

K.Gor & T. Chernigovskaya Rules in the Processing of Russian Verbal Morphology// *Current Issues in Formal Slavic Linguistics* ed. by Gerhild Zybatow, Uwe Junghanns, Grit Mehlhorn, and Luka Szucsich(= Linguistik International; 5)Frankfurt/Main [etc.]: Lang, 2001xvi, pp528-536. .ISBN 3-631-39187-0

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Rules in Processing of Russian Verbal Morphology*

1. Background

There are two main points of view in the literature regarding processing of regular and irregular inflectional morphology, and in particular regular and irregular verbs.

According to the modular approach, regular and irregular verbs are processed by two distinct mechanisms. Regular verb forms are computed in a rule-processing system, while irregular verbs are processed in associative memory. (Marcus et al. 1992, 1995, Pinker 1991, Pinker and Prince 1988, 1991, 1994, Prasada and Pinker 1993, Ullman 1999). This so-called dual-system view holds that since irregular verbs are retrieved from associative memory, they will be frequency-sensitive. Thus, high-frequency forms will be better remembered than low-frequency forms. Unlike irregular verbs, regulars will show no frequency effects.

The opposite single-system approach in its two variations, the connectionist (MacWhinney and Leinbach 1991, Plunkett and Marchman 1991, 1993, Rumelhart and McClelland 1986) and the network (Bybee 1985, 1988, 1995, Langacker 1987, 1988) approaches, holds that both regular and irregular verbs are processed by one single mechanism in associative memory. Consequently, it predicts that both regular and irregular verbs will show frequency effects.

Experimental data on frequency effects in English past-tense inflection are controversial. While several studies demonstrate frequency effects only in irregular verbs (Prasada, Pinker, and Snyder 1990, Ullman 1999) and therefore do not support the single-system view, other studies demonstrate frequency effects for regular verbs as well (Stemberger and MacWhinney 1988, Marchman 1997). The study by Alegre and Gordon (1999), which showed frequency effects in regular inflection, measured reaction times in a lexical decision task involving English verbs, nouns, and adjectives (as well as nonce forms). It detected whole-word frequency effects for regularly inflected verbs above the threshold of about 6 per million when stem-cluster frequencies were held constant.

* *Acknowledgments.* The work was partly supported by Russian Scientific Foundation for Research in Humanities (grant 00-04-00338a) and by Russian Foundation for Basic Research (grant 00-15-98855)

Obviously, English past-tense inflection with only one regular verb class and with no developed conjugational paradigm cannot be readily generalized to other languages with developed inflectional morphology. Two developmental studies of child L1 acquisition of complex verbal morphology, one in Norwegian and Icelandic and the other in Italian, recorded the influence of both type and token frequencies on their subjects' responses (Matcovich 1998, Ragnasdóttir, Simonsen, and Plunkett 1997, 1999, Simonsen and Bjerkan, 1998). (The Italian study also included adult Italian speakers and showed the same effect for adults.) For Norwegian and Icelandic, this influence was manifested in the generation of past participles of both strong (irregular) and weak (regular) verbs. In Italian, it was manifested across the different verb conjugation classes. The results of these studies, which assessed the influence of input frequencies through the rates of overgeneralizations, are in conflict with the predictions made by the proponents of the dual-system approach.

Another line of research that tests the claims of the dual- and single-system approaches is the study of lexical associations, or the so-called gang effects (Stemberger and MacWhinney 1988) or neighborhood effects (Plunkett and Marchman 1991, 1993, Rumelhart and McClelland 1986). English irregular past tense shows partial regularity, with several verbs clustering together (such as sing-sang, ring-rang, spring-sprang). These neighborhoods vary in size, and when they share some phonological properties, they form a neighborhood based on phonological similarity. In fact, phonological similarity was shown to influence processing of English irregulars, but not regulars (Prasada and Pinker 1993, Ullman 1999). Thus, acceptability ratings of irregular past-tense verbs (such as *blew*) correlated with the group size of similar-sounding irregular verbs (*threw*, *grew*), but no such correlations were found for regular verbs (Ullman 1999). Again, this issue is not uncontroversial, and both developmental and adult data on past tense processing in Italian show effects of phonological similarity even in the Conjugation 1 class, considered to be a regular and default class (Matcovich 1998). Thus, the data from a language with complex verbal morphology challenges the results obtained for English.

The Norwegian/Icelandic study also makes a claim that morphological complexity influences developmental rates. Icelandic has more complex verbal morphology than Norwegian does. In accordance with that, the Icelandic children were delayed relative to the Norwegian children at age 4 on the strong verbs. At the same time, the study hypothesizes that "greater morphological complexity of Icelandic may subsequently have facilitatory effect on children's acquisition of morphology, and contribute to the Icelandic children's sudden spurt in development at age 6". So far, there are very few studies investigating processing of complex morphology (for example, see Niemi et al. 1994, Laine et al. 1995, Orsolini and Marslen-

Wilson 1997, Orsolini et al. 1998, Bertram et al. 1999) and Russian verb conjugation easily lends itself to bridging this gap.

2. Experimental Design

This study explores the processing of verbal morphology in Russian, a language with numerous verb classes, which vary in size, and numerous conjugational patterns. It assumes that since Russian verb classes differ ‘gradually’ in ‘regularity’ and size, a sharp division into regular and irregular processing could hardly be expected. It focuses on the role of morphological cues and explores the hypothesis that the complexity of paradigm plays a role in native processing. The complexity of paradigm is understood as the number and type of rules shaping the conjugational pattern of individual verb classes. The study addresses the following issues:

1. What is the default pattern for Russian? Which conjugational patterns are more likely to be generalized to other verb classes?
2. Are generalizations influenced by type frequencies of the verbal classes involved and/or by the complexity of paradigm factor?
3. What is the role of morphological cues in verbal processing?
4. Are the rules shaping the conjugational pattern for a particular verb class applied in a set, or they may be disassociated in verbal processing?

The experiment was conducted at St. Petersburg State University, Russia, with 27 adult native speakers. It was conducted orally and individually with each subject, and recorded on audio tape. The testing material included 48 nonce verbs that were created by manipulating the initial consonants, and in some cases, the initial vowels in 48 existing Russian verbs. The initial existing 48 verbs belonged to the following verbal classes and sub-classes (based on Roman Jakobson’s one-stem verb system): -aj-, -ej-, (i)j-, (o)j-, -a-, -e-, -i-, -ova-, -avaj-. All the verbal classes included in the testing material, except for two, belong to the suffixed stems. Two stems, (i)j- and (o)j-, belong to non-suffixed stems ending in -j and differing by the root vowel (these are the subclasses of non-suffixed stems). The number of verbs in each class varied from 2 for very small (i)j- and (o)j- subclasses to 6-8 in other classes. The verbal stimuli were in the past tense plural form. Subjects were asked to generate the non-past 3rd person plural and 1st person singular forms of the verbal stimuli. All the verbs were embedded in simple carrying sentences, which together with follow-up questions formed a quasi-dialogue¹:

Experimenter: Yesterday they _____. And what are they doing today?

Subject: Today they _____.

Experimenter: And you?

¹ This elicitation technique is based on the adaptation of the instrument developed by Bybee and Slobin (1982) used in the studies of child L1 acquisition of Norwegian, Icelandic (Ragnasdóttir, Simonsen and Plunkett, 1997), and Italian (Matcovich 1998).

Subject: Today I _____.

The One-Stem Verb System of Russian

According to the one-stem description developed by Jakobson and his followers, Russian has 11 verb classes, each with its own suffix (verbal classifier). The eleventh class has a zero suffix, and is subdivided into smaller subclasses depending on the quality of the root-final consonant. This is a small class, especially given the variety of conjugational patterns it includes. The remaining 10 suffixed classes are identified by the suffix. These are: -aj-, -ej-, -a-, -e-, -i-, -o-, -ova-, -avaj-, -nu- (including the “disappearing -nu-”), and -zha¹ classes. The suffix determines all the parameters of the conjugational paradigm, which include:

1. Conjugational type, 1st or 2nd;
2. Consonant mutations;
3. Stress shift (specific patterns in -a-, -e-, and -i- classes);
4. Suffix alternations (-ova- alternates with -uj-, -avaj- alternates with -aj-, and -(nu)- disappears under specific conditions).

In addition to that, there occur vowel alternations in zero-suffixed stems: “o” in the (o)j- stem alternates with “y.”

When the endings are added to the stem, an automatic truncation rule works at the juncture of the stem and the ending. If the stem ends in a vowel and the ending begins in a vowel, the first vowel is truncated. The same is true for the consonants, it is the first one that gets deleted. Past tense endings begin in a consonant, and non-past tense endings begin in a vowel, therefore, stem-final vowels will be deleted in non-past tense forms, and consonants will be deleted in past tense forms.

We chose 3 pairs of stems, which have similar past tense (and infinitives as well), but have different conjugational patterns in the non-past tense:

-aj- and -a-
 -ej- and -e-
 (i)j- and -i-

The stem is not recoverable in the past tense because the “j” is truncated. Therefore the speakers need to “guess” the underlying stem to conjugate the verb in the non-past tense, and to make a decision whether to recover the “j” or not. The experiment aims at establishing which conjugational patterns will be generalized.

The next two stems, -ova- and -avaj-, show suffix alternations in the non-past tense: -ova- alternates with -uj-, and -avaj- alternates with -aj-. For such stems, the past tense form contains sufficient morphological information for the speakers to be able to identify the stems. The last stem - the subclass of zero-suffixed stems, (o)j-, has a very special feature: alternation of the root vowel in the past tense: “o” alternates with “y.” The vowel “y” does not occur in any of the suffixes, and the past tense form of such verbs sounds unusual. We wanted to see

¹ The consonant “zh” represents any palatal consonant: a hushing or “j” and is not part of the suffix.

whether the presence of the vowel “y” would serve as a cue to the (o)j- stems.

The morphological processes (“rules”) shaping the conjugational patterns of the stems chosen for the experiment include consonant and vowel deletion, consonant mutation, stress shift, suffix alternation, and vowel alternation. The –aj-, –ej-, and (i)j- stems have only one rule, that of consonant deletion, in their paradigm. The –a-, –e-, and –i- stems have three. The –ova-, –avaj-, and (o)j- stems have two.

If the complexity of paradigm influences the generalization rates, the –aj-, –ej-, and (i)j- patterns are at the lower end in terms of complexity, and therefore, they can be expected to be generalized to –a-, –e-, and –i- stems.

Type frequencies and productivity of the stems used in the study confirm the predictions made by Bybee (1995) that the patterns (schemas) with high type frequency are productive. Indeed, the largest classes –aj-, –i-, –ova-, and –ej- are productive in Russian. There are thousands of verbs belonging to the –aj-, –i-, and –ova- classes, and hundreds of verbs belonging to the –ej- class. Type frequencies of other classes are very low: approximately 60 –a- verbs, approximately 50 –e- verbs, 7 (i)j- verbs, 5 (o)j- verbs, and 3 –avaj- verbs. Based on these data, one can expect the conjugational patterns of the productive classes with high type frequency to be generalized more often than the patterns for the low type frequency classes.

Therefore, one can predict that the –aj-, –ej-, and –i- patterns will be generalized to the –a-, –e-, and (i)j- classes. One can easily see that there is a conflict between two predictions for the –i- and (i)j- stems. From the point of view of the complexity of paradigm, the (i)j- pattern should be generalized. But the (i)j- pattern occurs only in 7 stems, therefore based on type frequency, the –i- pattern should be generalized.

3. Data Analysis and Results

All the responses of 27 Russian subjects to the set of 48 verbs were transcribed, with the total number of responses analyzed at 2592 (speakers provided two forms for each verbal stimulus). The scores for all individual verbs grouped by the stem were entered in a table as numbers of verbs that were conjugated as belonging to one of the verbal classes included in the experiment. The last column, “Other,” was reserved for the responses that did not follow the paradigm for any of the stems used in the initial set of verbs. Averaging the responses for each verb class made it possible to compute the rates of generalization for each verbal class, as well as percentages of stem recognition based on the morphological cue.

The data are represented below in the form of charts (see Figures 1 and 2). It should be noted that the percentage of stem recognition was computed regardless of whether the produced form was targetlike, thus errors in consonant mutation or verbal endings were ignored.

Russian speakers consistently attributed the nonce verbs derived from the –aj- and –ej- classes, which are productive

classes, to the -aj- and -ej- classes correspondingly. The nonce verbs derived from the -a- and -e- stems were poorly identified, they were interpreted as -aj- and -ej- stems correspondingly. But we do not observe the same tendency in the -i- and (i)j- stems. Here the frequent -i- pattern is not dominant, it is the (i)j- pattern that is more active.

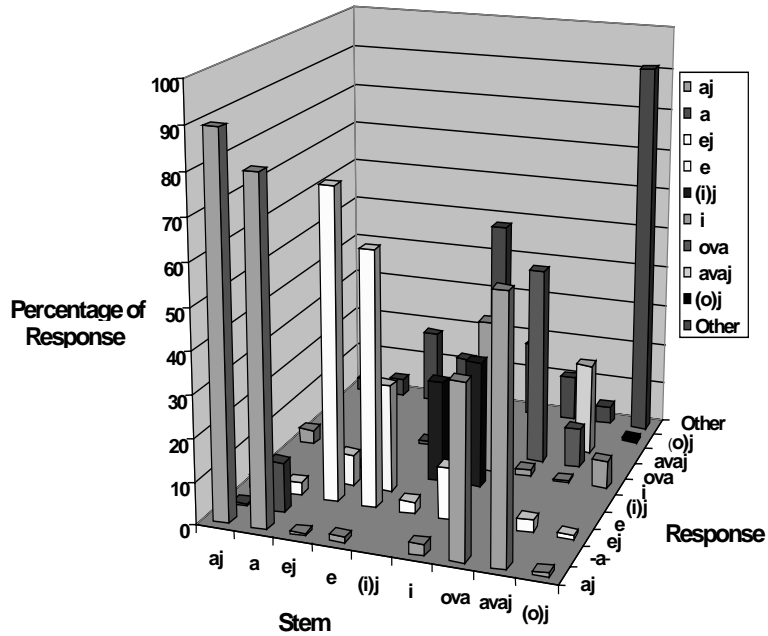


Figure 1 Distribution 1 of Responses

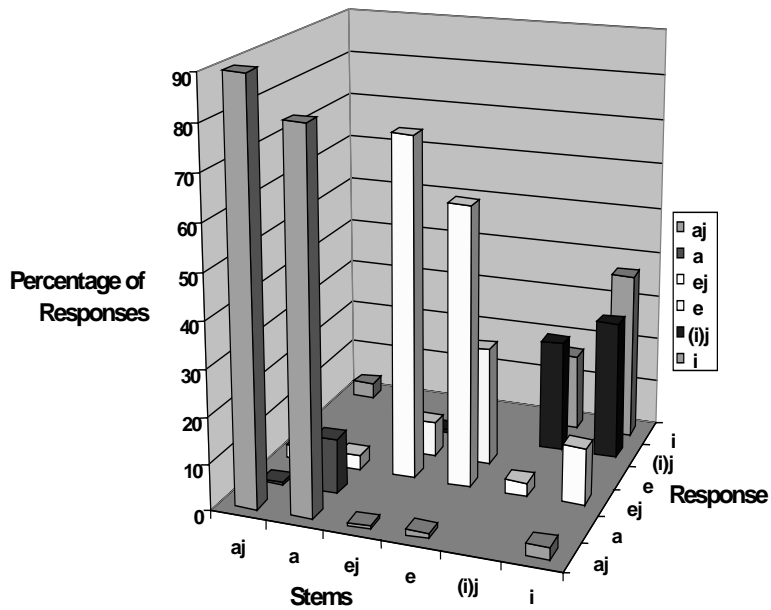


Figure 2 Distribution of Responses for the "Paired" Stems

Generating the non-past-tense forms of the next two stems, -ova- and -avaj-, involved the processing of the morphological cue present in the past-tense form. Russian speakers conjugated approximately 1/2 of the -ova- verbs (47.2%) using the -ova- pattern. But they did even worse on the -avaj- stem. Only 1/5 of the -avaj- verbs were conjugated using the -avaj- pattern (only 21.8%). Almost 2/3 of the -avaj- verbs were treated as -aj- verbs without suffix alternation -avaj-/-aj- (61.1%).

The last stem, (o)j-, is a subclass of zero-suffixed verbs, which has only 5 stems in it. In the past tense, these verbs have a very rare feature, vowel alternation. The vowel “y” rarely occurs in verbal conjugation and is not part of any verbal suffix. In our study, less than 1% of the verbs with “y” in the past tense were conjugated as (o)j- stems. At the same time, approximately 1/2 (47.3%) of the (o)j- verbs were conjugated using the non-existing *(y)j- pattern.

4. Discussion of the Results

The results obtained for the -aj-/-a- and -ej-/-e- pairs fully confirm the prediction that the conjugational pattern of high type frequency verbs will be generalized to low type frequency stems. At the same time, the results obtained for these two stems are not in conflict with the predictions based on the complexity of paradigm. However, the results for the -i- and (i)j- stems do not show the same tendency. Here the frequent -i- pattern was competing with a less complex (i)j- pattern. And the (i)j- pattern showed a higher generalization rate. There are two possible interpretations for this effect:

1. In individual stems the complexity of paradigm factor overrides the frequency factor.
2. The overall pattern of responses in the experiment suggests that the subjects favor the isolated rule “recover the j,” regardless of the stem.

The -ova- class has high type frequency and is productive, while the -avaj- class has only 3 stems in it. Therefore, the fact that the -ova- marker worked better as a cue to the conjugational pattern than the -avaj- marker confirms the role of frequency in morphological cue recognition.

At the same time, the -ova- marker successfully worked as a cue only in approximately 1/2 of the answers. This implies that the cue itself has limited efficiency and does not automatically trigger the suffix alternation.

As for the (o)j- stem, which has only 3 stems in it, the results seem to indicate that no analogies were established with this class in the processing of nonce verbs. The speakers preferred to apply the rule “recover the j”, and in doing so they generated a pattern illegal in Russian and created a non-existent verb type.

Overall, the results of this experiment suggest that conjugational patterns for different verb classes consist of discrete “rules,” and are not necessarily applied as one bloc. The experiment was not intended to support or refute the positions of

the dual- or single-system approaches, and consequently the use of the term “rule” does not imply the dual-system approach. In processing new verbs, native speakers can single out and apply individual discrete rules, and the whole pattern is not always activated. Instead, one such rule (“recover the j”) was generalized in cases of ambiguity, and its application even resulted in creating a non-existent pattern. This conclusion is also supported by the fact that the rate of consonant mutations, which are part of the conjugational pattern for the –a-, –e-, and –i- verbs, was much lower than the rate of the stem recognition.

5. Conclusions

This study analyzed the role of input frequency (type frequency), the complexity of paradigm, and morphological cues in processing of Russian verbal morphology. Default processing of the nonce verbs makes use of the –Vj- pattern. Russian speakers isolated and generalized one single rule rather than applying the entire conjugational pattern for a particular verb class. They generalized this single rule (“recover the j”) in the situation when the stem was not recoverable from the stimulus form. The application of this rule to an inappropriate verb class resulted in creating a conjugational pattern illegal in Russian. The low rates of consonant mutations also indicate that the rules constituting the conjugational paradigm are not necessarily applied in a set. The type frequencies of the verb classes influenced verbal processing. Thus, high frequency conjugational patterns were more readily generalized to other classes. Also, the morphological cues worked better in the processing of high frequency classes. However, in the task, which required generating forms of nonce verbs, the complexity of paradigm overrode the frequency factor.

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