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## **The Complexity of Paradigm and Input Frequencies in Native and Second Language Verbal Processing: Evidence from Russian<sup>1</sup>**

Tatiana Chernigovskaya\* and Kira Gor\*\*

\* St. Petersburg State University, Russia  
tatiana@TC3839.spb.edu

\*\*University of Maryland, USA  
kirao@wam.umd.edu

### **Abstract**

This study compares the processing of Russian verbal morphology in adult native speakers and American learners of Russian. It explores the role of type frequency, the complexity of paradigm, and morphological cues in Russian, a language with numerous verb classes and developed conjugational paradigms. Russian lacks the sharp distinction between regular and irregular verbs found in English, and accordingly, the study introduces the parameter of the complexity of paradigm to capture the gradual nature of regularity in a language with complex verbal morphology.

The data were collected from 27 adult native Russian speakers and 15 American learners of Russian in two matched experiments. In both experiments, the subjects were asked to generate non-past-tense forms of the verb stimuli presented in the past tense. In

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Experiment 1 with Russian speakers, the testing material included 48 nonce verbs created by manipulating the initial segments of the existing 48 verbs used in Experiment 2 with American learners. The existing 48 verbs belonged to 9 classes and subclasses based on the one-stem verb system developed by Jakobson and his followers. The study compared type frequencies for native Russians (Townsend 1975) and its own counts of type frequencies in beginning American learners of Russian.

The results obtained indicate that both native speakers and American learners dealt with the complexity of paradigm and morphological cues in similar ways. Both groups of subjects made use of the “Vowel+j” pattern as the default. The type frequencies of the verb classes included in the experiment influenced both native and non-native verbal processing. Thus, the high type frequency conjugational patterns were more readily generalized than the low frequency patterns. However, the complexity of paradigm overrode the frequency factor. The differences in the rates of generalizations of individual conjugational patterns reflected the differences in input frequencies for native speakers and beginning learners of Russian.

## **Background**

Research on the processing of English past-tense regular and irregular verbs raised the issue of modularity in morphological processing. The modular, or dual-system, approach claims that 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). The

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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.

Proponents of the dual- and single-system approaches make opposite predictions about the role of phonological similarity and input frequencies in processing English past-tense regular and irregular verbs. According to the dual-system approach, only irregular verbs, which are retrieved from associative memory, will show effects of phonological similarity and will be frequency-sensitive. Unlike irregular verbs, regular verbs, which are formed by the application of a symbolic rule, will show no phonological similarity or frequency effects. The single-system approach predicts that phonological similarity and frequency will influence the processing of both regular and irregular verbs.

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), is based on the observation that English irregular past tense shows partial regularity, with several verbs clustering together (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 the 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).

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). A study by Alegre and Gordon (1999) that showed token 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.

Obviously, English past-tense inflection with only one regular verb class and a virtually non-existent conjugational paradigm cannot be readily generalized to other languages with developed inflectional morphology. And indeed, the emerging data on languages with rich verbal morphology challenge the idea that the modular approach, which assumes a sharp distinction between regular and irregular verb processing, is readily applicable to such languages. 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 1998a, p. 127-130). Two developmental studies of child first language (L1) acquisition of verbal morphology, one in Norwegian and Icelandic and the other in Italian -- languages with complex verbal morphology -- recorded the influence of both type and token frequencies on their subjects' responses (Ragnasdóttir, Simonsen, and Plunkett 1997a, b, Matcovich 1998a,

b)<sup>2</sup>. For Norwegian and Icelandic, this influence was manifested in generating past participles of both strong (irregular) and weak (regular) verbs; in Italian, it was manifested across the verb conjugation classes. The results of these studies, which assessed the influence of input frequencies through the rates of overgeneralization, are in conflict with the predictions made by proponents of the dual-system approach.

Research on languages with highly developed verbal morphology raises the issue of the role of morphological complexity in verbal processing. The study of L1 acquisition of Norwegian and Icelandic makes a claim that morphological complexity influences developmental rates. Icelandic has more complex verbal morphology than Norwegian does. In accordance with this fact, the Icelandic children were delayed in relation to the Norwegian children at age 4 on the strong verbs (Ragnasdóttir, Simonsen, and Plunkett 1997a, p. 31). At the same time, the study hypothesizes that “greater morphological complexity of Icelandic may subsequently have a facilitatory effect on children’s acquisition of morphology, and contribute to the Icelandic children’s sudden spurt in development at age 6 ” (Ragnasdóttir, Simonsen, and Plunkett 1997a, p. 31).

### **Goals of the Study**

This study compares the processing of complex verbal morphology in adult native speakers of Russian and beginning second language (L2) learners, and identifies similarities and differences in native and non-native morphological processing. The study puts forward several claims about verbal processing in Russian, a language with complex verbal morphology. First, it assumes that since Russian has numerous verb classes with gradual differences in size and degree of regularity and numerous conjugational patterns,

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<sup>2</sup> The Italian study also included adult Italian speakers.

a sharp division into regular and irregular processing could hardly be expected. Second, it introduces the parameter of the complexity of paradigm, and tests the prediction that the complexity of paradigm will influence both native and non-native processing. The complexity of paradigm is understood as the number and type of rules<sup>3</sup> shaping the conjugational pattern of individual verb classes. And third, the study focuses on the role of morphological cues in verbal processing. It explores several aspects of the processing of complex verbal morphology:

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 the 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 may they be disassociated in verbal processing?

With regard to second language acquisition (SLA) data, the study addresses the following questions:

1. In what ways is L2 processing of complex verbal morphology similar to L1 processing?
2. In what ways do they differ?
3. Which factors account for the differences in L1 and L2 processing?
4. Do type frequency and the complexity of paradigm influence L2 processing in the same way they influence native processing?

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<sup>3</sup> The term “rule” is not intended to mean “symbolic rule” as it is used by the proponents of the dual-system

## The One-Stem Verb System of Russian and the Experimental Material

What will follow is a short introduction to Russian verb conjugation based on the one-stem verb system developed by Jakobson and his followers (Jakobson 1948, Townsend 1975, Davidson et al. 1997). This is not the only system describing Russian verb conjugation, and there is an alternative description endorsed by the Russian Academy of Sciences. There is no research to date demonstrating psycholinguistic validity of either system, and we have chosen the one-stem system for two main reasons:

1. This description allows the generation of all forms of all the Russian verbs, with the exception of a dozen truly irregular ones by the application of a set of rules. These sets of rules are different for the different verb classes (and subclasses).
2. The one-stem system was used in the instructional setting for the group of American learners taking part in the matching experiment.

According to the one-stem description, Russian has 11 verb classes, each with its own suffix/morphological marker/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, and there are less than 100 verbs in it (Townsend 1975). The remaining 10 suffixed classes are identified by the suffix. The suffixes are: -aj-, -ej-, -a-, -e-, -i-, -o-, -ova-, -avaj-, -nu- (including the “disappearing –nu-”), and -zha-<sup>4</sup> classes. The suffix determines all the parameters of the conjugational paradigm, which include:

1. Conjugational type (type of endings), 1<sup>st</sup> or 2<sup>nd</sup>;
2. Consonant mutations (mutations of the root-final consonant);

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, there are vowel alternations in zero-suffixed stems: “o” in the (o)j-stem alternates with “y.”

Before taking a closer look at the stems chosen for our experiment, we will review some facts about the morphological processes taking place in verbal conjugation. When the endings are added to the stem (which includes the optional prefix, the root, and the suffix), 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: the first one is deleted. Past tense endings begin with a consonant, and non-past tense endings begin with a vowel; therefore, stem-final vowels will be deleted in non-past tense forms, and consonants will be deleted in past tense forms.

The morphological processes in two Russian verbs, *chitat'* (to read), and *pisat'* (to write), will illustrate this description. Despite the fact that their infinitives look similar, they belong to different stems and have different conjugational patterns. The verb *chitat'* belongs to the -aj- class, and its stem *chit-aj-* ends in a consonant. In the past tense (and the infinitive as well), the -j- is truncated before consonantal endings:

*chit-aj-* + *-l* = *chital* (he read)

In the non-past tense, vocalic endings are simply added to the stem:

*chit-aj-* + *u* = *chitaju* (I read)

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<sup>4</sup> The consonant “zh” represents any palatal consonant -- a hushing or “j” -- and is not part of the suffix.

The verb *pisat'* belongs to the –a- class, with its stem ending in a vowel, and the past-tense consonantal ending is added to the stem:

*Pis-a-* + *-l* = *pisal* (he wrote)

In the non-past tense, vowel truncation takes place:

*Pis-a-* + *-u* = *pishu* (I write)

Note the consonant mutation “s”-“sh”, which in the –a- stem occurs throughout the non-past paradigm.

Table 1 lists the morphological processes or “rules” shaping the conjugational patterns of the stems chosen for the experiment and includes automatic consonant or vowel truncation, which occurs at the juncture of the stem and the ending.

Table 1 Morphological Processes in the Stems Included in the Experiment

Verbal classes	-aj-	-a-	-ej-	-e-	(i)j-	-i-	-ova-	-avaj-	(o)j-
Consonant truncation before conson. Endings	v		v		v			v	v
Vowel truncation before vowel endings		v		v		v	v		
Consonant mutation		v		v		v			
Stress shift <sup>5</sup>		v		v		v			
Suffix alternation							v	v	
Vowel alternation									v

The most straightforward way to assess the complexity of paradigm for each verbal class is to add up all the morphological processes occurring in this class. Thus, the

<sup>5</sup> This paper does not discuss stress shifts in the data obtained.

–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 oj- stems have two. However, this mechanical computation does not take into account the relative complexity of the individual rules. Consonant and vowel truncation are automatic processes, which take place in every conjugational pattern. Consonant mutation and stress shift occur only in the –a-, -e-, and –i- stems; therefore, they are less common, and involve more complex rules. Suffix alternation in the –ova- and –avaj- stems is even more marginal in the Russian verbal system. The vowel alternation occurring in the 5 (o)j- stems places this class in the exceptions category.

Type and token frequencies (whole-word and stem-cluster) were shown to influence verbal processing in both adult and child native speakers. But while adult native speakers potentially have full access to type and token frequencies, formal L2 learners with lower proficiency in L2 have limited access to input frequencies in the target language. A beginning classroom typically exposes learners to most verbal classes, but the relative size of classes (type frequency) is not available to the learners, and the frequency of use of individual verb classes may differ substantially from the one found in native Russian. Likewise, token frequencies of individual verbs used in a highly structured situation of learning and a controlled classroom setting do not reflect the ones found in native speech. As a result, L2 learners may develop an interlanguage (IL) system based on verb classes of a more uniform size than the classes in the native language and with non-native token frequencies of individual verbs. Therefore, one can hypothesize that native input frequencies will affect non-native verbal processing indirectly, only to the extent that they are reflected in the actual L2 input frequencies.

Accordingly, the study uses its own frequency counts which were done with the assumption that the frequencies found in the instructional materials used in first-year Russian would be the best approximation available of the input frequencies to which our subjects were exposed. The type frequencies and the number of uses of all the verbs were computed for two volumes of the textbook and two volumes of the workbook, which are part of the instructional package “Live from Moscow!” (Davidson et al. 1997) that was used in first-year Russian. The counts included not only all the verbs present in the books, but also the verbs in exercises that the students had to generate themselves. For example, if the assignment was to say where the student eats his/her breakfast, lunch, and dinner, the verb “to eat” was counted 3 times in the 1<sup>st</sup> person singular non-past tense. Type frequencies found in the input to the learners were compared with the estimates done for Russian as a whole (Townsend 1975).

Table 2 Type Frequencies of the Verbal Classes Included in the Experiment:  
Native and Second Language Input

Verbal classes	-aj- productive	-a-	-ej- productive	-e-	(i)j-	-i- productive	-ova- productive	-avaj-	(o)j-
Russian <sup>6</sup> Type frequency	Thousands	Appr. 60	Hundreds	Appr. 50	7 stems	Thousands	Thousands	3 stems	5 stems
Input to L2 learners <sup>7</sup> Type frequency	55 (86) <sup>8</sup>	14 (24)	0 (4)	8 (12)	3 (3)	52 (80)	13 (34)	2 (7) <sup>9</sup>	2 (5)
Input to L2	4333	1298	12	782	239	4546	555	273	158

<sup>6</sup> Based on Townsend 1975 and Davidson et al. 1997. These counts do not include all the prefixed stems.

<sup>7</sup> In the counts based on first-year Russian instructional materials, all prefixed verbs that are not members of true aspectual pairs were computed as separate items. The same is true for reflexive verbs.

<sup>8</sup> The first figure corresponds to the number of verbs in the active vocabulary, and the second number (in parentheses) to all the verbs from the active and passive vocabulary combined.

<sup>9</sup> This count includes prefixed stems.

learners Number of uses									
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Table 2 contains information about approximate type frequencies of the stems included in the experiment and about their productivity<sup>10</sup>. Type frequencies and productivity of the stems used in the study confirm the predictions made by Bybee (1995) that patterns (schemas) with high type frequency are productive. One can see that the largest classes –aj-, -i-, -ova-, and –ej- are productive in Russian. Type frequency of other classes varies from 50-60 to 3-7 stems. It also contains two types of data on input frequencies obtained for L2 learners taking part in Experiment 2 — type frequencies and the number of uses for each verbal class included in the study.

The experimental material included 3 pairs of stems, which have a 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-<sup>11</sup> 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. The experiment aims at establishing which conjugational patterns will be generalized. Of these 6 stems, three belong to the high type frequency productive classes

<sup>10</sup> According to Bybee (1995), type frequency contributes to the productivity of a given schema. At the same time, Bybee claims that productivity, regularity, and default are different categories, and they overlap in verbal processing only to a certain extent.

<sup>11</sup> All but two of the verbal classes included in the testing material belong to the suffixed stems (classes). 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).

–aj-, –ej-, and –i-. 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. At the same time, the three stems ending in –j-, –aj-, –ej-, and (i)j-, have less complex conjugational patterns, and if the complexity of paradigm plays a role in verbal processing, these stems should be more generalizable. 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.

The next two stems included in the testing material, –ova- and –avaj-, have similar conjugational features—they 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 (morphological cues) for the speakers to be able to identify the stems. However, these classes differ radically in their type frequencies: the –ova- class has high type frequency whereas the –avaj- class has only three basic stems. The experiment tests whether the subjects actually pay attention to the morphological cues and produce the suffix alternation expected in these stems, and whether type frequency influences their processing.

The last stem, or more exactly, 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. This stem was included to test whether the presence of the vowel “y” serves as a cue to the low type frequency (o)j- stems.

## **Experiment 1 with Russian Speakers**

### Data Collection

Experiment 1 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 audiotape. Subjects met with the experimenter and received the printed version of the test assignment, which included written instructions. The experimenter read aloud all the sentences carrying the verb in the past tense and the question designed to trigger the use of non-past forms by the subject. A warm-up containing verbs not included in the main testing material preceded the main part of the experiment.

The testing material included 48 nonce verbs that were created by manipulating the initial consonants, and in some cases, the initial vowels in the existing verbs chosen for Experiment 2 with L2 learners. The aim of the modifications was to preserve as much of the phonological shape of the real verbs as possible, but at the same time, avoid any close resemblance to the real verbs. In most cases, only one distinctive feature of the initial consonant was modified.

The initial existing 48 verbs belonged to the following verbal classes (based on Jakobson’s one-stem verb system): -aj-, -ej-, (i)j-, (o)j-, -a-, -e-, -i-, -ova-, -avaj- (see the Appendix for the list of verbs). 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 3<sup>rd</sup> person plural and 1<sup>st</sup>

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-dialogue<sup>12</sup>:

Experimenter: Yesterday they \_\_\_\_\_. And what are they doing today?

Subject: Today they \_\_\_\_\_.<sup>13</sup>

Experimenter: And you?

Subject: Today I \_\_\_\_\_.

### Results and Discussion, Experiment 1

All the responses of the 27 Russian subjects to the set of 48 verbs were transcribed, with the total number of responses analyzed at 2,592 (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. By averaging these data we computed the percentages of stem recognition as well as the rates of generalization for each verbal class. (Table 3 provides such data collapsed for each verbal class. The same data are represented in Figure 1. Figure 2 contains only the results for the “paired” stems.) 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 conjugation type were ignored.

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<sup>12</sup> This elicitation technique is based on the adaptations of the instrument developed by Bybee and Moder (1982) used in the studies of child L1 acquisition of Norwegian, Icelandic (Ragnasdóttir, Simonsen, and Plunkett 1997a, b), and Italian (Matcovich 1998a, b).

<sup>13</sup> In Russian, present-tense verb forms are synthetic.

Russian speakers consistently attributed the nonce verbs derived from the –aj- and –ej- classes, which are productive classes, to the –aj- and –ej- classes respectively. The rate of the –aj- verbs processed as –aj- stems is 89.7%; for the –ej- verbs it is somewhat lower, 73.8%. The nonce verbs derived from the –a- and –e- stems show the opposite tendency: only 11.7% of the modified –a- stems were processed as –a- verbs, but 80.9% were processed as –aj- verbs. Similarly, only 25.5% of the verbs derived from the –e- stem were interpreted as such, while 60.4% of the –e- stems were conjugated as –ej- stems.

We do not observe the same tendency in the –i- and (i)j- stems. 24.1% of the (i)j- verbs were conjugated as (i)j- stems, and 16.7% were interpreted as –i- stems. The nonce verbs produced by modifications of the –i- stem were conjugated as –i- verbs in 36.6% of cases, and in another 30% of cases they were interpreted as (i)j- verbs.

Generating the non-past-tense forms of the next two stems, –ova- and –avaj-, involved the processing of the morphological marker present in the past-tense form. Approximately 1/2 of the –ova- verbs (47.2%) were conjugated using the –ova- pattern, which involves suffix alternation in the non-past tense. In 40.4% of responses, the –ova- marker was ignored and the verbs were conjugated as –aj- stems. A much smaller number of the –avaj- verbs were conjugated using the –avaj- pattern (only 21.8%). Almost 2/3 of the modified –avaj- verbs were treated as –aj- verbs without the suffix alternation –avaj-/-aj- (61.1%).

The last stem, (o)j-, is a subclass of zero-suffixed verbs, which includes only 5 stems. In the past tense these verbs have a very unusual shape since 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.

The results obtained for the –aj-/-a- and –ej-/-e- pairs completely confirm the prediction that the conjugational pattern of high type frequency verbs will be generalized to low type frequency stems. However, the results for the –i- and (i)j- stems do not follow the same pattern. Since the –i- class is productive and has high type frequency, while the (i)j- subclass of zero-suffixed verbs includes only 7 basic stems, it was expected that the –i- pattern would be generalized to the (i)j- stems. This did not take place, and the rate of generalization of the –i- pattern was relatively low. 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 includes only 3 stems. 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 and/or productivity in processing new verbs. At the same time, the –ova- 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. Since the disyllabic –ova- marker is perceptually more salient than the verbal classifiers consisting

only of a vowel, a possible reason for the low efficiency of this marker is the complexity involved in the processing of a suffix alternation.

As for the (o)j- stem, 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.

Overall, the results of Experiment 1 suggest that conjugational patterns for different verb classes consist of discrete rules, and are not necessarily applied as a single block<sup>14</sup>. In processing new verbs, native speakers used one such rule (“recover the j”) in cases when they were not able to recover the stem of the stimulus verb, and its application even resulted in creation of a non-existent verb type.

Table 3 Distribution of Responses in Experiment 1 (Native Speakers of Russian)

Stimuli	Responses									
	-aj-	-a-	-ej-	-e-	(i)j-	-i-	-ova-	-avaj-	(o)j-	Other
-aj-	<b>89.7</b>	0.6	3.1			3.5				3.1
-a-	80.9	<b>11.7</b>	3.1							4.3
-ej-	0.6		<b>73.8</b>	7.4	0.6					17.6
-e-	1.3		60.4	<b>25.5</b>			0.8			12.0
(i)j-			2.8		<b>24.1</b>	16.7	8.3			48.1
-i-	2.6		12.2		30.0	<b>36.6</b>	0.2			18.4
-ova-	40.4					1.6	<b>47.2</b>			10.8
-avaj-	61.1		3.0			0.4	9.3	<b>21.8</b>		4.4
(o)j-	0.9		0.9			6.5			<b>0.9</b>	90.8

<sup>14</sup> 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 lower than the rate of stem recognition.

Table 4 Distribution of Responses in Experiment 2 (American Learners of Russian)

Stimuli	Responses									
	-aj-	-a-	-ej-	-e-	(i)j-	-i-	-ova-	-avaj-	(o)j-	Other
-aj-	<b>79.0</b>	12.0			2.2			0.8		6.0
-a-	66.0	<b>22.0</b>			0.5	0.5				11.0
-ej-	3.9	18.2	<b>56.0</b>	9.3	1.1	0.5				11.0
-e-	5.2	1.9	30.0	<b>46.6</b>	4.3		1.0			11.0
(i)j-	1.6	15.0		1.6	<b>55.0</b>	22.0			1.6	3.2
-i-	10.0	2.5	7.1		7.9	<b>62.0</b>				10.5
-ova-	68.3					6.7	<b>16.1</b>		0.6	8.3
-avaj-	80.6		0.6			3.3	5.8	<b>3.9</b>		5.8
(o)j-			1.7		13.3	1.7			<b>1.7</b>	81.6

## Experiment 2 with American Learners

### Data Collection

The data for Experiment 2 were collected from 15<sup>15</sup> volunteer students at the University of Maryland, College Park, USA, in the middle of their third semester of Russian. All but one of the students had studied Russian verbs using the one-stem verb system. The experimental procedure was exactly the same as in Experiment 1 (see above). Half of the students received the test with the different order of verb presentation—the last 24 verbal stimuli were moved to the beginning of the test in order to control for the fatigue factor. The testing material consisted of 48 real Russian verbs matched with the nonce verbs used in Experiment 1<sup>16</sup>.

<sup>15</sup> We discarded the data from 3 additional students since they indicated on their questionnaires that their native language was a language other than English.

<sup>16</sup> After the oral part was completed, students received the list of all the verbs included in the main part of the test and were asked to check off all the verbs they knew. Most of the verbs in the testing material were

### Results and Discussion

All the responses of the 15 students to the set of 48 verbs were transcribed, with the total number of responses analyzed at 1,440 (students provided two forms for each verbal stimulus). All the computations were done as in Experiment 1, and Table 4 and Figure 3 show the results obtained for the whole sample while Figure 4 represents the data only for the “paired” stems.

The –aj- stem followed the –aj- conjugational pattern in 79% of cases, and the –a- pattern only in 12% of cases. The –a- pattern was used in 22% of the –a- stems, while 2/3 (66%) of the –a- verbs were conjugated as –aj- stems. Together, the results obtained for the –aj- and –a- stems indicate that the L2 learners generalized the high type frequency - aj- pattern.

The next pair of stems, -ej- and –e-, manifest a weaker tendency to generalize the –ej- pattern. The subjects identified the –ej- stem in approximately 1/2 of the responses and generalized it to the –e- stem in 9.3% of the responses. At the same time, almost 1/2 of the responses to the –e- stem (46.6%) followed the –e- pattern, and 1/3 of the responses followed the –ej- pattern.

In the last pair of stems, (i)j- and –i-, the tendency to generalize the (i)j- pattern is even weaker. The L2 speakers conjugated half of the (i)j- verbs (55%) using the (i)j- pattern, and 1/5 (22%) using the –i- pattern. However, in processing the –i- stem, the

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unfamiliar to the learners, but we decided to include several verbs from the active 1<sup>st</sup> year vocabulary to make the task psycholinguistically more real for the beginning learners of Russian. Indeed, more than 2/3 of the subjects indicated that they knew 10 out of 48 verbal stimuli. One out of these 10 verbs was definitely mistakenly identified. This was the verb *plavili* (they melted), which sounds similar to *plavali* (they swam). This misidentification shows that phonetic associations work in non-native processing. In order to control for the familiarity factor, we performed all the computations separately for 25 verbs that no more than 2 students identified as familiar. In fact, 15 of these verbs were unfamiliar to any of the students.

subjects generalized the (i)j- pattern only in 7.9% of the responses, and in 62 % of the responses they used the –i- pattern.

Overall, the non-native processing of the “paired” stems shows the following tendency: The –aj- pattern demonstrates high generalizability, while the –ej- and (i)j- patterns are used more often in the responses to the appropriate stems than to their counterpart stems without the –j-. Thus, in the last two pairs of stems, the American learners prove to be reasonably efficient at “guessing” the underlying unrecoverable stem.

The L2 learners experienced difficulties identifying the –ova- and –avaj- suffixes (or possibly, applying the pattern with suffix alternation). Only 16.1% of the –ova – verbs were conjugated using the –ova- pattern, and this percentage was even lower for the –avaj- stems (3.9%).

The (o)j- stem was very poorly identified. The students conjugated only 1.7% of the (o)j- verbs with the past tense “y” alternating to “o.” At the same time, 30% of the (o)j- verbs were conjugated using the \*(y)j- pattern illegal in Russian.

This experiment used its own frequency counts for the L2 input and put forward the claim that native input frequencies influence L2 processing only to the extent that they are reflected in the actual input to L2 learners. The comparison of the type frequencies of the verb classes in native and L2 input used in the experiment revealed that while the type frequencies obtained for the non-native input generally reflect the ranking of classes in Russian language, there are significant differences (see Table 2).

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Since the results for these 25 unfamiliar verbs showed exactly the same tendencies as the entire sample, we will discuss the results for the entire set of 48 verbal stimuli.

1. The –ej- stem is significantly underrepresented in the L2 input. This stem occurs in no verbs in the active vocabulary.
2. In the L2 input, there are fewer –ova- verbs than verbs from the other productive classes, -aj- and –i-.
3. Quantitative differences between the verb classes are less salient in the L2 input. For example, there are thousands of –aj- verbs in Russian, and only approximately 60 –a- verbs. In the L2 input, there occur 55(86) –aj- verbs and 14(24) –a- verbs.

While the non-native data showed the same tendencies which were registered in native processing, the results for stem recognition in the two experiments were significantly different for all the stems in the study, except for the (o)j- stem<sup>17</sup>. Given the leveling of differences in class size in the non-native input, one could expect fewer generalizations of high type frequency classes to small classes in L2 processing. Indeed, the L2 speakers tended to generalize the –aj- and –ej- patterns less than the native speakers. Lower input frequencies can explain the lower rates of suffix alternation in non-native processing of the –ova- and –avaj- stems.

The most striking result, however, is that the L2 speakers consistently identified and processed the patterns that were poorly represented in the L2 input, -ej- and (i)j-, and even generalized these patterns to other verb classes. This suggests that the L2 learners were relying not only on input frequencies, but on their knowledge of the Russian verb system. This knowledge seems to include information about discrete rules shaping conjugational patterns. The L2 speakers abstracted the rule “recover the j” from the

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<sup>17</sup> The Z-test revealed significant differences at the 0.05 level for all the stems, except for the (o)j- stem, which had extremely low identification rates.

concrete conjugational patterns and generalized it even to the high type frequency productive class of –i- verbs. Thus, L2 processing made use of the same “Vowel + j” default pattern as native processing, though in L2 processing the use of this default rule was more limited. This in turn led to another tendency recorded in non-native processing: the American learners identified the –e- and –i- stems better than the native Russians. In other words, the L2 learners relied on the L2 input frequencies to a greater extent than the Russian speakers relied on the native input frequencies.

Both groups of subjects identified the high type frequency productive class of –ova- verbs less often than the other productive classes. The –ova- morphological cue was especially difficult for L2 learners, which may be due to its lower L2 input frequency. The conjugational pattern of the –ova- stem includes a complex rule of suffix alternation. Both the native and non-native speakers experienced difficulties with the processing of another stem with suffix alternation, the –avaj-. Therefore, the complexity of paradigm influenced both native and non-native verbal processing.

### **Conclusions**

This study analyzed the role of input frequencies, the complexity of paradigm, and morphological cues in native and L2 processing of Russian verbal morphology. The data obtained show that Russian native speakers and American learners of Russian dealt with morphological complexity and relied on morphological cues in similar, though not identical ways. Both native and non-native speakers isolated the default rule and generalized this rule 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 the creation

of a conjugational pattern illegal in Russian. The type frequencies of the verb classes influenced the verbal processing. However, the complexity of paradigm overrode the frequency factor in the task, which required generating forms of new (nonce) verbs. The differences in the rates of identification and generalization of individual conjugational patterns between the native and non-native speakers reflect the differences in the input frequencies for native speakers and beginning learners of Russian.

Figure 1 Distribution of Responses in Experiment 1 (Native Speakers)

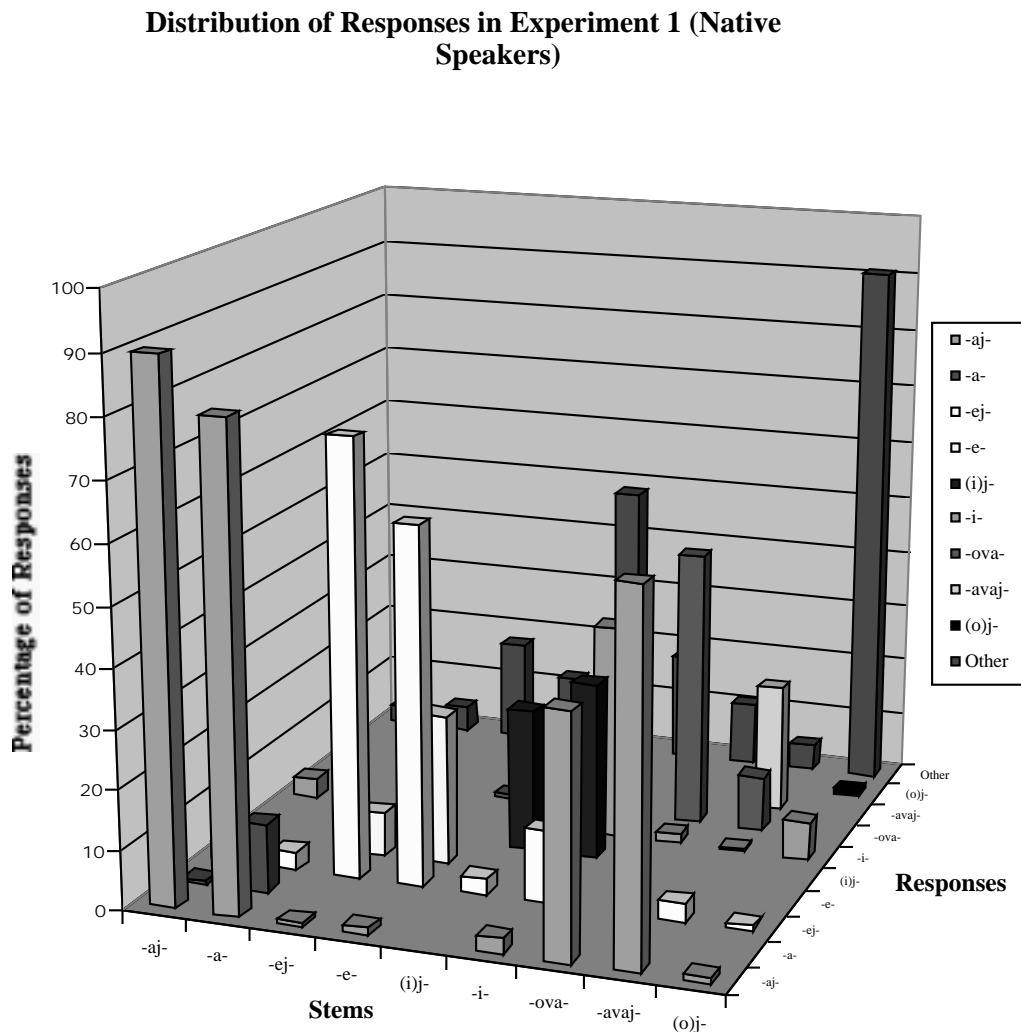


Figure 2 Distribution of Responses for the “Paired” Stems (Native Speakers)

**Distribution of Responses in Experiment 1 (Native Speakers) "Paired" Stems**

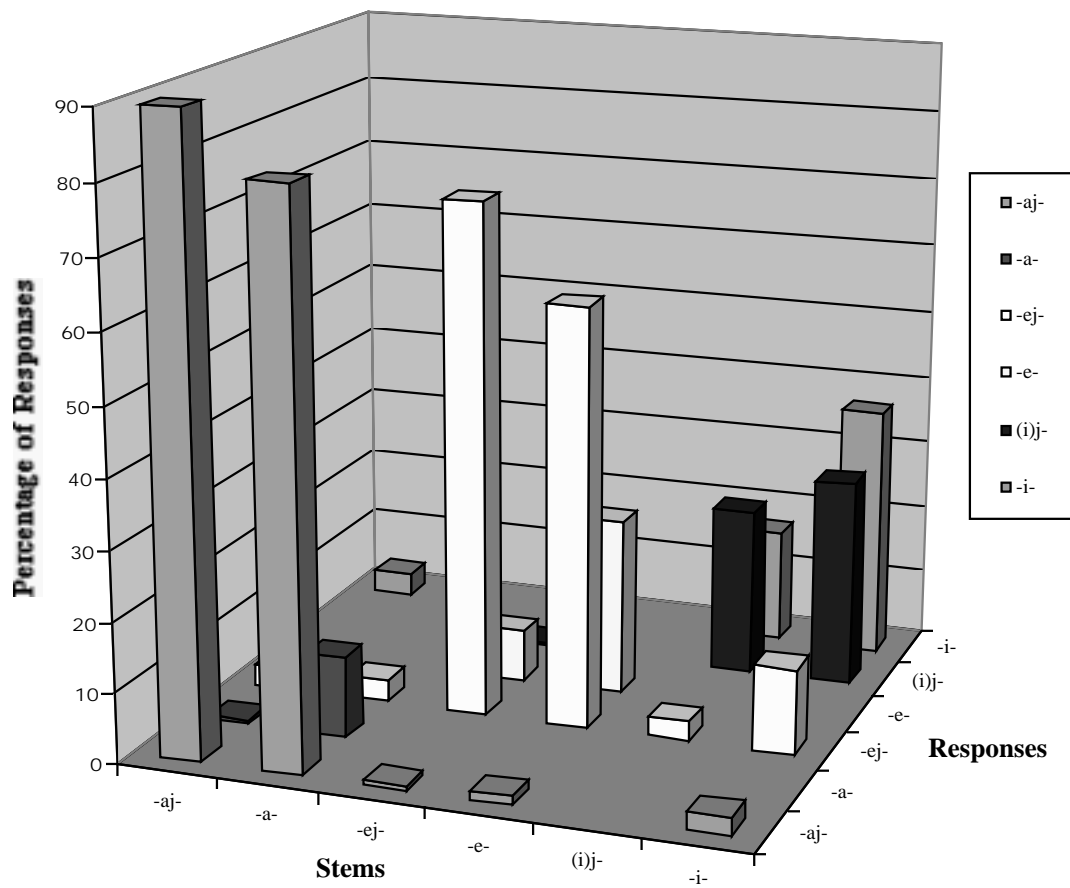
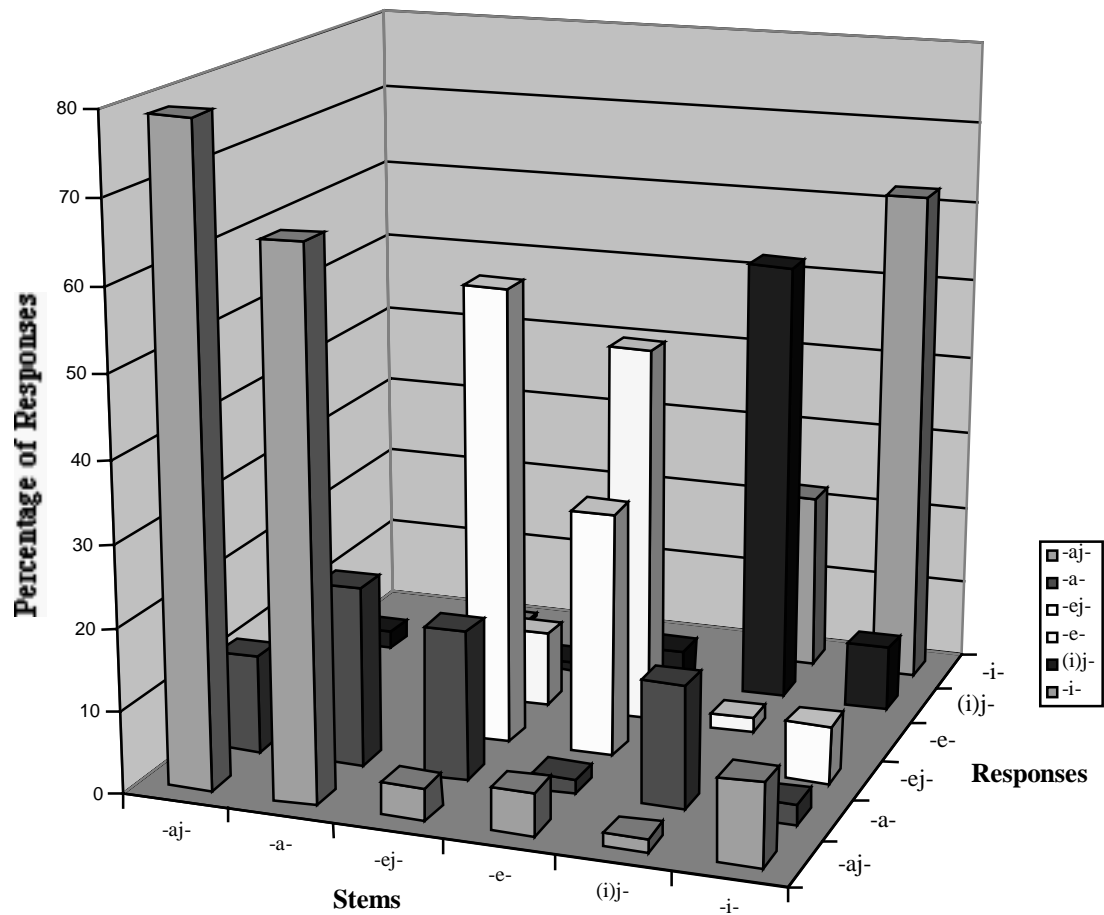




Figure 4 Distribution of Responses for the "Paired" Stems

**Distribution of Responses in Experiment 2 (American Learners) "Paired" Stems**



## Appendix

## The Russian Verbs and Matching Nonce Verbs Used in the Experiments \*

<b>Real Russian verbs</b>	<b>Nonce Verbs</b>
<b>-aj-</b>	<b>-aj-</b>
plAvali (they) swam	klAvali
pr'Adali (they) moved their ears	tr'Adali
kArkali (they) croaked	pArkali
igrAli (they) played	kidrAli
gul'Ali (they) walked	tul'Ali
lAzali (they) climbed	rAzali
<b>-a-</b>	<b>-a-</b>
pisAli (they) wrote	kisAli
mAzali (they) spread	vAzali
plAkali (they) cried	trAkali
klIkali (they) called	tlIkali
sYpali (they) strewed	tYpali
pr'Atali (they) hid	ml'Atali
<b>-ej-</b>	<b>-ej-</b>
umEli (they) were able	ugEli
zhalEli (they) felt sorry	talEli
krasnEli (they) turned red	plasnEli
imEli (they) had	irEli
grEli (they) warmed up	drEli
tlEli (they) smouldered	glEli
<b>-e-</b>	<b>-e-</b>
visEli (they) hanged	bisEli
sidEli (they) sat	fidEli
vIdeli (they) saw	mIdeli
kipEli (they) boiled	tipEli
zavIseli (they) depended	davIseli
xrapEli (they) snored	shkapEli
gl'adEli (they) looked	br'adEli
<b>(i)j-</b>	<b>(i)j-</b>
pIli (they) drank	kIli
gnIli (they) rotted	bnIli
<b>-i-</b>	<b>-i-</b>
l'ubIli (they) loved	d'ubIli
prosIli (they) asked	trosIli
vozIli (they) carried	gozIli
plAvili (they) swam	klAvili
krivIli (they) twisted	tlivIli
glAdili (they) stroked	grAdili
razIli (they) hit	gazIli
mutIli (they) stirred up	lutIli

<p><b>-ova-</b>  risovAli (they) drew  diktovAli (they) dictated  ekzamenovAli (they) examined  gazovAli (they) speeded up  prObovali (they) tried  kantovAli (they) edged</p> <p><b>-avaj-</b>  vstavAli (they) stood up  prodavAli (they) sold  ustavAli (they) got tired  predavAli (they) betrayed  uznavAli (they) recognized</p> <p><b>(o)j-</b>  mYli (they) washed  krYli (they) covered</p>	<p><b>-ova-</b>  lisovAli  biktovAli  vremenovAli  bazovAli  slObovali  tantovAli</p> <p><b>-avaj-</b>  vtlavAli  udavAli  ispavAli  kledavAli  oznavAli</p> <p><b>(o)j-</b>  zYli  brYli</p>
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\* In some cases both simple and progressive forms are possible in translating Russian forms

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