring noun, and AgN12, i.e., the verb agrees with both nouns in the sentence.

The third independent factor is contrast in animacy between the two nouns in the transitive sentence (AC). Animacy contrast is interpreted as the relative distance between the two nouns in terms of animacy rating and the direction of the imbalance between the two nouns. When both nouns in the sentence belong to the same subset, for example, both are from subset H, then the contrast in animacy ratings is negligible (AC=0). When the two nouns are derived from adjacent subsets, e.g., H and M, or M and L, then animacy contrast is one degree (AC=1). When the two nouns belong to the two most distant subsets, i.e., H and L, then noun animacy contrast is two degrees (AC=2). In addition, a distinction is made between cases when the first noun (N1) is higher in animacy than the second noun (N2) and vice versa (N1 and N2 are the first and second occurring nouns in the master sentence).

In summary, the third factor of animacy contrast (AC) differentiates among the following five levels:

AC= -2:	AN1 << AN2;
AC= -1:	AN1 < AN2;
AC= 0:	AN1 = AN2;
AC= +1:	AN1 > AN2;
AC= +2:	AN1 >> AN2.

In total, the above 5 conditions with 6 sentences each (animacy contrast) were combined with the 3 levels for agreement (AgN1, AgN2, AgN12) and the 3 levels for verb position (VNN, NVN, NNV), as a result of which 270 sentential stimuli were obtained.

There were two dependent variables used in this study—percent choice of first noun as the agent in the sentence (ChN1) and reaction time (RT). The first variable shows the meaning of the sentences as understood, or constructed, on the basis of the available cues. The second variable reveals some of the cognitive mechanisms of sentence processing.

Subjects

Subjects were 24 university students (17 female and 7 male). Their average age was 23.1. All subjects were right-handed native speakers of Bulgarian.

Procedure

Subjects were tested individually in an experimental station. They listened to sentences and saw drawings of referents of the two nouns in each sentence. Subjects were asked to choose one of the two nouns as the doer of the action as quickly as possible by pushing one of two corresponding buttons. Before the main section of the experiment, subjects were familiarized with the drawings and the lexical items for their referents and also completed a practice test. The order of presentation of the pictures was counterbalanced and a unique random order was used for the presentation of the sentence stimuli in the experiment for each subject.

Reaction times and choice data were collected by a Carnegie-Mellon button-box, an auxiliary to the MacIntosh workstation working with the PsyScope software package. Reaction times were measured from the onset of the auditory presentation of the sentences. As sentences varied considerably in length, the duration of each individual sentence was measured and subtracted from the values for the reaction times corresponding to it. In the subsequent statistical analysis, only the transformed reaction time data were used.

Results and Discussion

The results of the main experiment are reported here in parallel for the two dependent variables. For the purpose of identifying the values for the dependent variable "percent choice of first noun as the agent," the total number of 24 subjects was divided randomly into 3 subgroups of 8 each. The percentage of choices is calculated for the subgroup; it has three replications. For both dependent variables, ChN1 and RT, 3 x 3 x 5 (Word Order x Agreement x Animacy Contrast) ANOVA tests were performed.

Word Order (Verb Position)

The choice results (ChN1) for word order reveal a general tendency to interpret the first noun as the agent in Bulgarian sentences ($F_{(2,90)} = 9.3, p < .01$).

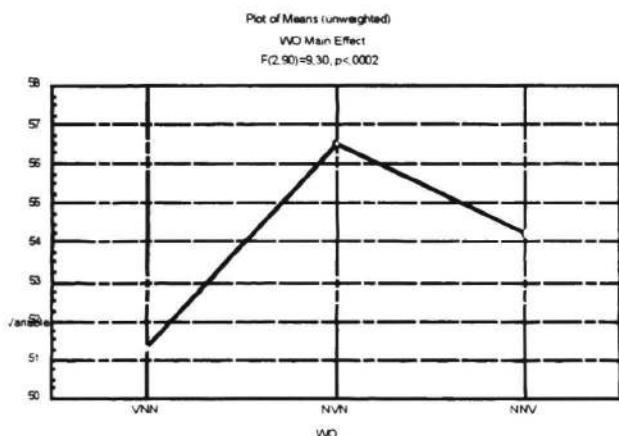


Figure 1: Word Order Main Effect for Percent Choice of First Noun as the Agent

In all three conditions, VNN, NVN, and NNV, the first noun is chosen more frequently than the second noun, although this bias is strongest in the NVN condition, the canonical, or basic, word order in Bulgarian sentences (Fig. 1). The reaction time ANOVA test also revealed a significant main effect for word order (Fig. 2). These results are in support of findings from an earlier study where it was established that in the NNV condition reaction times are considerably longer. As agreement is the most reliable and competitive cue in Bulgarian, the subjects' strategy appears to be to wait till they hear the verb-form which in NNV strings is at the end and thus slows down agency assignment.

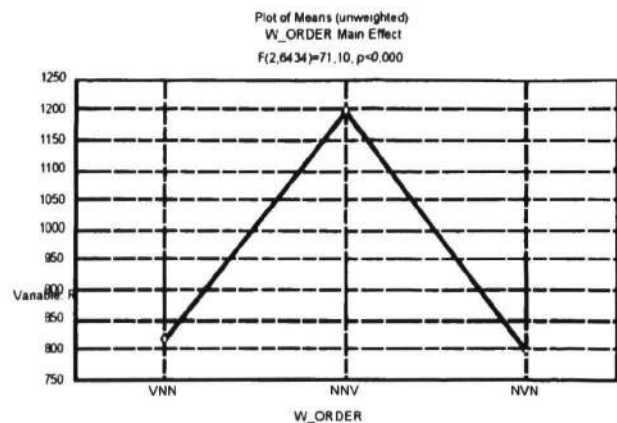


Figure 2: Word Order Main Effect for Reaction Time

Agreement

Agreement between the verb and the subject has been shown to be the most reliable cue in on-line comprehension in Bulgarian of those studied previously (Andonova, Gerganov, Petrov, & Misheva, 1995). It is the cue that "wins" in cases of cue conflict between agreement and word order. The results from this experiment indicate that it is also "victorious" in conflicts with the semantic cue of animacy contrast. There is a powerful main effect for ChN1 data for agreement ($F_{(2,90)} = 1964.6, p < .01$).

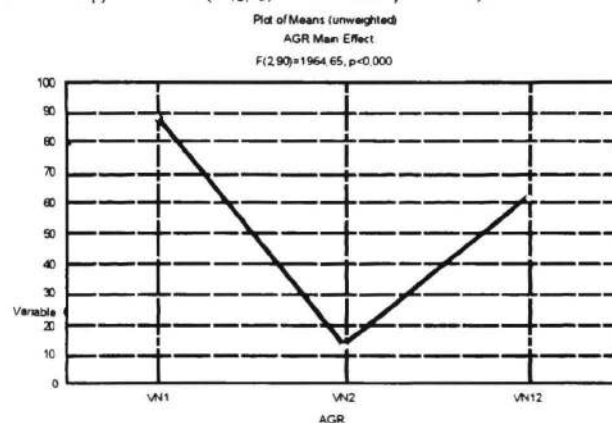


Figure 3: Agreement Main Effect for Percent Choice of First Noun as the Agent

Fig. 3 illustrates the strong preference for assigning agency to the noun which is in agreement with the verb, irrespective of word order variations. This figure also reveals a preference for choice of first noun over second noun even in VN12, i.e., cases of "neutralization" of the effect of agreement. As presaged by the results described in Fig. 1, there is a general tendency to ascribe agency to the first occurring noun and thus impart SVO, SOV, and VSO word order interpretations of sentential meaning.

Reaction time results are just as indicative of the unusually high degree of validity of agreement in Bulgarian with a major main effect ($F_{(2,0464)} = 58.14, p < .01$). Reactions were considerably faster when verb agreement was uniquely valid for only one of the two nouns (Fig. 4)

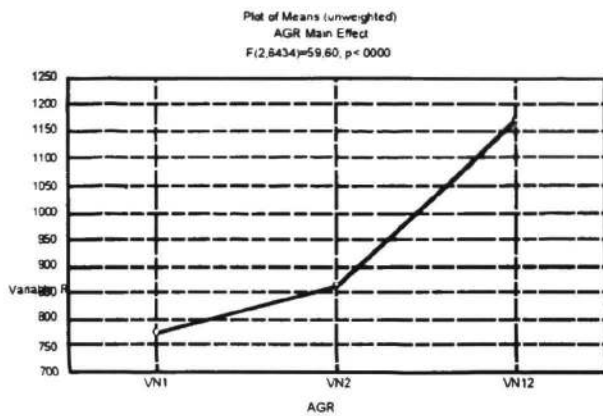


Figure 4: Agreement Main Effect for Reaction Time

Animacy Contrast

The third factor examined in this study is animacy contrast, whose definition is described in the section on stimuli preparation. This factor also has a main effect for the dependent variable of choice of first noun as the agent ($F_{(4,90)} = 38.8, p < .01$).

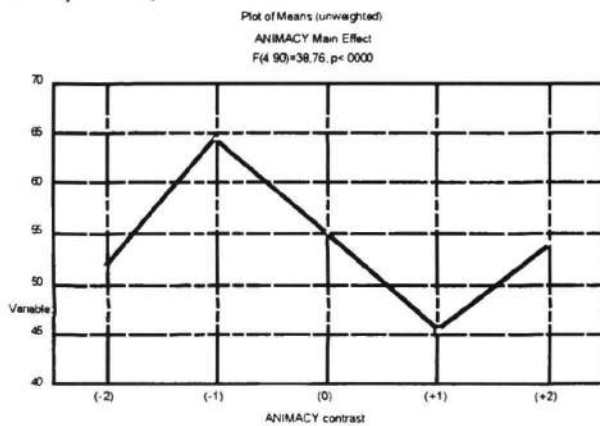


Figure 5: Animacy Main Effect for Percent Choice of First Noun as the Agent

In the absence of animacy contrast ($AC=0$), the values here are close to the level of the average percentages of Ch1 collapsed over all conditions in the full design of the experiment, re-stating the preference for assigning agency to the first noun. The results for the two conditions of animacy contrast at the two ends of the AC scale, i.e., when the two nouns belong to the two most distant subsets ($AC=-2$ and $AC=+2$), are comparable to those for absence of animacy contrast ($AC=0$) with values in the region between 50% and 55%.

As Fig. 5 demonstrates, however, the results for the second ($AC=-1$) and the fourth ($AC=+1$) conditions deviate considerably from the average overall level. Here subjects prefer the less animate noun as the agent, i.e., N1 in " $AC=-1$ " and N2 in " $AC=+1$ "

The second dependent variable, reaction time, also reveals a main effect of animacy contrast ($F_{(4,6434)} = 12.48, p < .01$). There is a striking difference between the speed of executing

the task in the conditions with animacy contrast of only one degree which are conditions 2 and 4 in Figure 6. As a reminder, $AC=-1$ accounts for those sentences in which the first noun is lower in animacy than the second one by one degree, for example, N1 belongs to subset L and N2 belongs to Subset M ("the hammer hit the arm/hand"). In the fourth condition of $AC=+1$, the ordering is reversed ("the hand/arm hit the hammer").

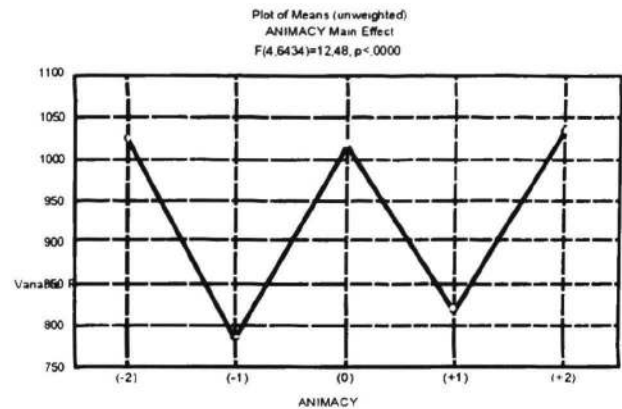


Figure 6: Animacy Contrast Main Effect for Reaction Time

The data reveal an important parallelism in the results for the two dependent variables for animacy contrast. The data for choice for the three conditions " $AC=-2$ ", " $AC=0$ ", and " $AC=+2$ " can be grouped together in contrast with the data for the other two conditions, " $AC=-1$ " and " $AC=+1$." Significantly, those are exactly the kind of groupings that emerge from the data on reaction time. Proper interpretation of this parallelism requires further investigation. The important point here is that this unique effect has not been revealed by previous studies because animacy was treated as a binary category only.

This kind of data may reflect different cognitive mechanisms of processing in these two conditions, or an inherent bias in the complex sentential stimuli. The very gradability of the semantic category of animacy has not been tested before in on-line language processing. The need to use verbs that are reversible has also escaped previous investigation. A reliable methodology for the selection of this type of stimuli is yet to be established. This study is only a first step in this direction. After all, the transitive verbs in these sentences may not be entirely reversible. These results demonstrate the complexity of semantic factors and the need to explore the interaction of the semantics of all "ingredients" in a sentence.

Verb Position – Agreement Interaction

There emerged also effects for the interaction of independent variables. Fig 7 shows the interaction of verb-noun agreement and word order (verb position relative to the two nouns). This interaction has a significant effect ($F_{(4,90)} = 7.16, p < .01$) for the variable choice of first noun as the agent. Here again the effect is mainly due to variation across word orders in the condition where there is least contrast in the other factor of agreement, i.e., VN12. Conversely, there

is little variation in Ch1 on word orders in the presence of such a powerful cue as agreement is in Bulgarian (see VN1 and VN2 conditions in Fig. 7), especially when it leads uniquely to one interpretation.

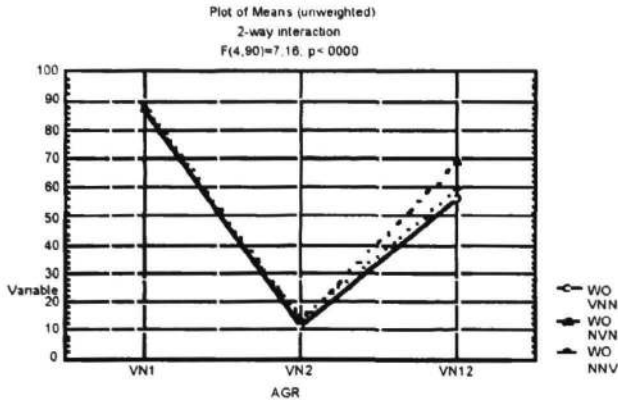


Figure 7: Word Order by Agreement Interaction for Percent Choice of First Noun as Agent

Finally, notice the recurrent preferential tendency for Ch1 in the neutral, or ambiguous, condition of VN12, reminiscent of the general outline for the main effect of verb agreement in Fig. 3.

Similarly, the two factors interact also in respect to the reaction times associated with them. Fig. 8 illustrates this interaction. The almost parallel trends for the second and third verb position conditions, NNV and NVN, are not repeated for the first condition VNN. In these cases, when the verb agrees with the second noun only and the verb comes first, the point in time when subjects can already rule out one of the two alternatives in their choice occurs early enough in the sentence for them to be able to make a faster "rejecting" decision. For example, in VNN and AgN2, the sentence "outlived-Pl the dog-Sg the teacher-Pl" allows subjects to reach an early decision that N1 is not the agent on the basis of a mismatch between the number of the noun and the verb which appears earlier here than in any of the other two conditions.

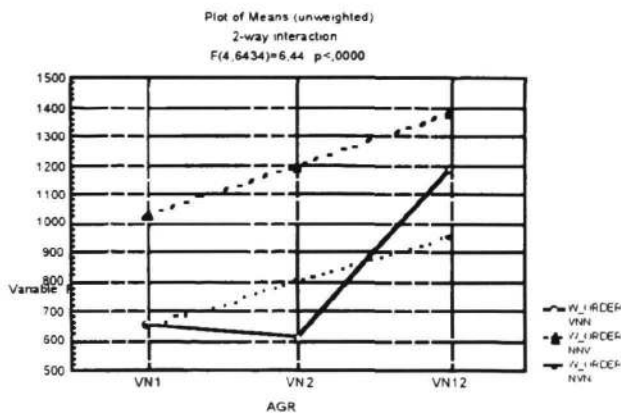


Figure 8: Word Order by Agreement Interaction for Reaction Time

Animacy Contrast - Agreement Interaction

Another interaction effect which reached statistical significance is that of agreement with animacy contrast ($F_{(8,90)} = 4.01, p < .01$) for the variable choice of first noun as the agent. Fig. 9 shows the differences between the levels of agreement for the five conditions of AC.

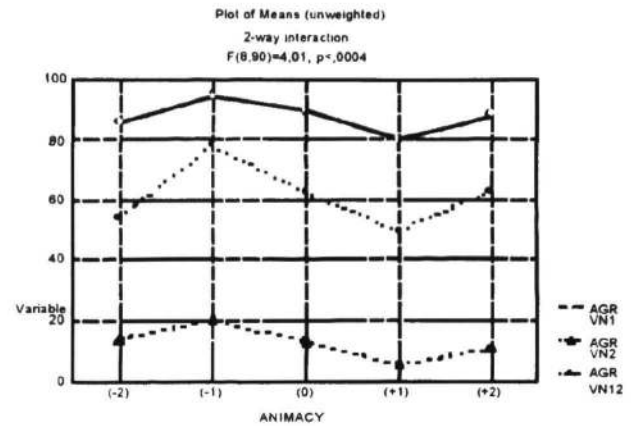


Figure 9: Animacy Contrast by Agreement Interaction for Percent Choice of N1 as Agent

The results for the VN1 and VN2 levels of agreement are predictably parallel, which reflects the strong and apparently uniform impact of agreement on the dependent variable choice of first noun as the agent. The results for VN12 follow closely the outline of the other two conditions but display more variation between the second and fourth conditions of animacy contrast in a way that refers back to the main effect for animacy contrast (see Fig. 5). This demonstrates once again the trend for greater variation in Ch1 across the conditions of a weaker cue in the absence of contrast within the stronger cue.

Relevance to Competition Model Predictions

In this section, I will examine briefly the results obtained in the main experiment in view of some off-line and on-line predictions of the Competition Model (Bates, Wulfeck, Hernandez, & Andonova, 1996). Predictions concerning reaction time include the hypothesis that competing cues should inhibit immediate interpretation and thus slow reaction times down. Indeed, this is what we observe in data illustrated in Fig. 8—when in competition, agreement and word order elicit slower reaction times than in those cases when the two cues operate in the same direction (AgN2 competes with NVN (SVO) and is slower than AgN1 in the same NVN condition).

Another reaction time prediction, however, is not so obviously supported by the data from this experiment, namely, that converging cues should facilitate sentence interpretation and thus lead to faster response times. In Fig. 8, in the basic word order NVN condition, those cases with a diverging cue (AgN2) are actually faster than those with a converging cue (AgN1). In such three-item transitive constructions a mismatch in markers between a verb and a noun is a certain indicator that this particular noun is not

the subject/agent of the sentence. In this sense, rejecting a wrong initial hypothesis is faster than confirming a (possibly) correct one.

However, there is another interpretation in which the RT prediction may indeed be found to be valid. It involves consideration of cues within this model not in terms of a particular marker but as the contrast between markers, on the analogy of animacy contrast.

Another group of CM predictions refer to the consistency and strength of choices in interpretation, for example, the prediction that stronger cues should result in more consistent decisions. Indeed, as shown in Fig. 9, for example, when the stronger cue exhibits no impact, or is ambiguous (as in AgN12), variation across conditions of the weaker cues increases (consider the differences in the AgN12 data as plotted here). This prediction as well as the next one are confirmed.

Decisions are expected to be more uniform under cue convergence but less uniform under cue competition. Analysis of the choice data for the combination of all three cues favoring one and the same interpretation shows that this is indeed so. Cases of convergence in this study include the following three conditions: NVN for word order, AgN1 for agreement, AC(+1 and +2), a total of 288 cases, for which ChN1=82.6%. Whereas in competition, such as a combination of NVN, AgN1N2, AC(-1 and -2), the percent choice drops to 73.6%.

Finally, it has been hypothesized that stronger cues may win despite a conspiracy from weaker sources of information. This is demonstrated in our data on sentences where the two weaker cues, word order and animacy contrast, combine forces to attempt to override the unusually powerful influence of agreement in Bulgarian (NVN, AgN2, and AC(+1 and +2). The percent choice of first noun as the agent is 6.6%, which means that agreement "won" this battle, as well as the whole war.

Conclusion

In conclusion, this study shows clearly the interaction of typologically different cues from syntax, semantics, and morphology in sentence interpretation in Bulgarian. In particular, animacy contrast between nouns plays a (modest) role in these processes. It becomes evident that animacy-related methodological issues require further investigation. The study also shows that the relevant predictions within the Competition Model are confirmed by data on the interaction of the three cues of word order, agreement, and animacy contrast in Bulgarian. Future research and analysis are needed in order to examine the possibility of construing other cues apart from a semantic factor such as animacy in terms of contrast.

Acknowledgments

I would like to thank my students for their help at different stages of the experiment, especially Milena Leneva and Ivaylo Milenkov. The research was supported by a McDonnell Foundation grant on "Cross-linguistic studies of aphasia."

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