March 1, 2010

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Thank you for contributing to this issue of Slavic and East European Journal. We are looking forward to having this special issue in print.

Cordially,

Susan
Edit. Asst., SEEJ

Attached: rough pages
FREQUENCY, REGULARITY, AND INPUT IN SECOND LANGUAGE PROCESSING OF RUSSIAN VERBAL INFLECTION

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Background
More than one generation of Russian linguists and instructors has been debating the issue of what is the best way to teach American students Russian verb conjugation. And indeed, the choice of the most efficient pedagogical technique and the most appropriate linguistic description of the Russian verbal system for classroom use are informed by a multitude of considerations. Recently, second language acquisition research has added a new dimension to this discussion by providing experimental data on explicit and implicit mechanisms underlying second language (L2) processing. However, there have been no studies that focus on L2 acquisition of the Russian conjugational system; the present study aims to fill this gap.

By looking at a set of empirical findings on Russian verb conjugation from several perspectives, we are hoping to find an intersection that would ultimately promote our understanding of psycholinguistic mechanisms involved in L2 verbal processing, and address the instructional needs. What does it take for adult native speakers of English to gain control of Russian conjugation? One can think of several possible factors that shape the internalized L2 verbal system. These include the set of rules used for instruction, which are more or less detailed and formalized; the amount of input and practice in different conjugational patterns; the number of verbs belonging to different classes that learners encounter; the types of activities that provide practice in verb conjugation, from decontextualized drills to meaningful communication; and the overall amount of exposure to the Russian language and to native Russian input. This article evaluates the role of these factors based on the results of two experiments on Russian verb generation by late American learners with

1. Due to space limitations, research on explicit and implicit input and learning will not be discussed here. For comprehensive accounts, see the 2005 thematic issue of Studies in Second Language Acquisition on explicit and implicit second-language learning, and DeKeyser.
varying levels of proficiency in Russian. Their performance on real and nonce verb generation is compared to that of heritage speakers of Russian, who can be considered early interrupted language learners with incomplete acquisition (Polinsky), with adult native speakers of Russian serving as the control group.

Psycholinguistic mechanisms underlying the processing of inflectional morphology have recently received a great deal of attention. To summarize the gist of the ongoing debates, nativists claim that simple uninflected and irregularly inflected words are stored in the mental lexicon, while regularly inflected words are generated online by the application of symbolic concatenative rules, and thus there are two separate mechanisms for regular and irregular morphological processing (Pinker). Constructivists, who often base their claims on connectionist modeling of neural networks, argue that all the words are stored in associative memory and are processed by associative patterning based on phonological and semantic similarity (Bybee). In this latter view, there is only one mechanism subserving both regular and irregular inflection (see Gor 2007 for a more detailed account of the positions involved in these debates). The principal criterion used to determine whether the inflected word is stored and accessed (de)composed or as a whole is the influence of frequency on different aspects of linguistic processing, such as error rate, speed of access, and generalization rate. There are two kinds of frequency implicated in linguistic processing: token frequency is the frequency of an individual word, and type frequency is the frequency of a linguistic pattern. It is hypothesized that frequency effects are a sign that associative patterning is at work, since symbolic rule computation is not subject to any constraints outside the linguistic conditions that call for a particular kind of rule. In other words, regular inflection should not show any frequency effects, while irregular inflection should.

English past tense with its sharp distinction between regular and irregular verbs often evoked in the debates (Pinker), is not representative of morphologically rich languages with highly developed inflectional paradigms and numerous inflectional patterns involving complex allomorphy, such as Russian. Instead, it is more productive to represent Russian verb inflection in terms of a set of conjugational patterns ranging in regularity (morphonological complexity) and type frequency. Additionally, several approaches to the processing of inflection depart from both extreme positions outlined above and promote parallel (dual-route) decomposition and whole-word access (Baayen et al.) or the influence of input frequencies and linguistic probabilities on rule-based processing (Gor 2003, 2004; Yang). The present research further explores the Rules and Probabilities model (Gor 2003, 2004), which postulates that regular inflection is rule-based and at the same time is influenced by input frequencies.

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2. Token frequency is further subdivided into lemma (cumulative) frequency, or the frequency of all the inflected forms of the word combined together, and whole-word (surface) frequency, or the frequency of an individual inflected word.
and linguistic probabilities. More frequent rules, patterns or word-forms are preferred to less frequent ones. The Rules and Probabilities Model was developed both for L1 and L2 processing and predicted that the differences in L1 and L2 processing of inflection would be in part a reflection of the differences in native and non-native input frequencies.

Two opposite points of view have been expressed with regard to late L2 acquisition and processing of inflectional morphology. According to Michael Ullman, beginning late L2 learners rely on whole-word processing, and only when they achieve high proficiency, do they switch to (de)composition of inflected words (Ullman). Conversely, a series of studies on the accessing of monomorphemic and inflected words in Swedish by L2 speakers with different L1 backgrounds and proficiency levels has demonstrated that (a) whole-word representations develop in L2 speakers after decomposed representations, and thus L2 learners lag behind native speakers in whole-word access; (b) morphological complexity in both L1 and L2 determines access strategies (whole-word access or decomposition); and (c) L2 speakers with similar L2 backgrounds may use different access strategies depending on their L2 learning experiences (Portin et al. 2007a, 2007b).

The one-stem verb system has been successfully used in beginning textbooks and many academic programs in the U.S. to teach Russian verb conjugation (e.g., Davidson et al.; Lekic et al.; Lipson). Its use requires an explicit analytical approach with abundant practice in rule application for different conjugational patterns. This investment of time and intellectual energy leads to positive learning outcomes. However, alternative approaches to teaching verb conjugation with two conjugations and lists of verbs that have special allomorphy are no less prevalent. These approaches typically provide examples of different conjugational patterns and often leave the learner to figure out the underlying system based on prototypes. There has not been much empirical classroom-based research conducted on the advantages and weaknesses of both pedagogical approaches. One can speculate that large amounts of structured input and practice typically associated with instruction in one-stem verb system benefit explicit mechanisms, while little instruction in rule-based allomorphy, and the use of prototypes and analogies characteristic of other approaches, which are closer to the traditional way of teaching native Russian children in K-12 school, benefit implicit analogy-based learning akin to associative patterning. Apparently, the amount of L2 input, including exposure to different type and token frequencies (or in other words, classes of varying sizes and individual verbs occurring with different frequencies) will exert its influence on any type of learning regardless of the approach.

**The Russian verbal system**

This section will review the basic facts about the one-stem verb system and the findings of previous studies of L2 processing of verbal morphology, and
present an attempt to develop a psycholinguistic approach to Russian verb conjugation that combines the one-stem verb system and linguistic probabilities. Russian verb conjugation can be described by a system of rules, which includes minor rules applied to very small sets of verbs with sometimes as few as three or five verb stems. The one-stem verb system first introduced by Roman Jakobson (1948) and later developed to meet classroom needs (Davidson et al.; Lipson; Townsend) is a powerful tool that makes it possible to generate the full paradigm of all the Russian verbs except for approximately 20 that are considered truly irregular (Townsend). To summarize, without going into the widely known and available details of the one-stem approach (see Gaines; Levin; Townsend), Russian has 11 verb classes, each with its own suffix, or verbal classifier. The eleventh class, with fewer than 100 basic stems, has a zero suffix, and is subdivided into smaller subclasses depending on the quality of the root-final consonant. Table 1 represents the verb classes used in the reported experiments. It demonstrates that the classes vary in morphological complexity, or the degree of regularity, and size.

The one-stem system is based on the core notion of a basic stem—verb root plus suffix, or the verbal classifier—that determines all the properties of the conjugational pattern and makes it possible to generate all the forms of a given verb. In order to do so, the L1 or L2 speaker needs first to have access to this stem, which is often unrecoverable from the infinitive form due to automatic truncation, and to know the system of rules shaping each conjugational pat-

Table 1. Automatic and non-automatic morphological processes in the verbs included in the experiments

<table>
<thead>
<tr>
<th>Verb classes</th>
<th>-aj-</th>
<th>-a-</th>
<th>-i-</th>
<th>-e-</th>
<th>-ova-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples</td>
<td>gul'at'</td>
<td>p'isat'</td>
<td>nos'it'</td>
<td>s'idet'</td>
<td>provobat'</td>
</tr>
<tr>
<td>Conjugation type</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Conson. deletion before cons. endings (autom.)</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vowel deletion before vowel endings (autom.)</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consonant mutation</td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stress shift</td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Suffix alternation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>
tern. It is hypothesized that when processing a familiar verb speakers access its basic stem and/or some other kind of representation that unambiguously contains the information about the conjugational pattern. If a novel verb infinitive (or another inflected form) contains strong morphological cues to its conjugational pattern, the degree of control of the conjugational system will determine whether an L2 learner can make use of this cue. In the case of a novel verb with an unrecoverable stem, the choice of the conjugational pattern will be guided by the implicit knowledge of probabilities, knowledge which develops under the influence of L2 input.

Previous research on novel verb generation by late L2 learners and adult native Russian speakers has demonstrated that in cases where the basic stem is unrecoverable from the infinitive or past-tense form presented as stimuli, speakers apply conjugational patterns based on probabilities. Moreover, the differences in L2 and L1 response biases correspond to the differences in type frequencies in L2 input and L1 use (Gor and Chernigovskaya, 2001, 2005). Based on these findings, a psycholinguistic interpretation of the one-stem system was adopted for L1 and L2 processing of novel verbs. According to that interpretation, there are two main conjugational patterns in Russian, “Vowel+j” (as in -aj-, -ej-) and “Vowel+ø” (as in -i-, -a-, -e-), plus several patterns with additional allomorphy involved. The “Vowel+j” pattern is the default pattern, and it is readily generalized to novel verbs. The “Vowel+j” and “Vowel+ø” patterns are associated with the rhyme vowel of the infinitive (the vowel of the suffix) in a probabilistic way. Those probabilities are available to language speakers and are used in verbal processing, e.g., to choose the appropriate conjugational pattern in novel verb generation. L2 learners develop a system of probabilities based on L2 input. This psycholinguistic adaptation of the one-stem system combines infinitive rhymes with the probability of the conjugational patterns associated with the rhyme vowel (see Table 2).

The present article reports a study of Russian real and nonce verb generation by L2 learners with different proficiency levels and different kinds of instruction in verb conjugation, and a second study comparing verb generation in highly proficient L2 learners and heritage speakers of Russian at the same proficiency levels. Both studies include a control group of native Russian adults. The choice to include a heritage group in the second experiment was driven both by theoretical and pedagogical considerations. If heritage speakers process inflectional morphology differently from late L2 learners, they may have special instructional needs. The following issues are addressed based on analyses of the two data sets:

3. Obviously, in the processing of real familiar verbs the speaker accesses a stored representation of the verb containing the information about the conjugational pattern.
Table 2. Type frequencies for the main conjugational patterns based on infinitive rhymes (Zalizniak, prefixed verbs included)

<table>
<thead>
<tr>
<th>Infinitive Rhyme/Conjugational pattern</th>
<th>“Vowel+j”</th>
<th>“Vowel+o”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class/subclass</td>
<td>Frequency/Class of bare stems</td>
<td>Number of bare stems</td>
</tr>
<tr>
<td>-at’</td>
<td>-aj-</td>
<td>11,814</td>
</tr>
<tr>
<td></td>
<td>-ova- (-uj-)</td>
<td>2,816</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-et’</td>
<td>-ej-</td>
<td>608</td>
</tr>
<tr>
<td></td>
<td>(ij)j-</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td>(uij)-</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-ot’</td>
<td>(oj)-</td>
<td>98</td>
</tr>
<tr>
<td>-yt’</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Total Frequency</td>
<td>15,540</td>
<td></td>
</tr>
</tbody>
</table>

- How is the Russian conjugational system represented in the minds of late L2 learners?
- Is L2 production of verbal morphology different from that of native speakers’?
- How does L2 verbal processing change with proficiency levels?
- Is L2 verbal processing different from heritage processing when L2 and heritage learners are at the same proficiency levels?
- What is the impact of intensive explicit instruction on verb conjugation?
- How is the one-stem verb system internalized by L2 learners who receive intensive instruction in it? What exactly is being internalized?
  - Rules that shape different conjugational patterns;
  - Cues in the verb which point to a certain pattern;
  - Probabilities of the particular pattern given the verb’s morphophonological make-up.

Experiment 1

**Russian real and nonce verb generation by low-proficiency L2 learners**

The first experiment compared oral non-past verb generation in L2 learners with varying amounts of explicit formal instruction in verb conjugation and exposure to natural Russian input shaping implicit processing mechanisms. Formal classroom instruction provides L2 learners with explicit rule explana-
tions, focused practice, but also limited input with reduced type and token frequencies. At the same time, uninstructed acquisition mainly through meaningful interactions with native speakers activates implicit learning, does not provide opportunities for focused practice in rule application, but exposes L2 learners to native input. The experiment uses low-proficiency L2 learners after one and two years of intensive instruction in the one-stem verb system, and more proficient L2 learners with several years of exposure to Russian, but with the more proficient L2 learners having little formal instruction in verb conjugation and no exposure to the rigorous one-stem verb system. It tests the hypothesis that the group with higher proficiency, which received high exposure but little formal instruction, will perform well on high-frequency regular verb classes, but not on low-frequency classes involving complex morphological rules; and the groups that received intensive instruction, but low levels of native input, will perform on rule-based patterns equally well and show a developmental tendency to increased accuracy with more instruction.

Experimental Material
The material for this study consisted of 80 Russian verbs, 60 test verbs belonging to four classes and 20 fillers belonging to five classes and subclasses (see Table 3). There were 50 real and 30 nonce verbs. The nonce verbs were created by manipulating the initial segments of the 30 high-frequency real Russian verbs. In each of the four classes, -aj-, -a-, -i-, and -ova-, there were five high-frequency real verbs, five low-frequency real verbs, and five nonce verbs. The fillers included real and nonce verbs belonging to the following classes and subclasses: -e-, -ej-, -avaj-, -(i)j- and -(o)j-. This research design was borrowed from earlier experiments (Gor and Chernigovskaya 2001, 2005).

Table 3. Average lemma frequency* in the testing material for Experiment 1

<table>
<thead>
<tr>
<th>Verb Class/Infinitive/Basic Stem/Gloss</th>
<th>High-Frequency</th>
<th>Low-Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>-aj- gul’ar’ (gul’-aj-) “walk”</td>
<td>173.2</td>
<td>10.8</td>
</tr>
<tr>
<td>-a- pisat’ (pis-a-) “write”</td>
<td>174.4</td>
<td>13.4</td>
</tr>
<tr>
<td>-i- nosit’ (nos-i-) “carry”</td>
<td>170.2</td>
<td>11.0</td>
</tr>
<tr>
<td>-ova- probovat’ (prob-ova-) “try”</td>
<td>149.8</td>
<td>11.0</td>
</tr>
</tbody>
</table>

*Frequencies reflect the number of occurrences per one million word uses (based on Zasorina).

Experimental Procedures
All of the verbs were generated by the participants using the same elicitation technique. The stimuli were presented to the participants in simple carrying sentences in the infinitive form. After the presentation of each stimulus a short

4. This elicitation technique is based on adaptations of the instrument developed by Bybee and Slobin used in the studies of child L1 acquisition of Norwegian, Icelandic, and Italian.
quasi-dialog occurred between the researcher and the participant. That exchange served to elicit the needed verb forms from the participants (1st person singular and 3rd person plural).

Example:

Researcher: *Ja xoču* (verb in the infinitive)________
Participant: *Ja xoču* (verb in the infinitive)________
Researcher: *A sejčas čto ty delaś?*
Participant: *Ja* (verb in the 1st person singular)________
Researcher: *A Maša i Petja?*
Participant: *Oni* (verb in the 3rd person plural)________

Each participant generated a total of 160 verb forms: 80 verbs in the first person singular, and 80 verbs in the third person plural in the non-past tense. In cases of self-correction, when the participant produced more than one answer for the same item, only the last response was considered. All the responses were audio-recorded, transcribed, and grouped according to class, frequency, and person. Accuracy rates (in percent) and correct stem rates were computed from the raw numbers. The percentages for correct stem rates were computed regardless of whether responses were target-like, whereas accuracy rates included only correct target-like forms.

Participants

The first group of participants consisted of adult L2 learners of Russian (N = 15; 7 males and 8 females). All the members of this group had completed one year of intensive Russian (6 hours of instruction per week) at the same large state university in the United States. With the exception of one bilingual person, all of the members of this group were native English speakers. This group of participants received intensive explicit instruction in the one-stem verb system with abundant practice in verb conjugation. This group was defined as high-instruction low-exposure group after one year of Russian study (HILE 1).

The second group consisted of adult L2 learners of Russian (N = 16; 5 males and 11 females). All of the members of this group had completed two years of intensive Russian at the same large state university in the United States (6 hours of instruction per week in the first year and 5 hours per week in the second year). All of the participants in this group received instruction according to the one-stem verb system. The introduction to this system began in the first year of classroom instruction and continued into the second year. With the exception of one bilingual individual, all the members of this group were native English speakers. The above-described experimental procedure was administered to this group of participants once, at the end of the spring semester, after they had received two full semesters of classroom instruction in first-year Russian and two semesters in second-year Russian. This group was defined as high-instruction low-exposure group after two years of Russian study (HILE 2).
The third group consisted of American adult learners of Russian (N = 15; 3 males and 12 females) with intermediate to advanced proficiency in Russian and an average of 5.5 years of Russian language use (including instruction, study abroad, use at the workplace, in the family with a spouse, etc.). The selection of participants for this group was based on two parameters: amount of exposure to the target language and amount of focused training in verb conjugation. The participants of this group did not receive their Russian language instruction at the same academic institution as the first two groups, and did not learn Russian verbal conjugation patterns according to the one-stem verb system. Overall, their exposure to classroom instruction in verb conjugation was low, and their Russian language proficiency was mostly due to implicit learning and immersion experiences, i.e., spending time in Russian-speaking countries, speaking Russian at work, with a spouse, friends, etc. Thus, their level of exposure to native or near-native Russian was high, but the amount of focused formal instruction in verb conjugation was low. This group was defined as low-instruction high-exposure (LIHE).

The fourth group consisted of adult native speakers of Russian (N = 15; 6 males and 9 females). Participants were selected based on their educational background (they had to hold a college degree), since literacy plays a major role in the development and maintenance of stable mental representations of morphological structures in language contact situations. All the participants were born in the territory of the former Soviet Union or Russia. There were no limitations set on the parameters of age and gender. This group was defined as native speakers (NS).

Results
By-subject Analysis of Variance
A by-subject Univariate Analysis of Variance (ANOVA) was conducted to assess correct stem and accuracy rates with group, verb class, and frequency as independent variables and correct total score as a dependent variable. The frequency variable compared high-frequency, low-frequency, and nonce verbs, the latter technically having a zero frequency. All of the statistical analyses were carried out using SPSS 15.0 with the level of significance set at 0.05.

For correct stem rates ANOVA indicated a significant difference among the four subject groups (F (3, 684) = 69.399, p < 0.01), four verb classes (F (3, 684) = 57.981, p < 0.01), and the three different frequencies (F (2, 684) = 5.399, p < 0.01). Tukey’s Post Hoc analyses make it possible to establish which groups in fact differ when more than two are involved in the main ANOVA analyses. For more information on ANOVA for SPSS the reader is referred to Levine’s Guide to SPSS for Analysis of Variance.
7.475, \( p < 0.01 \)). For accuracy rates ANOVA also indicated a significant difference among the four subject groups (\( F (3, 684) = 131.117, p < 0.01 \)), the four verb classes (\( F (3, 684) = 22.531, p < 0.01 \)), and the three different frequencies (\( F (2, 684) = 12.632, p < 0.01 \)).

**Within-group Analyses**
In addition to the analyses reported above, a separate ANOVA was conducted for all four groups individually in order to compare the correct stem and accuracy rates in response to the four classes within the groups. Analyses of correct stem rates in the HILE 1 group indicated a significant effect for the four verb classes (\( F (3, 168) = 12.760, p < 0.01 \)). In the HILE 2 group, ANOVA indicated a significant main effect for the four verb classes (\( F (3, 180) = 97.391, p < 0.01 \)) and the three frequencies (\( F (2, 180) = 8.051, p < 0.01 \)). In the LIHE group, a significant main effect was found for the four verb classes (\( F (3, 168) = 28.872, p < 0.01 \)). In the NS group, a significant main effect was observed for the three different frequencies (\( F (2, 168) = 24.729, p < 0.01 \)).

Analyses of accuracy rates in the HILE 1 group indicated a significant difference for the four verb classes (\( F (3, 168) = 19.052, p < 0.01 \)). In the HILE 2 group, a main effect was observed for the four verb classes (\( F (3, 180) = 81.193, p < 0.01 \)) and the three frequencies (\( F (2, 180) = 7.936, p < 0.01 \)). In the LIHE group, ANOVA demonstrated a significant main effect for the three frequencies (\( F (2, 168) = 3.321, p < 0.05 \)). In the NS group, a significant main effect was observed for the three frequencies (\( F (2, 168) = 33.332, p < 0.01 \)).

**Post hoc analyses: Stem rates**
Post Hoc Tukey comparisons conducted to assess the differences in correct stem rates in the four groups indicated that the HILE 2 group outperformed the HILE 1 group (Mean Difference = 2.1142, \( p < 0.01 \)) and the LIHE group, though the difference was not statistically significant (Mean Difference = 0.5865, \( p = 0.1 \)). The LIHE group outperformed the HILE 1 group (Mean Difference = 1.5278, \( p < 0.01 \)). The NS group outperformed the HILE 1 group (Mean Difference = 3.6944, \( p < 0.01 \)), the HILE 2 group (Mean Difference = 1.5802, \( p < 0.01 \)), and the LIHE group (Mean Difference = 2.1667, \( p < 0.01 \)).

Post Hoc Tukey comparisons conducted to assess the differences in correct stem rates for the four individual verb classes indicated that the participants performed better on the -i- class verbs than on the -aj- class (Mean Difference = 1.5355, \( p < 0.01 \)), the -a- class verbs (Mean Difference = 3.4098, \( p < 0.01 \)), and the -ova- class verbs (Mean Difference = 1.6612, \( p < 0.01 \)). Correct stem rates were higher for the -aj- class verbs than for the -a- class (Mean Difference = 1.8743, \( p < 0.01 \)). Correct stem rates were higher for the -ova-class verbs than for the -a- class (Mean Difference = 1.7486, \( p < 0.01 \)).
Post hoc Tukey comparisons conducted to assess the differences in correct stem rates for the two frequency ranges (high and low) and nonce verbs indicated that participants performed better on high-frequency verbs than on low-frequency verbs (Mean Difference = .7418, \( p < 0.01 \)), and nonce verbs (Mean Difference = .7500, \( p < 0.01 \)).

**Post hoc analyses: Accuracy rates**

Post hoc Tukey comparisons conducted for accuracy rates indicated that the HILE 2 group outperformed the HILE 1 (Mean Difference = 2.7097, \( p < 0.01 \)) and the LIHE group, though the latter difference was not statistically significant (Mean Difference = 0.6653, \( p = 0.075 \)). The LIHE group outperformed the HILE 1 group (Mean Difference = 2.0444, \( p < 0.01 \)). The NS group outperformed the HILE 1 group (Mean Difference = 2.7736, \( p < 0.01 \)), and the LIHE group (Mean Difference = 3.4389, \( p < 0.01 \)).

Post hoc Tukey comparisons conducted to assess the differences in accuracy rates of the four verb classes indicated that participants performed better on the -ova- class verbs than the -a- class verbs (Mean Difference = 2.1803, \( p < 0.01 \)) and the -i- class verbs (Mean Difference = .8033, \( p < 0.05 \)). Participants performed better on the -i- class than the -a- class (Mean Difference = 1.3770, \( p < 0.01 \)), and on the -aj- class than the -a- class (Mean Difference = 1.8415, \( p < 0.01 \)).

Post hoc Tukey comparisons conducted to assess the differences in accuracy rates for the two frequency ranges and nonce verbs indicated that participants performed better on high-frequency than low-frequency verbs (Mean Difference = .9836, \( p < 0.01 \)) and nonce verbs (Mean Difference = 1.0902, \( p = .00 \)). No significant difference was observed between the accuracy rates for low-frequency and nonce verbs (Mean Difference = 0.24026, \( p = 0.897 \)).

**By-item analyses of variance**

A by-item univariate analysis of variance (ANOVA) was conducted to assess the differences in correct stem and accuracy rates. Group, class, and frequency were considered within-item independent variables and the correct total score was taken as a dependent variable. For correct stem rates in the 1st person significant differences were found for group (F (3, 144) = 61.967, \( p < 0.01 \)) and the 3rd person (F (3, 144) = 56.857, \( p < 0.01 \)). Significant differences were also observed for frequency in the 1st person (F (2, 48) = 4.042, \( p < 0.05 \)), but not the 3rd person. For accuracy rates significant differences were found for group in the 1st person (F (3, 144) = 124.958, \( p < 0.01 \)) and the 3rd person (F (2, 1440 = 49.116, \( p < 0.01 \)). Significant differences were observed for frequency in the 1st person (F (2, 48) = 19.91, \( p < 0.01 \)) and the
By-class analyses of variance

A univariate analysis of variance (ANOVA) was conducted to assess the differences in correct stem rates for real and nonce verbs within each verb class. Subject group was designated as an independent variable with four factors (HILE 1, HILE 2, LIHE, and NS), and correct total score was taken as a dependent variable. All of the statistical analyses were carried out using SPSS 15.0 with the level of significance set at 0.05.

A statistically significant difference among the four groups in correct stem rates was found for real -aj- verbs (F (3, 52) = 11.216, p < 0.01). Post hoc Tukey comparisons revealed that the LIHE group outperformed the HILE 1 group (Mean Difference = 2.533, p < 0.01) and the HILE 2 group (Mean Difference = 2.700, p < 0.01). The NS group outperformed the HILE 1 (Mean Difference = 3.733, p < 0.01) and the HILE 2 group (Mean Difference = 3.900, p < 0.01). No statistically significant differences among the groups were found for the correct stem rates in the nonce -aj- verbs (F (3, 52) = 2.298, p = 0.088).

A statistically significant difference among the four groups was found for real -a- verbs (F (3, 52) = 15.108, p < 0.01). Post hoc Tukey comparisons revealed that the NS group outperformed the HILE 1 group (Mean Difference = 4.750, p < 0.01), the HILE 2 group (Mean Difference = 3.931, p < 0.01), and the LIHE group (Mean Difference = 4.150, p < 0.01). No statistically significant differences among the groups were found for correct stem rates in the -a- nonce verbs (F (3, 52) = 1.634, p = 0.193).

A statistically significant difference among the four groups was found for real -i- verbs (F (3, 52) = 11.243, p < 0.01). Post hoc Tukey comparisons revealed that the HILE 2 group outperformed the HILE 1 group (Mean Difference = 3.022, p < 0.01) and the LIHE group (Mean Difference = 0.866, p < 0.01). A significant difference among the four groups was found for nonce -i- verbs (F (3, 52) = 4.821, p < 0.05). Post hoc Tukey comparisons revealed that the HILE 2 group outperformed the HILE 1 group (Mean Difference = 0.787, p < 0.05) and the LIHE group (Mean Difference = 0.820, p < 0.05).

A statistically significant difference among the four groups was found for real -ova- verbs (F (3, 52) = 10.781, p < 0.01). Post hoc Tukey comparisons revealed that the HILE 2 group outperformed the HILE 1 group (Mean Difference = 5.045, p < 0.01) and the LIHE group (Mean Difference = 3.212, p < 0.05). The NS group outperformed the HILE 1 group (Mean Difference = 5.733, p < 0.01) and the LIHE group (Mean Difference = 3.900, p <
A significant difference among the four groups was found for nonce -ova- verbs ($F(3, 52) = 7.636, p < 0.01$). Post Hoc Tukey comparisons revealed that the HILE 2 group outperformed the HILE 1 group (Mean Difference = 2.352, $p < 0.01$) and the LIHE group (Mean Difference = 1.652, $p < 0.05$). The NS group outperformed the HILE 1 group (Mean Difference = 2.233, $p < 0.01$).

Comparison of response biases in the four groups

All of the above analyses were conducted on the rates of “correct” responses, in which the same class of verb was used as in the stimulus infinitive. However, responses to one verb class using a different verb class are indicative of the kinds of generalizations that underlie the processing of verbal morphology in different subject groups. Figures 1–4 represent two main response choices to each verb class, one intended (“correct”), and another most often used, and treats all other choices together in the category “Other.” Figure 1 compares the responses of the four groups to the -aj- verbs, both real and nonce. As can be seen, the HILE 1 and HILE 2 groups lag behind the NS group in using the -aj- pattern in response to the -aj- stems, with a considerable percentage of responses using the -a- pattern instead. The LIHE group is close to the NS group in its pattern of responses to the -aj- class.

Figure 2 represents the same information for the -a- class. It demonstrates that the rate of correct responses using the -a- class increases from first to second year (from HILE 1 to HILE 2), and is the highest in NS. The LIHE group is close to the HILE 1 but lags behind the HILE 2 on this stem.
The results for the -i- class represented in Figure 3 indicate that the HILE 2 group considerably outperforms the HILE 1 group and shows identification rates for the -i- class similar to native speakers. The LIHE group performs similarly to the HILE 1 group but lags behind the two other groups.

Finally, for the -ova- class a similar response pattern is observed (see Figure 4). The HILE 1 and the LIHE groups lag behind the HILE 2 and the NS groups on the use of -ova- verbs in response to the infinitives that belong to the -ova- class.

**Discussion**

The experiment compared real and nonce verb generation by late L2 learners of Russian after one and two years of intensive formal instruction and practice in verb conjugation using the one-stem verb system. These learners have low proficiency in Russian, and have been exposed to Russian language mostly in the classroom. Given that L2 input to these learners is limited to the instructional materials used in the classroom, it is possible to produce reasonably accurate estimates of the number of verbs in different classes these learners have been exposed to through input and classroom use. The number of verbs in the instructional materials used in the first and second years of instruction, Russian: Stage 1 (Davidson et al.) and Russian: Stage 2 (Martin and Zaitsev), was calculated and is represented in Figure 5. The estimates include all the verb classes and subclasses used as the main testing material and fillers.

Figure 5 shows that the distribution of different classes and subclasses is...
similar to that found in native use; however, the differences between high-frequency and low-frequency classes are much smaller in L2 input. Predictably, a comparison of class sizes in first-year and second-year input indicates that the main growth occurs in the two largest productive classes, -aj- and -i-. At the same time, while there is a considerable increase in accuracy for the -i-
class between first and second year, there is no significant gain for the -aj-class. Given that the choice of the -i-pattern is guided by the knowledge of the conjugational system, since it does not have any strong competitors, while the choice between the -aj- and -a-patterns for novel verbs with unrecoverable stems is guided almost entirely by the knowledge of probabilities, this result is to be expected. The most remarkable results are observed in the LIHE group of L2 learners with several years of exposure to Russian and more native input, but less formal instruction in verb conjugation and no knowledge of the one-stem verb system. Indeed, the LIHE group outperformed both beginning groups, HILE 1 and HILE 2, only on the high-frequency productive default -aj-pattern, which can be interpreted as a purely input-driven processing strategy.

In summary, the beginning late L2 learners of Russian show a robust developmental tendency with their accuracy in verb generation. This increases from their first to second year of study. They approximate native use on the main productive conjugational patterns -i- and -ova- where the stem is recoverable from the infinitive with high probability. However, they lag behind native speakers on the -aj- and -a- classes when the choice of the conjugational pattern is guided by the probabilistic system shaped by L2 input. Unlike the two high instruction low exposure groups, the LIHE group shows native levels of accuracy on the default -aj- class, but it lags behind the HILE 2 group.
on all the other classes. These results indicate that L2 input has an impact on the internalized conjugational system that L2 learners develop on two levels. Explicit L2 input in the form of instruction shapes rule-based processing, while implicit input in the form of input frequencies shapes the probabilistic mechanisms in the processing of verbal inflection. Additionally, verb frequency and the novelty factor play an important role in morphological processing. While one can be sure that NSs can access all real verbs in the mental lexicon, they still need to rely on their knowledge of the conjugational system. This includes the rules, probabilities, and morphological cues in processing nonce verbs. Beginning L2 learners are likely to treat low-frequency verbs as novel as well. The higher the proficiency level, the more verbs are stored in the L2 mental lexicon. One would think that the larger the mental lexicon, the more efficient L2 learners would become in morphological processing of novel verbs, but our data show that high exposure to input without explicit instruction leads to higher accuracy only in the use of high-frequency default conjugational pattern.

**Experiment 2**

**Real and nonce verb generation by highly proficient late L2 learners and heritage speakers of Russian**

Experiment 1 demonstrated that more proficient L2 learners with more exposure but less explicit instruction in verb conjugation outperformed beginning L2 learners with limited exposure but intensive explicit training in verb conjugation only on the high type frequency productive regular default -aji- pattern. This, however did not hold true on the low type frequency less regular -ova- and -i- patterns. Experiment 2 extends the predictions to two groups of highly proficient Russian speakers, and hypothesizes that early and more extensive exposure to native (implicit) input will create an advantage for heritage speakers over L2 learners, especially when processing real verbs. However, since heritage speakers often lack formal instruction in verb conjugation and do not receive sufficient native input as adults, there is a chance that they would show similarities with the low-instruction, high-exposure group of L2 learners who took part in Experiment 1. Thus, the goal of Experiment 2 was to explore the impact of structural and input-driven factors on highly proficient L2 morphological processing, and compare the morphological processing of familiar and novel verbs by ‘true’ late L2 learners and heritage speakers of Russian matched in proficiency, with an attempt to connect the differences in their performance with their language-learning experiences.

Experiment 2 tested the following hypotheses:

1. Accuracy rates in verb generation by highly proficient nonnative speakers of Russian will depend on morphological complexity, type frequency of the verb class, and the presence of morphological cues in the infini-
tives used as stimuli.

2. Highly proficient nonnative verbal processing will lag behind native processing in accuracy, especially on novel and low-frequency verbs involving complex allomorphy.

3. Heritage speakers will outperform L2 learners in accuracy in real verb, but not nonce verb, generation.

4. Late L2 learners and heritage speakers will show differences in the processing of different verb classes. More specifically, L2 learners will be more efficient at using complex conjugational rules and morphological cues, while heritage speakers will be better at relying on statistical probabilities.

While the regular high-frequency productive default -aj- pattern should not present any difficulties for nonnative speakers, the choice between the -aj- pattern and the low-frequency -a- pattern with complex allomorphy for -at’ rhymes is mainly guided by implicit knowledge of statistical probabilities, thus giving a possible advantage to heritage speakers. L2 learners are expected to outperform heritage speakers on the -ova- and -i- patterns with both high-frequency and productive classes, but which involve more complex rules. The processing of the -ova- and -i- patterns also depends on the efficient use of morphological cues present in the infinitive.

Participants
Seventy paid volunteers took part in the experiment: 36 adult American learners of Russian, 24 heritage speakers of Russian living in the U.S., and 10 adult native Russian controls. The age range of L2 learners was from 21 to 56 years (mean = 32.1); for heritage learners, 18–51 years (mean = 22.5); and for native speakers, 20–54 years (mean = 36.7). Among all participants, 31 were male and 39 were female. Nonnative participants were pre-tested using the ILR oral proficiency interview format, and the two nonnative groups were matched in proficiency level. Both groups ranged from 1 to 4 on the ILR scale, with most participants falling between ILR levels 2 to 3. This corresponds to advanced and superior oral proficiency. For statistical analyses, both the L2 and Heritage groups were divided into two subgroups, corresponding to high (ILR 2+ and above) and low (ILR 2 and below) oral proficiency. The mean age of English onset for heritage learners was 6.9 years (ranging between 0 and 14 years), while for L2 learners the average age of first exposure to Russian in the classroom was 18.4 years (ranging between 13 and 27 years). Thus, L2 learners started learning Russian at or after puberty, while heritage speakers had been exposed to Russian at home since birth. They had switched to English at various ages, and at the moment of testing English was.

7. The ILR (Interagency Language Roundtable) oral proficiency scale goes up to level 5, which corresponds to ‘highly articulate well-educated native speaker.’
their dominant language. None of them lived in a Russian-speaking environment after puberty, and while all could read Russian, they had little or no formal schooling in Russian. Thus, our two groups of nonnative speakers were matched in their oral proficiency in Russian; however, ‘true’ L2 learners were late starters, while heritage speakers were early starters, with Russian being their first language.

**Materials and method**

Experiment 2 was computer-based, with no live interaction between the researcher and the test-taker. No carrying sentences were used; subjects were presented with isolated verbs and were asked to generate two forms of each verb (see details below). Table 4 contains the information on the testing material. Experiment 2 used five verb classes, two frequency ranges, and two sets of verbs: real and nonce. There were five verbs in each class and frequency range, with a total of 100 stimuli. The lemma frequencies in this experiment were obtained from the Uppsala Corpus, an online Russian corpus with one million running words. The verbs not found in the corpus were assigned the frequency of less than one per million. The nonce verbs were created by manipulating the initial segment, usually the initial consonant or consonant cluster of the real verbs. The frequency ranges in Experiment 2 are lower than in Experiment 1, which corresponds to higher proficiency level, and presumably, a much larger mental lexicon, of participants in Experiment 2 than in Experiment 1.

The verbs were presented auditorily twice in infinitive forms through head-

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8. The Uppsala Corpus can be found at http://www.sfb441.uni-tuebingen.de/b1/en/korpora.html#uppsalakorpus.

9. The frequency ranges chosen for this experiment, while labeled as high and low, in fact represent the medium-low and very low frequency ranges. Thus, the frequency range labeled as “high” in Experiment 2 corresponds to the “low” frequency range in Experiment 1 (see Table 3). Any such labeling is arbitrary, and it is only used here to differentiate the frequency ranges within each experiment.
sets and subjects were asked to generate first the 1st person singular and then the 2nd person singular non-past tense. The responses were digitally recorded and then transcribed and coded. Two parameters of the responses were computed and statistically analyzed: accuracy rates corresponding to the percentage of correct responses for each verb class, and correct stem rates. The latter category treated a response as ‘correct’ every time the same stem was used in the response as in the stimulus infinitive, even when some aspects of the generated verb were non-target, i.e., the expected consonant mutation was missing. These two measures were used in Experiment 1 as well.

**Results**

A four-way by-subject ANOVA (group x stimulus type (real or nonce verb) x verb class x frequency) was performed first on the accuracy data for all the three groups of subjects. The analysis revealed significant main effects for group (\(F(2, 65) = 5.43, p < 0.01\)), stimulus type (\(F(1, 65) = 92.80, p < 0.0001\)), verb class (\(F(4, 260) = 19.54, p < 0.0001\)), and frequency (\(F(1, 65) = 54.80, p < 0.0001\)). There were also significant interactions between group and verb class (\(F(8, 260) = 9.63, p < 0.0001\)), group and stimulus type (\(F(2, 65) = 6.13, p < 0.01\)) and verb class and frequency (\(F(4, 260) = 5.47, p < 0.001\)). In three-way interactions, only the group by verb class by frequency interaction (\(F(4, 260) = 4.22, p < 0.0001\)) and stimulus type by verb class by frequency interaction (\(F(4, 260) = 4.08, p < 0.01\)) were significant. These results primarily indicate that all four factors contributed to accuracy in the generation of the target form. As confirmed by a significant three-way effect in the group by verb class by frequency interaction, the three groups treated various verb classes differently.

The same analyses were conducted with two nonnative groups—L2 and Heritage. The two-group ANOVA also yielded significant stimulus type (\(F(1, 54) = 100.65, p < 0.0001\)), verb class (\(F(4, 216) = 35.36, p < 0.0001\)), and frequency effects (\(F(1, 54) = 106.61, p < 0.0001\)). The group effect did not reach significance (\(F(1, 54) = 0.07, p = 0.7991\)). These results indicate that the group effect in the three-group ANOVA can be primarily attributed to differences between the native control group, on the one hand, and nonnative speakers, on the other hand. Although the L2 and Heritage groups did not reveal significant differences in the main effect, the two-way interactions between group and verb class (\(F(4, 216) = 12.80, p < 0.0001\)) and between group and stimulus type (\(F(1, 54) = 12.20, p < 0.001\)) reflect significant differences in the production of inflected verbs by these two groups for individual verb classes and real and nonce verb types. The analysis of cell means revealed that the Heritage group consistently outperformed the L2 group on real verbs, but not on nonce verbs.

Tukey’s test of paired comparisons revealed that heritage learners outperformed L2 learners on the -aj-, -a-, and -e- classes across different stimulus
types and frequency levels. However, L2 learners performed significantly better on the \textit{-ova-} and low-frequency nonce \textit{-i-} verbs than their heritage counterparts. This finding indicates that L2 learners took better advantage of the morphological cues, with the salient \textit{-ova-} and \textit{-i-} suffixes present in the infinitive stimuli. Heritage learners, on the other hand, relied more strongly on statistical probabilities, and were better at the use of the default pattern. The correct stem ANOVA results followed closely those of the accuracy ANOVAs. The Tukey’s post hoc analyses for individual verb classes and two learner groups (type x verb class x frequency) revealed that L2 learners treated all the high-frequency productive classes, \textit{-ova-}, \textit{-i-}, and \textit{-aj-}, equally and showed the highest correct stem rates for them. The \textit{-e-} class had lower correct stem rates, and the \textit{-a-} class, which in addition to all the conjugational features similar to the \textit{-e-} class, also competed with the strong productive \textit{-aj-} class, which was the lowest of all. The Heritage group performed best on the high-frequency regular default \textit{-aj-} class, with the \textit{-a-} class showing the lowest correct stem rates. The \textit{-ova-}, \textit{-i-}, and \textit{-e-} classes involving complex allomorphy and salient morphological cues showed comparable rates. These results are in line with our predictions that late L2 learners will be better at the use of complex morphological rules and morphological cues, while heritage speakers will be better at the use of the default pattern.

**Discussion**

Verb class, frequency, and stimulus type (real or nonce verb infinitive) were significant factors in verb generation in both the three-group and the two-group analyses. Thus, high-frequency real verbs were predictably produced with higher accuracy rates than low-frequency verbs, and nonce verbs were more difficult than real verbs. All the groups showed the highest accuracy and correct stem rates on the high-frequency regular productive default \textit{-aj-} pattern, and the lowest ones on the low-frequency unproductive \textit{-a-} pattern with complex allomorphy. The \textit{-a-} pattern was also competing with the \textit{-aj-} pattern in nonce verbs ending in \textit{-at’} with unrecoverable conjugational patterns.

While the general tendencies in responses were similar across the three groups, both L2 and Heritage groups lagged behind the Native group in their correct stem and accuracy rates in real and nonce verb generation. At the same time, there were significant differences between the results obtained for the two nonnative groups that can be potentially linked to the differences in their learning experiences, as early and late starters, and therefore to important differences in the amount of native implicit input and explicit training in verb conjugation they had received. Heritage speakers steadily outperformed L2 learners in accuracy on the \textit{-aj-} and \textit{-a-} classes, which for novel verbs involves implicit knowledge of probabilities that develops under the influence of native input. At the same time, L2 learners were better on the \textit{-ova-} and \textit{-i-} classes involving the use of complex conjugational rules and morphologi-
cal cues. Additionally, L2 learners treated all the regular productive classes similarly, while Heritage speakers were significantly better only on the default -aj- class. Overall, Heritage speakers’ accuracy rates were consistently higher than L2 learners’ rates only on real verbs. Therefore, one can conclude that both nonnative groups demonstrated the role of morphological complexity and morphological cues as structural aspects of verbal inflection, and of type and token (lemma) frequency in verb generation. The differences between L2 and Heritage processing indicate a greater role of input-based processing in heritage speakers and a greater role of cue-based processing in L2 learners.

Conclusion
The two experiments reported above on Russian real and nonce verb generation by late L2 learners and heritage speakers, with control groups of native Russian speakers, have confirmed several predictions based on previous research. Thus, both L1 and L2 speakers made use of conjugational rules, morphological cues, and probabilities based on type frequencies, or verb class sizes. In novel verb processing, all the subjects relied on morphological cues to recover the stem, and in cases where the stem was unrecoverable, applied the conjugational rules with probabilities. Their probabilistic systems were shaped by the amount and type of input they had received. Therefore, the data on L2 and heritage novel verb generation support the Rules and Probabilities Model (Gor, 2003, 2004). Morphological complexity, or degree of regularity, and input frequencies were the leading factors in the choice of a conjugational pattern based on incomplete information contained in the infinitive stimuli. Part of this information used to recover the stem was contained in the rhyme vowel of the infinitive, which is probabilistically associated with one of the main conjugational patterns in Russian, the “Vowel + j” or “Vowel + ø” pattern, plus additional patterns involving such rare features as suffix alternation, as in the -ova- class, or vowel alternation, as in the -o(j)- subclass. Thus, the psycholinguistic adaptation of the one-stem verb system used in novel verb generation appears to combine basic stems and probabilities, and also infinitive rhymes.

This study documented the developmental tendency in beginning formal L2 learners who received intensive instruction in the one-stem verb system. Explicit rule explanations and practice benefit late L2 learners and help them overcome the lack of abundant native input. Conversely, late L2 learners with extensive exposure to native input, but no structured formal instruction in verb conjugation, lagged behind formal learners, with lower proficiency on all the rule-based patterns except the high-frequency regular default -aj- pattern. A comparison of highly proficient L2 and heritage verb generation revealed a similar tendency for L2 learners who had received formal instruction to have control of all the rule-based patterns and make efficient use of the
morphological cues. At the same time, heritage speakers matched with L2 learners in proficiency systematically outperformed L2 learners on the high-frequency default -aj- pattern. In addition, heritage speakers showed higher accuracy scores on real, but not nonce verbs, and thus showed a greater dependence on stored representations. L2 learners were able to use the internalized system of rules in novel verb processing. The results of the experiments have three implications for Russian language pedagogy, and more specifically, instruction in verb conjugation. First, they reveal the efficiency of explicit instruction in verb conjugation using the one-stem verb system at the beginning level. Second, they demonstrate the role of probabilistic mechanisms that are shaped by abundant implicit input and therefore promote increasing L2 input, which is the source of implicitly acquired linguistic frequencies. And third, they make obvious the need for specialized structured input to heritage speakers who develop efficient input-based strategies, but lack structural knowledge of the verbal system.

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Кира Гор и Татьяна Вдовина
Роль регулярности, частоты и свойств речи «на входе» при усвоении русской глагольной морфологии

В статье обсуждаются ряд факторов, которые оказывают влияние на усвоение русской глагольной морфологии взрослыми студентами—американцами, по результатам двух экспериментов на устное производство глагольных словоформ.

Испытуемые спрягали реальные и гипотетические глаголы различной частоты, принадлежащие к нескольким различающимся по сложности и размеру классам. Глагольные классы устанавливались в соответствии с одноосновной системой. В первом эксперименте сравнивались группы учащихся с низким владением русским языком и разной степенью опыта общения на русском языке и количеством аудиторных занятий. Во втором эксперименте участвовали группы изучающих русский язык как иностранный и как семейный язык в нерусскоговорящей среде на продвинутом этапе. На основании полученных данных делаются три вывода, связанные с преподаванием русского спряжения.
Во—первых, подтверждается эффективность эксплицитной формы преподавания спряжения начинающим. Во—вторых, подчеркивается роль вероятностных механизмов, а следовательно, формирования имплицитных представлений о лингвистических частотах под действием общения с носителями языка и использования оригинальных текстов. И в—третьих, устанавливается необходимость обучения структуре русского спряжения изучающими русский язык как семейный в неруссоговорящей среде.